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February 2025

TECHNICAL NOTE ON STRESS TESTING AND SYSTEMIC RISK ANALYSIS

This Technical Note on Stress Testing and Systemic Risk Analysis for the Indonesia FSAP was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on February 5, 2025.

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TECHNICAL NOTE

STRESS TESTING AND SYSTEMIC RISK ANALYSIS

Prepared By

Monetary and Capital Markets Department

This Methodology Note is prepared by IMF staff in the context of the Financial Sector Assessment Program in Indonesia. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Further information on the FSAP can be found at http://www.imf.org/external/np/fsap/fssa.aspx

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AC	Amortized Cost
ASF	Available Stable Funding
AT1	Additional Tier 1
BI	The Central Bank
BIS	Bank for International Settlements
CAR	Capital Adequacy Ratio
CBC	Counterbalancing Capacity
CCyB	Countercyclical Capital Buffer
CET1	Core Equity Tier 1
COVID	Coronavirus Disease
D-SIBs	Domestic Systemically Important Banks
DSTI	Debt-Service-to-Income
ELA	Emergency Liquidity Assistance
EM	Emerging Market
FSAP	Financial Sector Assessment Program
FSI	Financial Soundness Indicator
FVOCI	Fair Value through Other Comprehensive Income
FVPL	Fair Value through Profit and Loss
FX	Foreign Exchange
GDP	Gross Domestic Product
GFSR	Global Financial Stability Report
HQLA	High Quality Liquid Assets
IFRS	International Financial Reporting Standard
IMF	International Monetary Fund
LCR	Liquidity Coverage Ratio
LTV	Loan-to-Value
MCM	Monetary and Capital Markets Department, IMF
MSMEs	Micro, Small and Medium Sized Enterprises
MoF	Ministry of Finance
NBFI	Non-Bank Financial Institutions
NFC	Non-Financial Corporations
NIM	Net Interest Margin
NPL	Non-performing Loans
NSFR	Net Stable Funding Ratio
OJK	Otoritas Jasa Keuangan, (the Financial Services Authority)
OCI	Other Comprehensive Income
P2G	Person to Government
P2P	Person to Person
PD	Probability of Default
PiT	Point-in-Time

PL	Performing Loans
RAM	Risk Assessment Matrix
RKP	Rasio Premi Terhadap Klaim (Claims to Premiums Ratio)
RoA	Return on Assets
RoE	Return on Equity
RSF	Required Stable Funding
RWA	Risk Weighted Asset
RWD	Risk Weighted Density
SME	Small and Medium Size Enterprise
SOB	State-owned Banks
STeM	Stress Test Matrix
ST	Stress Test
TD	Top-down
WB	World Bank
WEO	World Economic Outlook

EXECUTIVE SUMMARY[1]

The FSAP team undertook a thorough top-down corporate and bank solvency, bank liquidity stress tests as well as analysis of interconnectedness using mid-2023 data. This note covers the methodology and results of the scenario-based solvency test, the single factor sensitivity analysis, the liquidity test, and interconnectedness analysis. The stress test exercise was carried out on a sample of 105 commercial banks. The analysis is heavily dependent on supervisory data on individual banks' positions shared by the OJK and BI as well as publicly available information on corporate sector. While FSAP results are not directly comparable to the authorities' own stress testing results due to differences in scenarios, methodologies, and objectives, they provide an assessment of the system-wide resilience of the Indonesian banking sector at the current juncture.

The financial system is relatively small and dominated by banks with high capital and liquidity buffers. The financial sector is relatively small with total financial assets of 73 percent of GDP and dominated by banks which accounts for 76 percent of financial sector assets. Large banks typically operate as financial conglomerates, with their assets having increased by about 8 percent since 2021 to June 2023, reaching to 58 percent of total financial sector assets. Capital buffers and liquidity coverage ratios remain well above the regulatory minima, and banks are highly profitable although notable variation exists across banks. State-owned banks play an important role in the banking system, while non-bank financial institutions (NBFIs) remain relatively small with assets making up to a quarter of the overall financial sector. FinTech companies continue to represent a small portion of the financial system but have experienced significant growth.

Notwithstanding this generally positive macrofinancial environment, the financial system is exposed to multiple structural and cyclical risks. Cyclical risks, considering robust credit growth, are moderate, but credit risk is higher in pandemic-hit industries and highly leveraged corporations. A challenging external environment has also heightened downside risks, such as intensified geopolitical and fragmentation risks, slowdown in key trading markets, tightened global financial conditions, volatility in energy and commodity markets and supply chain disruptions. These risks, along with the loan forbearance measures currently implemented by banks - could mask vulnerabilities related to delays in credit loss recognition, which can have an impact on non-performing loans (NPLs). Small banks have lower profitability with higher funding and operational costs. Similar to other emerging economies, structural risks to the financial system arise from an increase in banks' holdings of government bonds and concentrated loans to State Owned Enterprises (SOEs), which led to increased "sovereign-bank nexus". Offshore FX debt securities issuance by large publicly traded companies may also be subject to refinancing risks. Indonesia also

[1] This Technical Note has been prepared by Xiaodan Ding (lead), Ashique Habib, Brandon Tan, and Lu Zhang (all IMF) under the guidance of Ranjit Singh (mission chief) and Mindaugas Leika (deputy mission chief). Zoltan Matyas Jakab, Ruy Lama, and Hou Wang provided modeling support for stress testing scenarios. The team is grateful to BI and OJK for their excellent collaboration in this exercise.

faces a steep energy transition, exposing its financial sector to transition risks, and it is vulnerable to a range of climate-related natural disasters, the frequency and severity of which are likely to be impacted by climate change.

While corporate vulnerabilities have declined since the pandemic, the potential for significant deterioration remains under stress scenarios. Post-COVID-19 recovery has been uneven across sectors, and smaller firms have higher shares of debt at risk than larger ones. A corporate stress test focusing on the solvency health of the firms and their resilience against large macroeconomic shocks point to significant deterioration in debt servicing capacity under the recession and stagflation downside scenarios, with debt-at-risk rising by 10 and 14 percentage points respectively. With cash buffers for at-risk firms already at low levels in 2022, such a shock could impair corporates' capacity to service their debt.

The results of the bank solvency stress test suggest that the banking sector is resilient to multiple macroeconomic shocks, although there are tail risks for small banks. Under a baseline scenario, systemwide Core Equity Tier 1 (CET1) ratios remain above 22 percent over a five-year horizon. Under an adverse stagflation scenario, the systemwide CET1 ratio declines by about five percentage points, with capital losses mostly driven by credit risk, followed by market and interest rate risks. Banks with CET1 falling below the regulatory minimum in the stress test tend to have lower initial capital ratios, lower net interest margins, higher cost-to-income ratios, and higher NPL ratios. While results confirm the strength of capital position of the banking system, authorities need to further address credit risks stemming from legacy loans to COVID-sensitive sectors as well as micro, small and medium enterprises (MSMEs). Better loan quality data as well as requirement for banks to recognize NPLs on a timely and full basis would help strengthen the credit quality assessment.

The overall liquidity position of banks is sound, but foreign exchange (FX) liquidity risks need to be closely monitored, and Liquidity Coverage Ratios (LCR) should be made mandatory for all banks. While all banks have enough liquidity to cover severe outflows, the liquidity stress test identifies several bank-specific risks. First, a few small and medium sized banks with higher reliance on wholesale and uninsured funding face challenges in meeting severe liquidity outflows over a 3-month horizon. Second, the results signal FX liquidity shortfalls, albeit manageable at 0.7 percent of total assets. Third, there are funding concentration risks in smaller regional banks, driven by large interbank deposits and large funding from other banks or public entities. Finally, an exercise focusing on the liquidity-solvency interaction finds that a non-negligible share of banks would need to sell or repo bonds to meet severe liquidity drawdowns, but overall capital impact is small.

The systemwide liquidity analysis suggests that the liquidity impact stemming from the NBFI sector is limited and that banks have enough FX liquid assets to cover severe FX outflows from corporate FX deposits, with a few important caveats. A systemwide liquidity analysis was performed on total currency level to assess jointly banks and NBFIs' resilience against large liquidity shocks. Results suggest that the banking system remains resilient with commercial banks backstopping liquidity needs of all sectors. However, data constraints limit the scope of the analysis to the sector level and total currency exposure which may mask important variation and

vulnerabilities at the entity level and in separate currencies. To complement the analysis, a combined corporate and bank FX liquidity stress test focusing on the 15 largest firms found that banks have adequate FX liquid assets to cover severe FX outflows from large corporate FX deposits. To mitigate liquidity risks, authorities should remove LCR exceptions to small banks as well as integrate corporate and banks' FX liquidity analysis to monitor FX risks.

The interconnectedness analysis points to limited interbank exposure, although cross-border analysis is hindered by data availability. Results of domestic interbank analysis indicate that SOBs are the least vulnerable, while regional development banks face higher vulnerabilities due to higher interbank deposits into and funding from other banks. Large banks (mostly SOBs) exhibit the highest contagion levels among all types of banks while small banks typically are less contagious yet highly vulnerable. Although constrained by data availability, the cross-border analysis focuses on authorities' supervisory data on Indonesia banks' cross-border exposure and reveals a strong interconnection between the Indonesian banking sector and the global banking system, particularly with Asian countries, such as Singapore, China, Japan, Hongkong, as well as the United States.

Table 1. Indonesia: 2023 FSAP: Key Recommendations

Recommendations	Authorities	Timeline[1]
Systemic Risk Analysis		
Implement LCR and NSFR across all banks. Monitoring LCR for significant foreign currencies. Enhance data collection and stress testing for small banks. (¶69)	BI, OJK	ST
Require banks to recognize NPLs in a timely and full basis; increase intensity in scrutiny of restructured loans and use multiple benchmarks to capture problem loans properly and promptly in top-down stress tests; fully implement IFRS9 consistent forward-looking provisioning and stress testing methodology. (¶45)	BI, OJK	MT
Collect additional data on large corporates and MSMEs by sectors, regularly conduct top-down concentration analysis while allowing distinction between SOEs vs non-SOEs in the risk assessment and perform regular corporate stress test. (¶45)	BI, OJK	MT
For liquidity monitoring purposes, apply an array of unified liquidity stress scenarios with different levels of severity and time horizons across all banks to identify evolving liquidity risk across banks and in the system. (¶69)	BI, OJK	ST
Consider implementing contagion analysis for interbank spillover risk assessment. (¶83)	BI, OJK	ST
Collect more data on 1) NBFI balance sheet, and solvency and liquidity conditions at institutional and sectoral level to improve risk monitoring. 2) Bank-NBFI linkages at sectoral and institutional level to facilitate systemwide risk analysis. (¶109)	BI, OJK	MT
Integrate FX liquidity analysis of non-financial firms and banks to strengthen FX liquidity risk analysis and inform relevant micro and macroprudential instruments. (¶116)	BI, OJK	ST
Monitor largest FX deposit concentration, which may be used to calibrate FX outflow rates. (¶116)	BI, OJK	ST
Monitor systemwide FX HQLA concentration, and in case of excessive exposures, limit FX HQLA by removing assets potentially subject to ringfencing by foreign jurisdictions. If capacity is reducing, consider further increasing FX RR and/or limiting FX net outflows in FX LCR. (¶116)	BI, OJK	MT
Enhance data collection on financial conglomerates, particularly on banks and NBFIs and including not only asset size at aggregate level but also sub-entities and their interconnections (e.g., ownership structure and bilateral balance sheet exposure), to facilitate the identification of any large and opaque intra-group relationship. (¶116)	BI, OJK	ST

[1] I = Immediate (within one year); ST = Short Term (within 1–3 years); MT = Medium Term (within 3–5 years).

INTRODUCTION

1. The FSAP took place against a backdrop of robust economic growth and strengthened financial sector. The financial system has weathered the global pandemic on the back of strong fundamentals as well as the targeted forbearance measures supporting COVID-sensitive and structurally weak sectors. Economic growth has been robust at around 5 percent since the pandemic with contained inflation within BI's target band and ample fiscal space.

2. The financial system is relatively small (72 percent of GDP) and dominated by banks (76 percent of total financial system assets, Figure 1). The size of the financial system reflects low financial inclusion, informality, and high cost of provision of services in rural areas. While the number of banks is high at around 1515, most of them are small rural banks (around 1410 banks[2]). There are 105 commercial banks, which are typically classified based on size and business models (Figure 1 bottom table). The top 10 banks, including four state-owned banks that constitute 42 percent of the banking sector, hold 66 percent of total bank assets. The business model of banks is traditional banking, engaging in deposit taking and lending activities and interest income is the main source of profit. Non-bank financial institutions remain relatively small with total assets of up to 24 percent of the overall financial sector. The four subsectors with the largest number of assets include insurance companies, finance companies, investment funds, and pension funds. Life insurance companies dominate insurance sector with gross premium income making up 62 percent of that of the industry. The finance companies rely on loans from banks and issuance of long-term bond in capital market to finance relatively short-term credit, mainly in motor vehicles. Investment funds only account for 4 percent of system assets and are dominated by protected and fixed income mutual funds, equity mutual funds, and money market mutual funds. They mainly invest in money market and capital market in government bonds and stocks. FinTech lending companies continue to represent a small portion of the financial system but exhibit significant growth (assets rising by 51 percent in 2022). Large non-financial companies tend to borrow internationally.

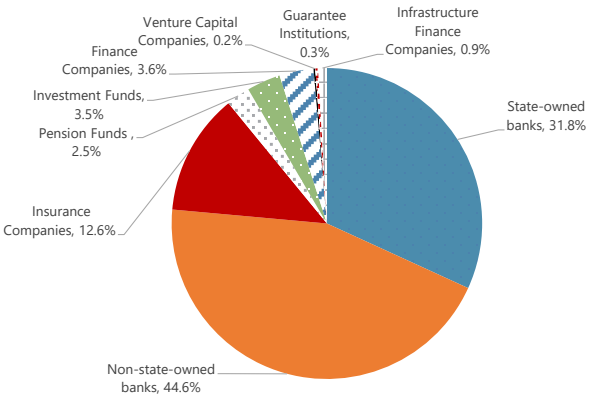
3. Financial conglomerates, mainly comprised of large banks, remain a major segment in the financial system. A change in the definition of financial conglomerates in 2020[3] reduced the number of financial conglomerates from about 49 entities to 15 entities in 2023. Nevertheless, the total asset of this segment has increased since 2021 by about 8 percent, in line with the growth of the financial industry, and remains high at 58 percent of the total financial sector assets as of June 2023.

[2] For conventional rural banks only. The number of sharia rural banks is 171 banks as of June 2023.

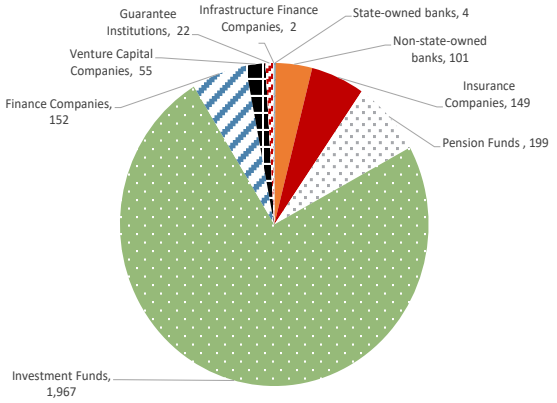
[3] A financial conglomerate is defined as a financial institution that has a main entity, and subsidiary companies, and/or related companies and their subsidiary companies. In 2020, a new criterion was introduced to further refine the scope of financial conglomerates to those that have assets greater than or equal to 100 trillion IDR and engage in more than one type of financial services, ranging from banks, capital markets, insurance, pension funds, financing institutions and other financial service institutions. This has resulted in a decline in the number of financial conglomerates from about 49 to 15 entities.

Figure 1. Indonesia: Financial Sector Structure

Financial Sector—Assets



Financial Sector—Number of Institutions



Banking Sector Characteristics					
Bank Group 1	Number of banks	Total Assets (Trillion IDR)	Bank Group 2	Number of banks	Total Assets (Trillion IDR)
KBMI1	68	1,363	State-owned banks	4	4,601
KBMI2	20	1,443	Regional development banks	27	936
KBMI3	13	2,719	Private banks	67	4,996
KBMI4	4	5,527	Foreign branches	7	519
Total	105	11,052	Total	105	11,052

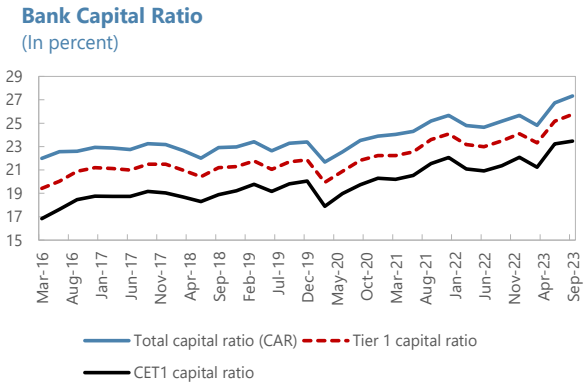
Source: BI, OJK and IMF staff estimates.
Note: Statistics above excludes conventional rural banks, which currently stand at around 1410 banks and around 1.7 percent of total banking sector assets. There are also additional 171 sharia rural banks as of June 2023. The rural banks carry a higher NPL ratio at around 10 percent relative to that of the commercial banks at around 2 percent. KBMI1 denotes banks with a core capital of up to IDR 6 trillion; KBMI2 denotes banks with a core capital of between IDR 6 trillion to IDR 14 trillion; KBMI3 denotes banks with a core capital of between IDR 14 trillion to IDR 70 trillion and KBMI4 denotes banks with a core capital of more than IDR 70 trillion. Out of four banks in KBMI4, three are state-owned banks and one is a large private bank. Banks can also be classified based on ownership, into state-owned banks, regional development banks, private banks, and foreign branches. The bank classification does not separate Islamic banks from non-Islamic banks, given that the business model of Islamic banks in Indonesia is akin to that of the traditional banks and their asset size relative to the overall banking system is limited at about 7 percent.

4. The banking sector capital buffers are high, asset quality ratios have not deteriorated due to forbearance measures and potential delay in NPL recognition, yet small banks[4] are more vulnerable (Figure 2). The significantly strengthened and stringent regulatory and

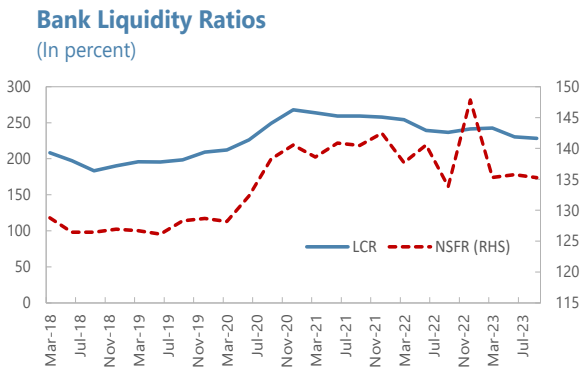
[4] Small banks are defined as those classified under the KBMI1 and KBMI2 groups. Large banks are defined as those classified under the KBMI3 and KBMI4 groups.

Figure 2. Indonesia: Banking Sector Characteristics

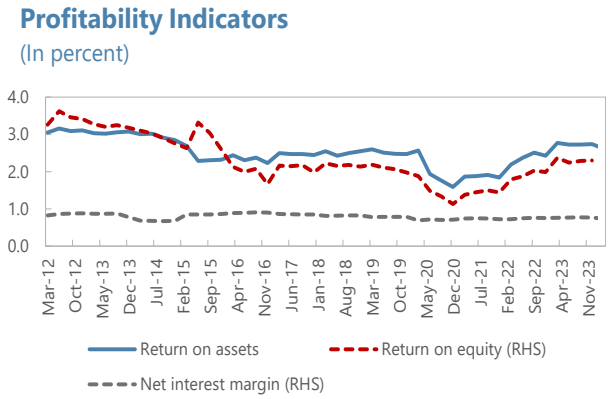
Capitalization ratios appear to be high…



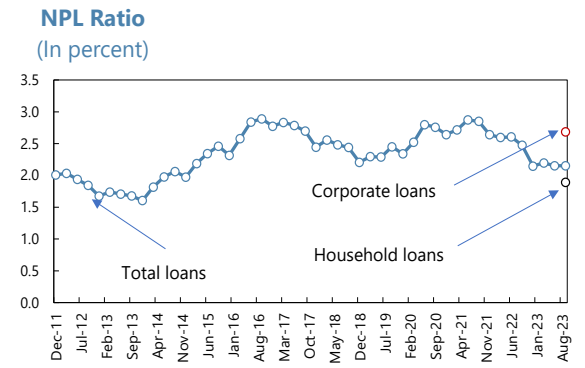
…so do liquidity indicators.



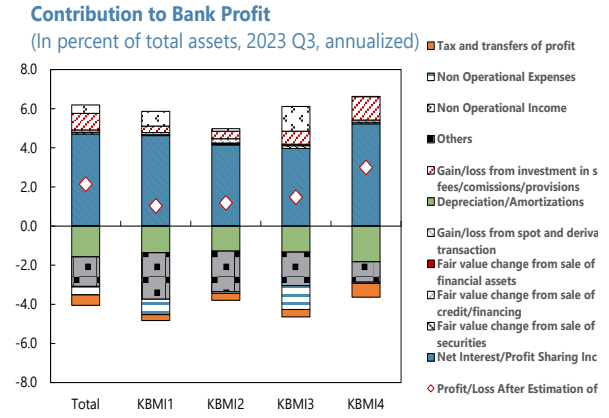
Profitability returned to pre-pandemic levels and interest margins remained stable with a slight decline in 2024 due to a pickup in deposit rates…



…and overall NPL ratio has improved since the pandemic and remains close to the historic average.



Small banks tend to be less profitable…



…yet SOBs carry a higher NPL ratio at a level similar to private banks…

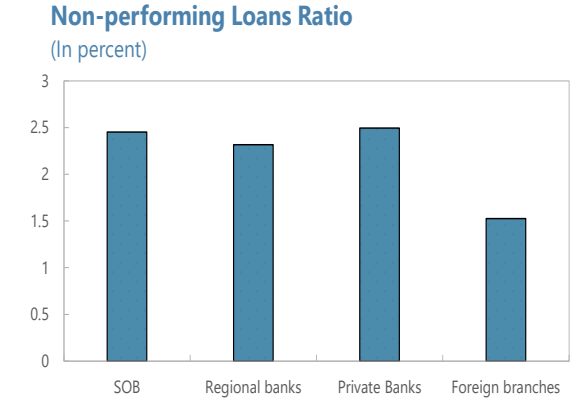
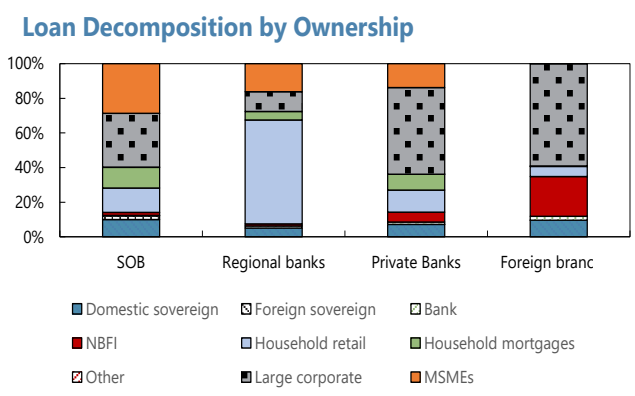
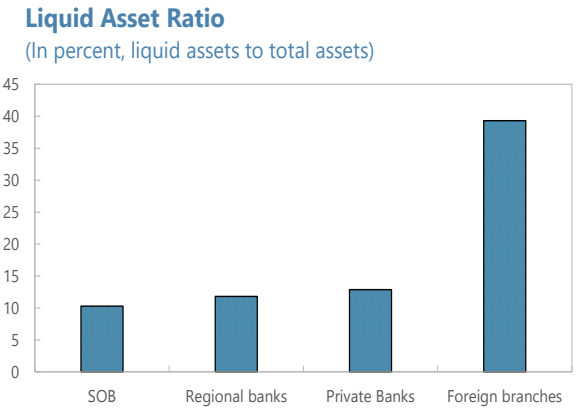


Figure 2. Indonesia: Banking Sector Characteristics (concluded)

…due to large credit exposure to corporates, including MSMEs.



The higher credit exposure also leads to a less liquid asset profile of the SOBs.



Source: BI, OJK and IMF staff estimates.

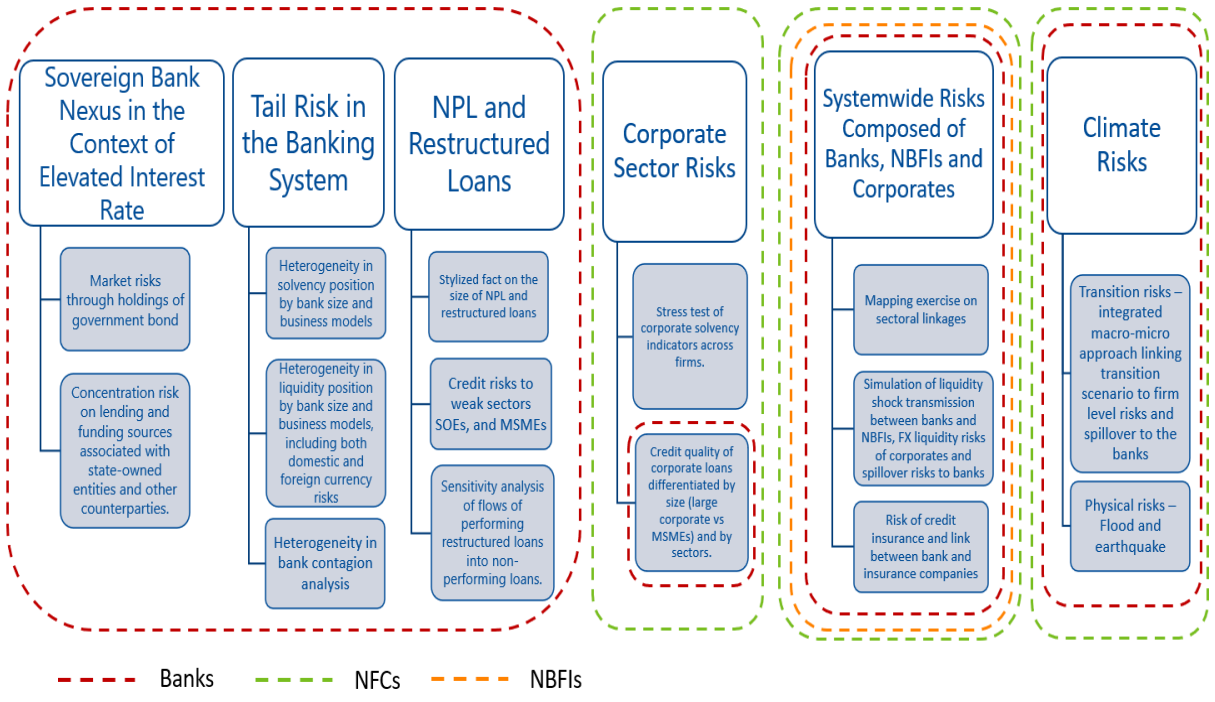
supervisory framework post-GFC, has led to Indonesian banks having built up strong capital buffers and weathered the pandemic shock, with CET1 ratios at 23 percent, well above regulatory minima. Liquidity ratios also saw a rise with LCR increasing from 151 to 210 percent since 2020, driven by higher deposit inflows supported primarily by COVID-related policies, and subsequently declined as economic activity rebounded in 2022. Profitability remains robust reflecting high interest margins, high fees and commissions, and low cost-to-asset ratio. Overall ROA and NIM stands at 2.7 and 4.8 percent, well above its regional peers (Appendix V).[5] Although headline Non-Performing Loan (NPL) ratios appear low at about 2 percent, there could be delays in NPL recognition due to forbearance measures. RWAs density has declined since 2017 and is now aligned with regional peers at around 62 percent.[6] The credit to-GDP ratio reached 31.4 percent by the end of 2023, yet it is still well below peer countries in the region. FX net open position of the banks has been small at around 1.5 percent of total capital. Nevertheless, these headline figures may mask important heterogeneity across banks and banking groups. Small banks are structurally less profitable due to high funding costs and operating expenses, especially banks classified under KBMI1 and KBMI2 as well as local rural banks, and therefore require higher capital buffers. Although SOBs are more profitable, they also carry a higher NPL ratio - at a level similar to the private banks—than other banking groups, due to their large credit exposure to corporate lending, including to MSMEs. Finally, the reduced foreign ownership of sovereign bonds has increased the domestic sovereign-bank nexus.

[5] In early 2024, there has been a moderate deterioration of banks' return on assets and net interest margin due to a higher pick-up of deposit rates than lending rates, which warrants close monitoring amid a higher-for-longer interest environment.

[6] RWA declined in 2023 relative to 2022 due to a downward adjustment of the Operational Risk RWA under the Basel III implementation. As a result, total RWA has declined while banks' capital ratios increased.

5. Notwithstanding the generally positive developments, the banking sector and the financial system could still be exposed to several structural and cyclical vulnerabilities. Figure 3 highlights the main themes related to specific vulnerabilities in the financial sector. Specifically:

Figure 3. Indonesia: Main Themes of the Systemic Risk Analysis



Source: IMF staff.
Note: Climate risk analysis is covered in a separate technical note.

Banking Sector

- **Tail risks across banks vary with size and business models.** Notwithstanding solid fundamentals on aggregate, there are notable variations of capital and profitability across banks depending on their size and business model. This is reflected in wider distribution with fatter tails in various capital, NPL and profitability indicators for these groups (Figure 4). Such heterogeneity also reflects the fact that large banks—especially state-owned banks—act as safe havens and thus attract a stronger and stable customer base and have larger bargaining power and stronger profitability than small banks. Variation in liquidity condition is also reflected in wider distribution of open-maturity liquidity mismatches for small banks such as small private banks, regional banks, and foreign branches, with larger tail risks.

- **NPL Ratio and Provisioning.** NPL ratio for the banking system appears to be low at around 2 percent while the NPL provision coverage ratio has been high reaching almost 70 percent (Figure 4). In the meantime, the stress test finds notable gap between banks actual impairment

Figure 4. Indonesia: Bank Risk Indicator by Groups

(In percent)

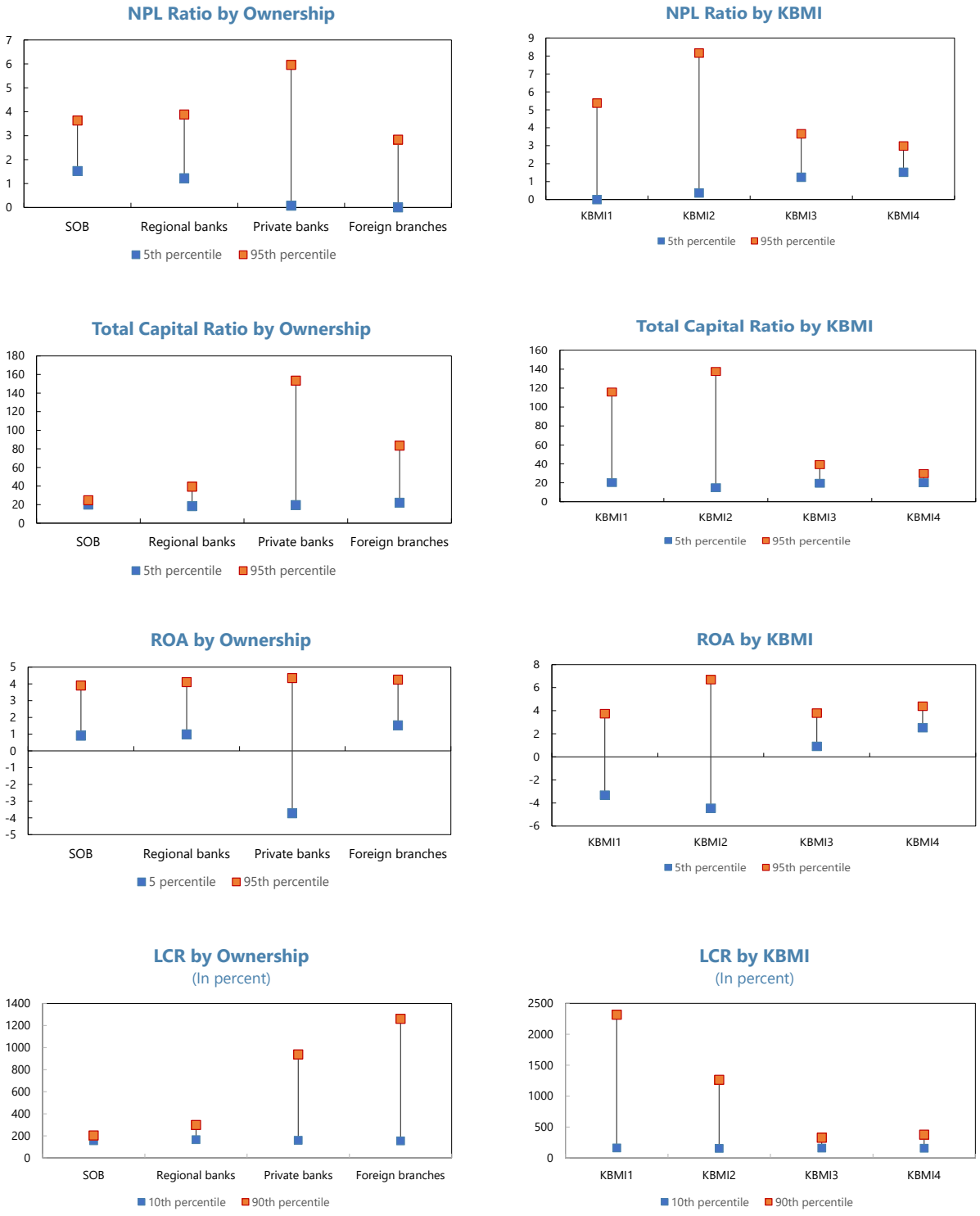
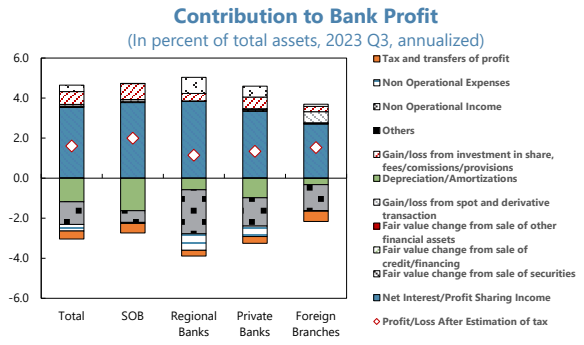
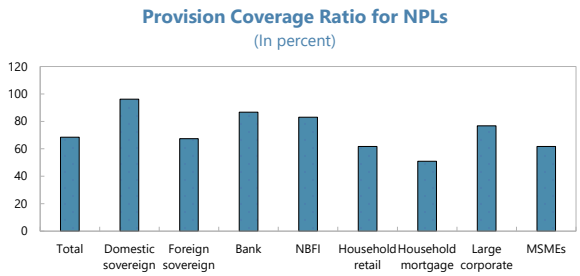


Figure 4. Indonesia: Bank Risk Indicator by Groups (concluded)





Source: Bank Indonesia, OJK, and IMF staff.
Note: KBMI1 denotes banks with a core capital of up to IDR 6 trillion; KBMI2 denotes banks with a core capital of between IDR 6 trillion to IDR 14 trillion; KBMI3 denotes banks with a core capital of between IDR 14 trillion to IDR 70 trillion and KBMI4 denotes banks with a core capital of more than IDR 70 trillion. Out of four banks in KBMI4, three are state-owned banks.

and the impairment calculated based on new NPL formation over the same period in 2023.[7] Although data limitation hinders a clear identification of the underlying drivers, such gap underscores the importance of a timely and full recognition of NPLs and intensified scrutiny on restructured loans. This could be further strengthened by the expiration of the OJK's forbearance program in March 2024 and a well-defined bank forbearance policy aligned with the concept of borrowers' viability going forward.[8] Such efforts will also limit the risks of zombie firms persisting, which may otherwise hamper macroeconomic performance (2024 Indonesia Article IV staff report).

- **Exposure to corporate credit risks to weak sectors, large SOEs and MSMEs.** Bank lending to corporates is high at about 60 percent of total loans, of which about 40 percent are issued to large corporates and 20 percent to MSMEs. NPL ratio for MSME loans is higher at 3.7 percent relative to large corporates at 2.9 percent. MSME and SOE loans also account for a high share of restructured loans, at 25 and 17 percent, which suggests higher credit risks for these segments. COVID-sensitive and structurally weak sectors,[9] such as the construction, accommodation, processing, and wholesale industry, also carry higher NPL ratios at 4.9, 3.6, 3.8, and 3.7 percent, respectively.

[7] The estimated impairment based on NPL flow measure is at 69 trillion IDR in 2023 whereas the actual impairment is at 146 trillion IDR. The notable differences can be driven by several factors, such as additional provision booked for existing NPL stock due to the reclassification of asset stages (movement between doubtful, substandard and loss loans), and additional provision incurred for performing loans over the same period.

[8] OJK announced the termination of the COVID-19 forbearance program at end-March 2024 (see OJK press release). The expiration of OJK's loan restructuring policy relaxation in March 2024 would help return the full recognition of NPLs as banks are required to re-evaluate borrowers' viability based on the III (three) pillars namely the borrower's repayment capacity, financial performance and business prospect going forward.

[9] Structurally weak sectors are defined as those that require improvement in the operation and production process to remain competitive in the market, such as upgrades in equipment and technology, etc.

- **Loan forbearance measures.** The loan forbearance measures mask vulnerabilities related to delays in credit loss recognition, which can have an impact on non-performing loans (NPLs), profitability, and capital ratios. While its application has been tightened, it remains broad, covering loans to MSMEs and companies in certain pandemic-hampered or labor-intensive sectors (accommodation, food and beverage, textile, and footwear). Due to the expiration of OJK's forbearance measures in March 2024, the share of restructured loans, which peaked at 20 percent of total loans in 2020—has gradually declined to around 10 percent in June 2023 and then 8 percent in Dec 2023. This is nearing pre-pandemic level at 5 percent but higher than regional peers at 2–3 percent. The portion of COVID-related restructured loans is 46 percent of the total restructured loans or 3.7 percent of total loans, reaching IDR 266 trillion with NPL ratio reaching 13 percent. As such, banks are required to provide sufficient loan loss provision for their COVID-19 restructured loan, at 21 percent of performing restructured loans and 70 percent of non-performing restructured loans.

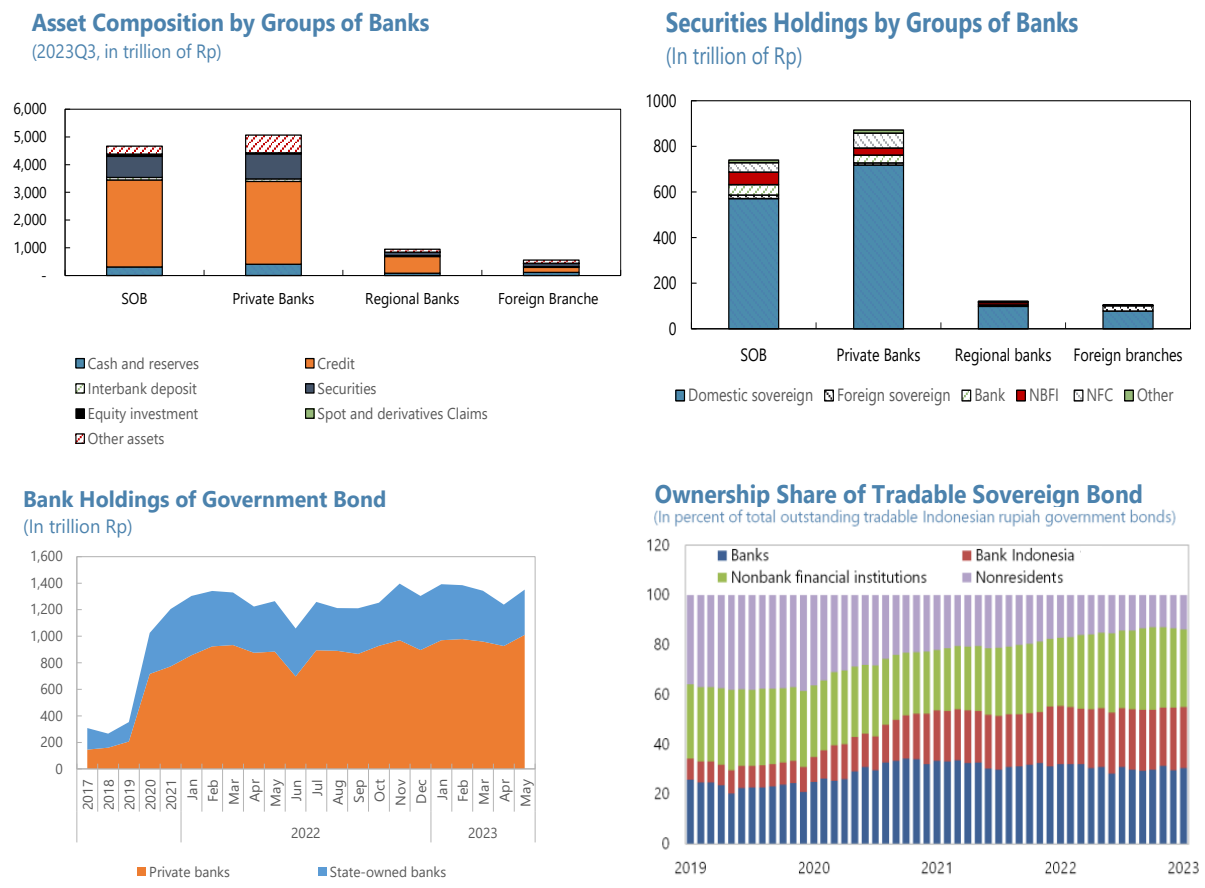
- **Sovereign-Bank nexus.** The increase in banks' holdings of government bonds (around 13 percent of total assets) has tightened the nexus between the sovereign and banks (Figure 5). To reduce the impact of rising interest rates on mark-to-market losses, banks rebalanced their portfolio by shifting the portion held in fair value to amortized cost (43 percent of debt securities)[10]. The average duration of sovereign debt securities held by banks is around 3.5 years and those for corporate securities is around 2.4 years. Yields on long-term sovereign bonds remained stable due to BI's operation twist. Concentrated bank lending and funding exposures to state-owned companies further intensified the sovereign-bank nexus. Banks' exposure to SOE loans is at 7 percent of total loans, and higher for state-owned banks at 8 percent. Importantly, 40 percent of the top 20 corporate loans of the state-owned banks are granted to SOEs, suggesting concentrated SOE lending.[11]

- **Bank exposure to commodity price volatility.** The impact of volatile commodity prices to bank credit risks should be assessed periodically as credit to the commodity related sectors such as the mining sector had fueled credit growth last year. The supply-chain disruption could also cause commodity prices to increase and push the inflation rate and subsequently tighten financial conditions, thereby impeding the economic recovery.

[10] Indonesian banks recorded an unrealized loss of 5.7 trillion IDR as of June 2023, while in December 2021 banks were sitting on an unrealized gain of 11.2 trillion IDR. Hence, the unrealized losses recorded by the banking sector have decreased in line with the shift from fair value to AC securities and relatively lower pressure on yields. Such shift is justified and fully compliant with existing accounting principle, and such change can defer the recognition of potential losses resulting from higher interest rates.

[11] Nevertheless, as shown by the solvency stress test, the overall solvency impact from sovereign-bank nexus remains contained.

Figure 5. Indonesia: Sovereign-Bank Nexus



Source: Bank Indonesia, OJK, and IMF staff.

Corporate Sector

- **Indonesian corporate sector has been rebounding from the pandemic, though with some sectoral imbalances (Figure 6).** Median ICR and return on assets have risen, leverage has fallen, while cash buffers have recovered in many of the sectors experiencing sharp declines during the pandemic. The recovery in 2022 was helped along by the commodity price boom, but has been uneven, with scars remaining in sectors hardest hit by the pandemic (e.g., tourism). SOE construction firms have seen an increase in leverage and a sharp decline in ICR over the past decade, reflecting their role in a public investment push, and a few are in default.

- **The corporate sector analysis focuses on external debt, which has moderated over the past decade**. Corporate external borrowing has fallen as a share of GDP over the past decade, from about 15 percent to about 9 percent, improving relative to regional and selected EM peers. About 20 percent of external debt is short-term, suggesting resilience against short-term shocks. FX debt-at-risk (defined as debt held by firms with ICR less than 1) has been between 10–20

percent in the late 2010s, and following a pandemic-induced spike, declined sharply in 2022 amid the commodity boom. Natural hedging also helps to mitigate risks, with sectors with significant export earnings more likely to have FX debt, though with some signs of currency mismatch. At the same time, corporates' external and FX debt remains a significant proportion of their total debt, estimated at 37 percent and 51 percent in 2022.[12] Higher external borrowing likely reflects a relatively shallow domestic financial sector.[13]

Household Sector

- **Household vulnerabilities remain contained, though LTV ratio for mortgages has increased following the relaxation of LTV caps.** Household debt, at about 16 percent of GDP in 2023Q3, remains low and has not yet fully recovered to end-2019 levels (17 percent of GDP). However, there may be some underreporting, as household borrowing via cooperatives may not be reflected due to data issues. Since the 2017 FSAP, the composition of households' bank loans has remained broadly similar, though the share of consumer loans has continued to rise. The LTV regulation was updated on March 2021, where bank can offer mortgage loans with LTV ratio up to 100 percent, subject to the requirement that bank's gross NPL ratio is below 5 percent. As a result, the average LTV ratio has increased since 2021 by about 13 percentage point from 69 to 83 percent across all segments.

NBFI Sector

- The insurance sector has seen rising risks stemming from inadequate premium management due to the contraction in the unit-linked business and risk transfer from the banking sector through credit insurance offered to domestic banks. Insurance companies face a high ratio of claims to premiums (RKP), in particular life insurance companies at 92 percent. This is primarily due to several recent disputes in the unit-linked business line that led to a deterioration of market confidence in the industry. Spillover risks to the banking sector appear to be contained due to a low share of loans covered by credit insurance, around 1 percent,[14] albeit with a higher share for small banks and regional banks. Other nonbank financial institutions (NBFIs) have significant investment in banks in the form of deposits and stocks (at around 14 percent of total NBFI investment) but this exposure becomes small when measured against bank balance sheet.[15] Finance companies generally rely on funding from banks.

[12] Estimates shared by BI.

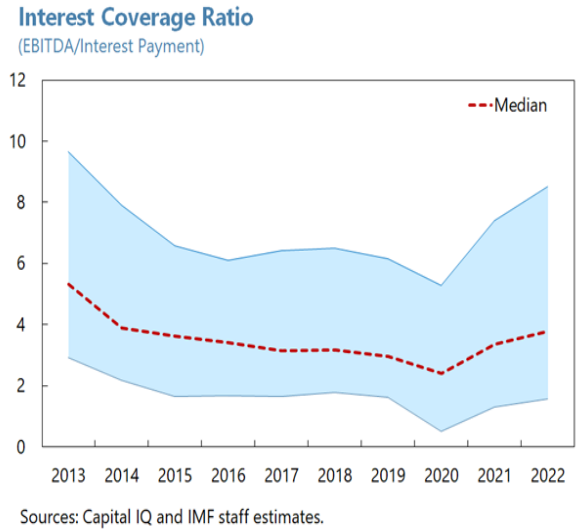
[13] Nevertheless, to mitigate potential adverse impacts stemming from short-term shocks in FX markets, firms are maintaining a minimum hedging ratio of 25 percent and a liquidity ratio of at least 70 percent of their net open FX positions pursuant to BI's prudential regulations on nonbank offshore borrowings.

[14] The coverage could be understated as it only covers exposure which treats the credit insurance as its first collateral which is embedded in the calculation of provisions.

[15] For instance, loans from banks to NBFIs account for 5.2 percent of total bank loans and deposits to banks from NBFIs account for 6.8 percent of total bank deposits.

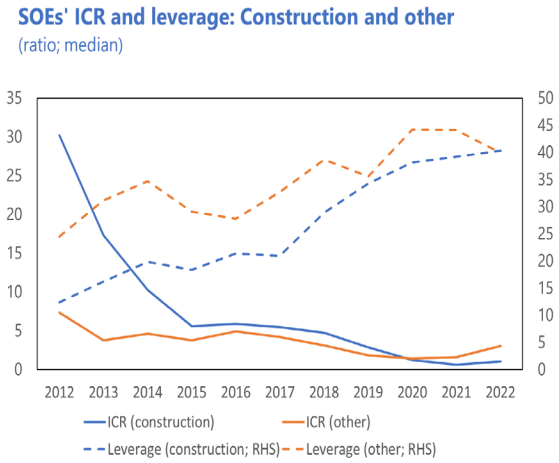
Figure 6. Indonesia: Corporate Sector Developments

Interest coverage ratios have improved since the pandemic.

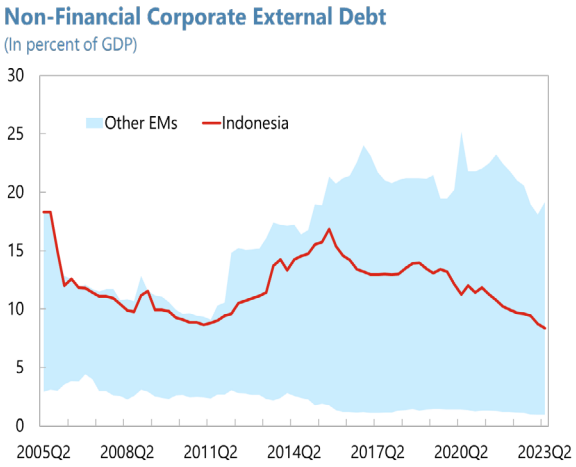


Sources: Capital IQ and IMF staff estimates.

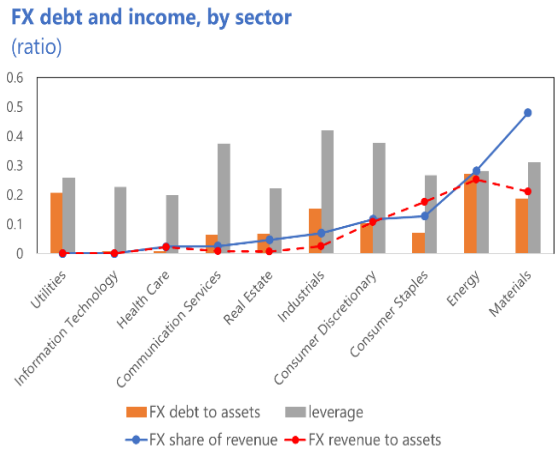
For construction SOEs, leverage has risen and ICR have fallen over the past decade.



Corporate external debt to GDP has declined…



…while external borrowers tend to have natural hedges



Source: Capital IQ, IMF, Systemic Risk Tracker, and IMF staff calculations.
Note: Top-left chart: Shaded area indicate inter-quartile range. Bottom-left chart: Other EMs included are Argentina, Brazil, China, India, Malaysia, Mexico, Philippines, Russia, South Africa, Thailand, and Turkey.

- **Common exposure to capital market including sovereign bond market.** In addition to increasing holding of sovereign bonds by the banks, the share of sovereign bonds on NBFI balance sheets are also non-negligible, at around 26 percent of total assets with longer duration than banks. Hence large fluctuations in sovereign bond yields could imperil NBFIs' solvency and liquidity position.

6. Direct exposure of Indonesian banks to both the Russia-Ukraine and Israel-Gaza conflict is assessed as not material. The only exposure was from deposit funds from both countries that only accounted for IDR 1.4 trillion or less than 0.02 percent of total banks deposit in Indonesia. Indirect exposures however can be large and more unpredictable, as supply disruptions could lead to large volatility in energy and commodity prices, which could further push up the inflation rate, potentially impeding the economic recovery.

7. Against this backdrop the FSAP conducts a comprehensive set of stress tests and risk analyses to assess the resilience and vulnerabilities of the banking, corporate and NBFI sectors via the following dedicated workstreams (Figure 7):[16]

- *The solvency stress test* assesses the impact on banks of severe but plausible shocks to the economy in a top-down manner. The exercise uses scenario-based stress test to assess the resilience of 105 commercial banks, which covers almost 100 percent of the banking sector assets and includes cross-border subsidiaries and branches, to adverse macroeconomic shocks, complemented by a series of sensitivity tests encompassing restructured loans, lending concentration, revaluation of bond portfolios and a further tightening of financial conditions.

- *The liquidity stress test* uses several approaches. A cash-flow based approach is used to assess the liquidity resilience to large withdrawals of funding across multiple time horizons, using maturity ladder data. The regulatory based approaches include NSFR which focuses on the longer-term structural liquidity. Finally, the liquidity stress test also assesses concentration risk of funding, performs reverse stress test of selected funding items, and explores liquidity-solvency interactions via the selling of AC securities at market price to meet large liquidity drawdowns.

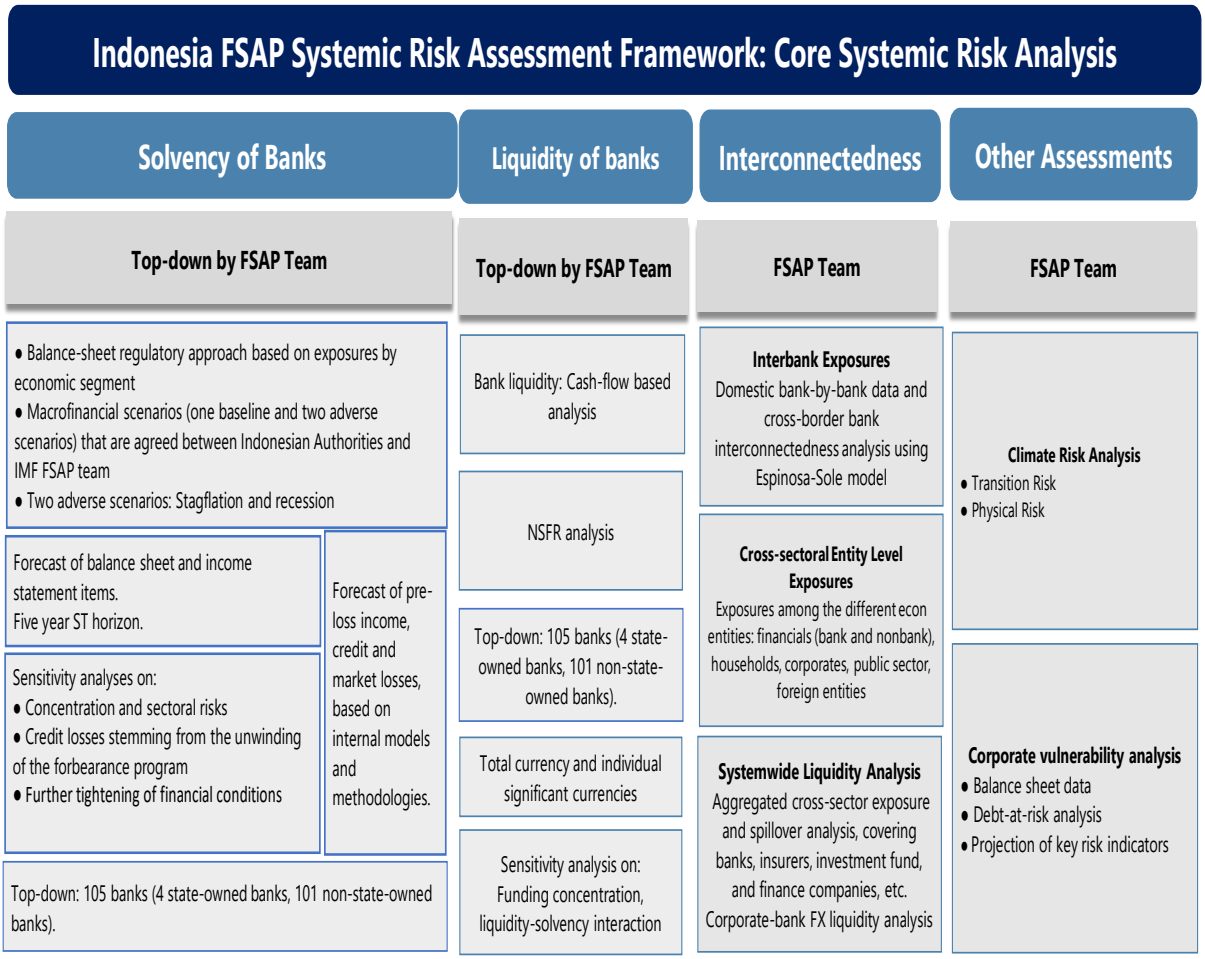
- *The contagion analysis* covers both domestic interbank exposures, as well as cross-border interlinkages at country level based on data obtained from BIS and authorities' supervisory templates.

- *A systemwide liquidity analysis* assesses the adequacy of the liquidity buffers of the entire financial sector, taking into account simultaneous liquidity shocks affecting different sectors of the economy—such as banks, insurers, pension funds, investment funds, financing companies and other NBFIs—and their interconnections. It also takes a granular approach to assess FX liquidity risks of the top nonfinancial firms and potential spillover risks to the banking sector, by quantifying FX liquidity position of those firms having difficulties refinancing their short-term and long-term FX debt as well as systemwide implications, particularly on banks.

- *The corporate solvency analysis* complements the bank solvency stress test by using highly granular firm-level balance sheet data to assess corporate resilience against the same adverse scenarios used in the bank solvency stress test and simulates evolution of key corporate risk indicators under stress.

[16] Climate risk analysis is covered in a separate technical note.

Figure 7. Indonesia: Overview of the Systemic Risk Analysis



Source: IMF staff.

SOLVENCY STRESS TEST OF THE BANKING SECTOR

A. Introduction

8. The stress test covers 105 commercial banks, constituting around 100 percent of total banking system assets. The stress test uses supervisory data as of 2023:Q2 at the bank level.[17] Banking statistics, including regulatory reports which contain bank specific balance sheet information and income statements, and other risk indicators such as system level lending and funding rates, non-performing loan ratios and probabilities of default were provided by the authorities on a confidential basis. The exercise adopts a scenario-based approach to stress test the banking sector, complemented by a series of sensitivity tests encompassing credit analysis of

[17] Since the stress test covers 105 commercial banks, which in some cases include both parent banks and subsidiaries, the data were reported at the non-consolidated level to prevent double counting.

restructured loans, concentration analysis of top counterparty exposures, and additional impact from a further tightening of financial conditions. Given the large number of banks in the system with varying sizes, ownership types and business models, the assessment and results are presented either by sizes (KBMI1-4)[18] or by ownership majority (state-owned banks, regional development banks, private banks, and foreign branches).

9. The stress test adopts a tailored approach in assessing specific vulnerabilities facing the Indonesian banking sector. For instance, a complete coverage of banks in the analysis could identify potential tail risks in the system, especially small banks. The stress test also attempts to gauge the potential credit losses associated with the unwinding of the supervisory forbearance measures, in light of the non-negligible amount of restructured performing and non-performing loans targeted at COVID-sensitive sectors. Market losses associated with banks' holdings of sovereign securities (currently amounting to 13 percent of total assets) are assessed, given the significant role of the banking sector in the sovereign bond market compared to other sectors of the economy. More importantly, underlying risks associated with the securities booked under the amortized cost category are evaluated, amid the recent migration of debt securities from the fair value to amortized cost category to prevent further valuation losses as financial conditions continue to tighten. Concentration analysis on bank lending portfolios allows the identification of large exposure of banks to specific segments, such as to SOEs, private corporates and other banks. Finally, results of the interest rate risk analysis differentiate groups of banks and their unique vulnerabilities to funding risk, since small banks tend to be funded by less stable deposits and hence bear higher funding cost.

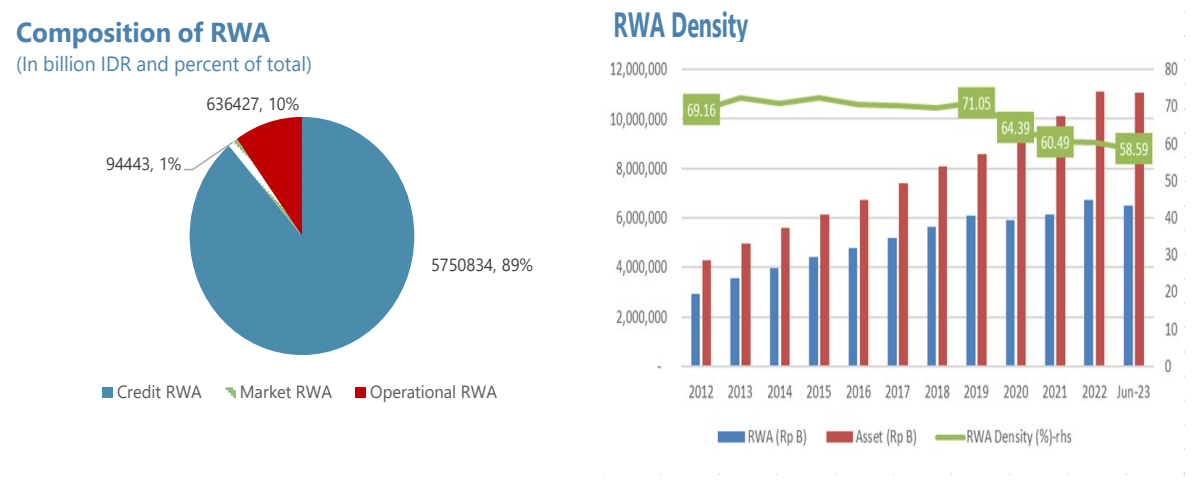
B. Banking Sector Characteristics and Vulnerabilities by Risk Categories

Credit Risks

10. Credit risk constitutes the largest risk factor for the banking system (Figure 8). RWAs of credit risk account for 90 percent of total RWAs in the sample banks, in line with the banking system's asset composition. All banks use STA approach for the computation of their credit RWAs. In 2020, the COVID-19 shock, and the accompanying public support has contributed to a decline in risk weighted densities, driven by strong growth of high-quality liquid assets which were fueled by increasing customer deposits on the liability side and reduced customer lending on the asset side. Subsequently, RWAs declined further in 2023 compared to 2022 due to a downward adjustment of the Operational Risk RWA under the Basel III implementation. As a result, total RWA has declined while banks' capital ratios increased. The credit risk RWAs are allocated to mainly large corporates and MSMEs.

[18] KBMI1 denotes banks with a core capital of up to IDR 6 trillion; KBMI2 denotes banks with a core capital of between IDR 6 trillion to IDR 14 trillion; KBMI3 denotes banks with a core capital of between IDR 14 trillion to IDR 70 trillion and KBMI4 denotes banks with a core capital of more than IDR 70 trillion. Out of four banks in KBMI4, three are state-owned banks.

Figure 8. Indonesia: Bank Credit Risks



Sources: BI, OJK, and IMF staff estimates.

11. Banks' asset composition reflects their business models and market orientation (Figure 9). The largest portion of assets are loans, representing 60 percent of total assets across all banks, followed by securities which account for about 17 percent. Small banks are more liquid than large banks with lower loan share at around 54 percent, relative to large banks at 64 percent. By sector, loans are mostly concentrated in corporates at around 60 percent (of which 40 percent is to large corporates and 20 percent to MSMEs) followed by households, at around 27 percent (of which 17 percent is to household retail and 10 percent is to mortgages). Furthermore, asset composition differs notably between banking groups. Large banks in the KBMI4 groups (comprised of three SOBs and one large private bank) hold more corporate loans than other groups—including both large corporate and MSMEs—accounting for about 66 percent of total loans. In contrast, regional banks—focus on credit to civil servant and government employees—holds more retail loans making up 60 percent of total loans.

12. Asset quality also varies across segments (Figure 9). Corporate loans in general are riskier than household loans. Within corporate loans, MSMEs carry higher NPL ratios than large corporates. Sectors that are COVID-sensitive or structurally weak—such as the tourism, construction, and processing and wholesale industry—carries higher NPL ratios than other sectors. Going forward, the winding down of the forbearance measures—which focus on these weak sectors—calls for more timely and full recognition of the NPLs to promptly capture and mitigate credit risks on bank balance sheet.

Figure 9. Indonesia: Banking Sector—Asset Composition and Quality

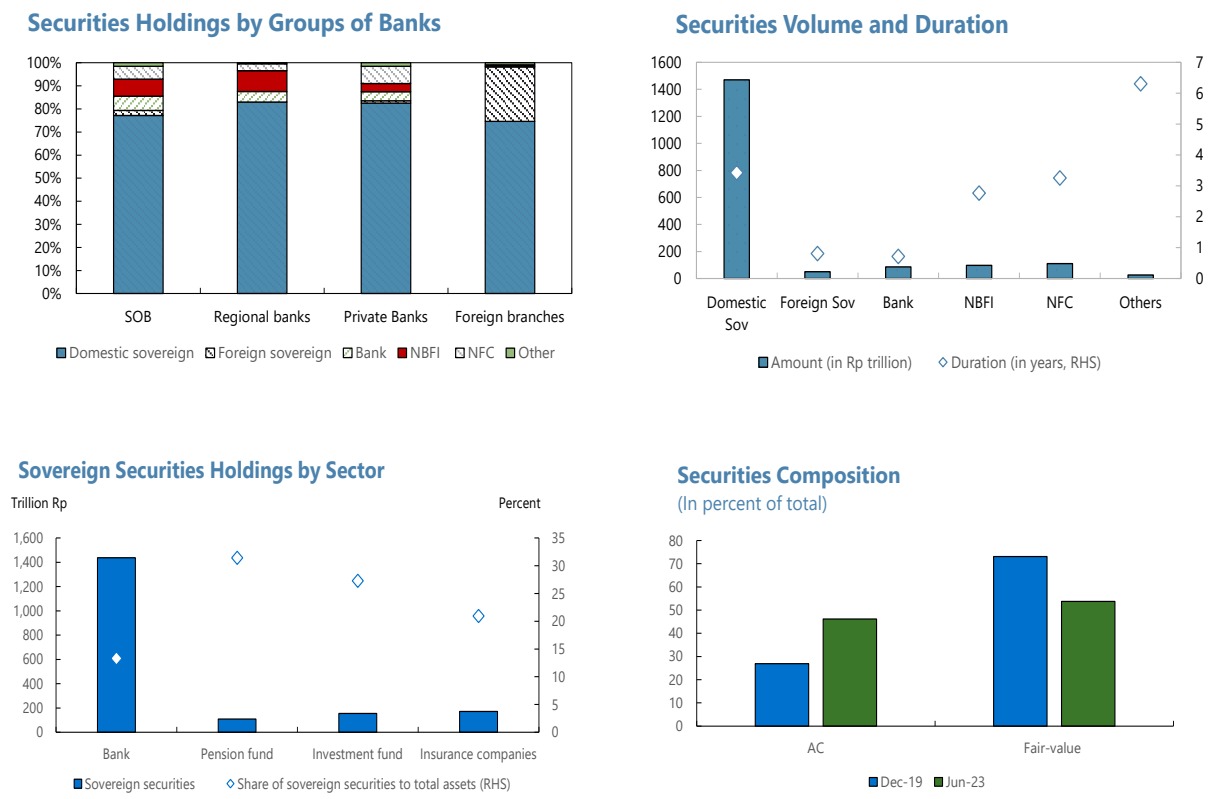
Sources: BI, OJK, and IMF staff.

Market Risks

13. Holdings of sovereign securities are moderate with short duration (Figure 10). At 13 percent of total banking assets (around 80 percent of total debt securities), banks' exposure to sovereign bonds remains moderate following the recent increase but introduces linkages via the

capital and liquidity channels. Majority of the sovereign holdings are domestic sovereign bonds as foreign sovereign bonds only account for a small share at 3 percent of total securities outstanding due to low market appetite. A significant portion of the sovereign securities were placed in the AC category rather than in the fair value category. There is also a recent shift of securities from fair value into the AC category, which could intensify liquidity-solvency linkages should banks be prompted to sell the AC securities at market price to meet large liquidity drawdowns. Average duration of the sovereign securities is short at 3.5 years, and even shorter in non-sovereign securities at around 2.4 years, suggesting limited market impact on bank balance sheet due to large swings of sovereign yields.

Figure 10. Indonesia: Banking Sector—Sovereign Exposure



Sources: BI, OJK, and IMF staff.

Interest Rate Risks

14. Bank assets comprise a mix of floating and fixed rate instruments. As of June-2023, More than 70 percent of the newly issued loans were denominated in variable rates, with lower share for household mortgage (around 60 percent). On the liability side, majority of the deposits are to be repriced within one-month and in general faster than the speed of the repricing of loans (Figure 11). Comparing across banks, small banks—such as regional and private banks—are more dependent on funding via time deposits than large banks, which may expose them to higher

funding cost shock to retain a higher share of unstable source of funding. Going forward, the large share of demand and saving deposits subject to short-term repricing, slower repricing on the asset side, and slower passthrough from funding to lending rates[19] could potentially compress bank net interest margin in a context of rising interest rate.

Figure 11. Indonesia: Banking Sector—Interest Rate Risks

Sources: BI, OJK, and IMF staff.

C. Macroeconomic Scenarios and Growth at Risk

15. The scenario-based bank stress test assesses banks resilience towards a joint realization of several key macro-financial risks. Specifically, the stress test constructs one baseline scenario and two adverse scenarios. The baseline scenario draws on projections from the IMF October 2023 WEO. The adverse scenarios include one stagflation scenario and one

[19] Banks do not fully pass-through higher funding costs to consumer in terms of higher lending rates. Higher competition in credit market, as potential debtors are becoming price sensitive, and banks' tendency to keep credit risks (NPLs) in a manageable level are some reasons that leads to the incomplete pass-through. As a result, an increase in interest rate will likely generate loss to banks on aggregate.

recessionary scenario and are separately simulated using the Global Macro-financial Model, a structural macroeconometric model of the world economy, disaggregated into forty national economies, as documented in Vitek (2018).[20, 21]

16. The scenarios feature the major risks in the February 2024 GRAM risk matrix (Figure 13, Table 11). The *stagflation scenario* features resurgence of COVID-like lockdown in the first year subsequently compounded by the escalation of global and regional geopolitical tensions with resulting global trade disruptions (e.g., energy, food, tourism, and/or critical supply chain components), remittances, FDI and financial flows. Supply-chain disruptions lead to synchronized sharp slowdown in both advanced economies and emerging markets, as well as de-anchoring of inflation expectations leading to higher energy prices. In the meantime, lower global demand relative to supply of key commodities (e.g., metals such as nickel) reduces commodity prices. This creates a knock-on effect on the Indonesian economy via reduction in trade and capital inflows, leading to currency depreciation and together with COVID lockdown effects reducing consumer confidence. Policy makers respond by tightening monetary policy to tame inflationary pressure. Tighter financial conditions reduce credit growth, domestic consumption, real estate prices, and push up firms' cost of funding as well as the unemployment rate. These downside risks increase the term premium on long term bonds, leading to asset price (equity and house prices) decline and rising markups. The *recessionary scenario* features a global, synchronized recession triggered by both global and idiosyncratic risk factors (e.g., cyclical drivers) in conjunction with systemic financial instability. Sharp swings in real interest rates and risk premia, and the repricing of assets amid an economic slowdown accompanied by policy shifts trigger insolvencies in countries with weak banks or non-bank financial institutions, causing market dislocations and adverse cross-border spillovers. These compounded effects lead to a sharp fall in trade and FDI inflows, subdued domestic demand, a rising unemployment rate, and a further decline in housing, equity, and commodity prices (see also the Risk Assessment Matrix in Appendix I).[22]

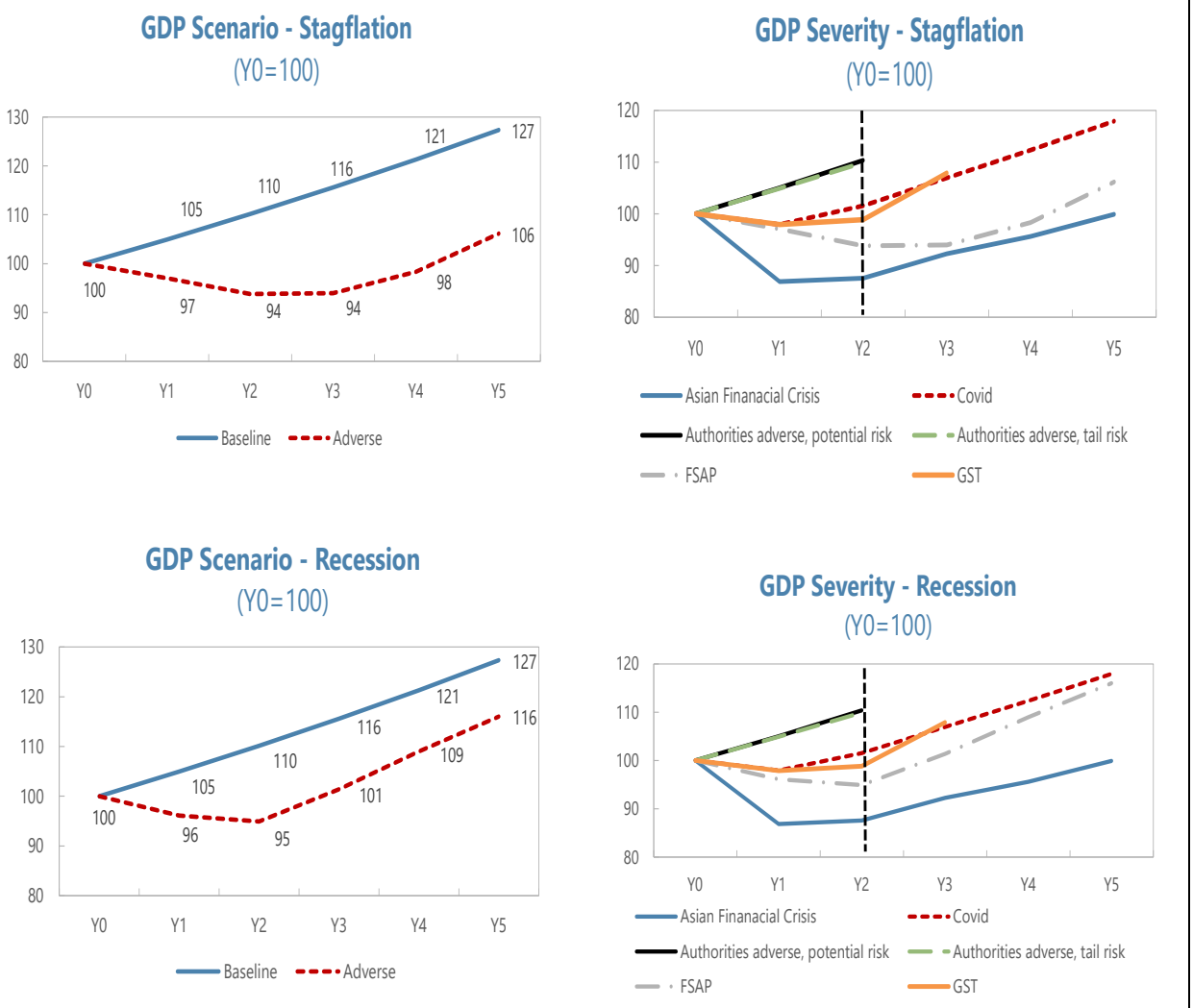
17. The two scenarios differ in terms of severity and the duration of shocks. The differences between the two scenarios lie in the fact that the former entails a structural change of the domestic economy (including potentially also protracted negative spillover from China slowdown) which could prolong both the duration of the shock and subsequent recovery, whereas the latter features a V-shape growth shock with transitory impact on the economy and quicker rebound. The severity in terms of impact on a real GDP growth of the stagflation (recessionary) scenarios is closely aligned with a 5 percent Growth-at-Risk estimate (Appendix III), implying 15 (14) percent or 2.6 (2.4) standard deviation shock to real GDP growth relative to the baseline, and 6 (5) percent decline relative to the starting point over a two-year horizon (Figure 12).

[20] Vitek, Francis. (2018). "The Global Macro-Financial Model." IMF Working Paper No. 2018/081.

[21] The adverse scenarios are hypothetical severe but plausible shocks and assumes no policy responses to the shocks, except changes in the policy rate.

[22] The stress scenarios are hypothetical simulations of severe conditions, not representing forecasts. These scenarios typically assume no policy beyond adjustments to the policy rate, in order to assess the system's vulnerability to various shocks.

Figure 12. Indonesia: Output Contractions and Scenario Design



Source: IMF staff.

18. The real GDP shock over two years is much more severe than the COVID-shock and interest rate paths reflect different policy trade-offs. Under the two adverse scenarios, the output shock is more severe than the COVID shock but is milder than that observed during the Asian Financial Crisis over a two-year horizon. The unemployment rate is also broadly in line with past stress, accompanied by a decline in real estate and equity prices as well as currency depreciation. In the stagflation scenario, the short-term interest rate continues to tighten till 2024 driven by higher inflation and rising spreads and declines thereafter in response to a contraction of output and lower inflation. In the recessionary scenario however, the short-term interest rate immediately declines below the baseline to accommodate lower output. Most variables converge to their pre-shock path by the end of the forecast horizon.

Figure 13. Indonesia: Adverse Scenario
(In percent unless otherwise noted, starting point 2023:Q2)

Stagflation and Recessionary Scenario.

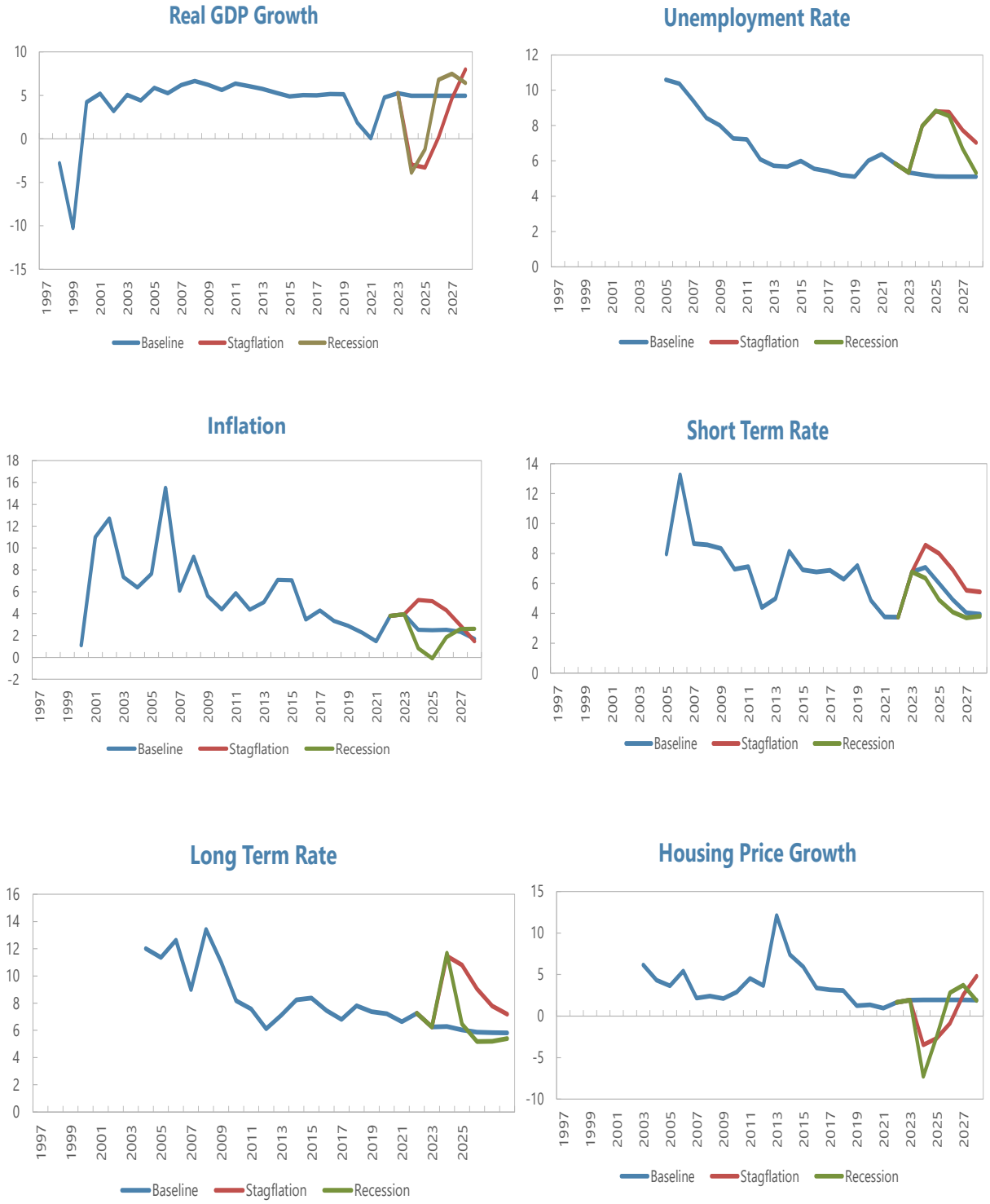
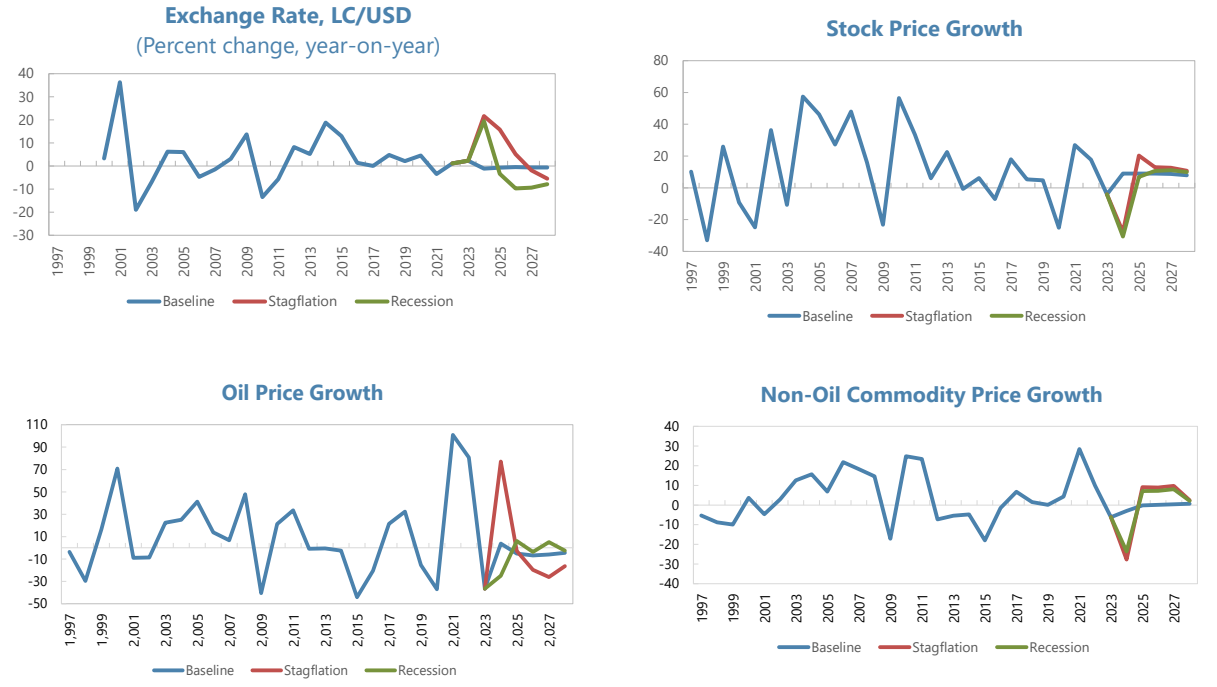


Figure 13. Indonesia: Adverse Scenario (concluded)



Source: IMF staff.

D. Scenario-Based Solvency Stress Test

Methodology

19. The stress test uses regulatory capital requirement calculations. The performance of the sampled banks is assessed based on total capital adequacy ratio (CAR), Tier 1 capital (T1), Common Equity Tier 1 (CET1) capital and leverage ratios. Under both scenarios, capital requirements include, in addition to minimum capital ratios, bank specific D-SIB buffer, and Pillar-II requirements where applicable. Banks are allowed to deplete their capital conservation buffers (CCBs) and countercyclical capital buffer under the adverse scenario.[23]

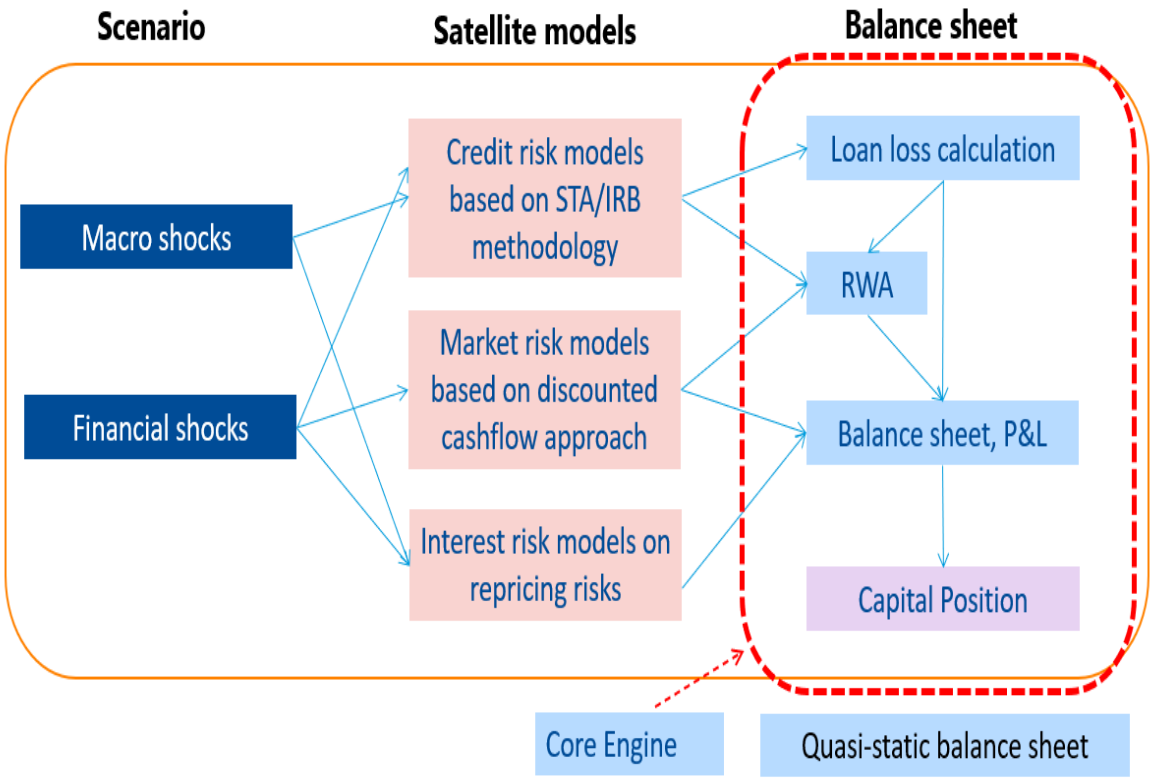
20. The stress test adopts a solvency framework that covers a comprehensive set of risks (Figure 14). It includes credit risk associated with all exposures, market risks, sovereign risk and interest rate risk in the banking book. By contrast, the derivatives book is not considered, due to small exposure to stress the derivatives portfolio in a meaningful way.[24] Macro scenarios are translated into the evolution of PDs, LGDs and interest rates using a set of satellite models, and in the meantime indirectly affect the growth of balance sheet items, pre-provision net income and other components. Shocked risk parameters drive Risk-Weighted Assets and provisions (via incurred loss approach), market valuation and net interest income changes. The final step combines all P&L

[23] As of June 2023, the Capital Conservation Buffer is bank specific and is at around 2.5 percent of RWA which is applied to KBMI group 2–4, and Countercyclical Buffer at 0 percent.

[24] As of June 2023, the derivative exposure only account for less than 1 percent of total and credit RWA.

items and balance sheet and RWA evolution under each scenario to obtain CET1, Tier 1 and total capital and leverage ratios over the stress testing horizon. Figure 14 summarizes key elements of the solvency framework.

Figure 14. Indonesia: Structure of Solvency Stress Testing Framework



Source: IMF staff.

21. A quasi-static approach is used for the growth of banks' balance sheet items over the stress-test horizon. Under this approach, balance sheet growth is assumed to follow Indonesia's nominal GDP growth given the limited cross-border lending exposure of banks. However, to prevent banks from deleveraging, a floor of zero percent is set on the rate of change of balance sheets. This constraint could be binding in the adverse scenarios. In addition, balance sheet growth (also including growth of performing and non-performing exposures) can be driven by foreign exchange movements under both the baseline and adverse scenarios, based on bank exposure to FX-denominated assets and liabilities, as well as conversion of a portion of off-balance sheet items (i.e., credit lines and guarantees) to on-balance sheet exposures. As a result, balance sheet expansion could in parallel lead to higher RWAs, and subsequently lower capital ratio of the banks.

22. The evolution of default under stress in Indonesia is estimated separately for household and corporate portfolios, using a model selection technique. Historical default rates (PDs) at the aggregate level, which are provided by the OJK, are estimated for household and

corporate loans separately. Point-in-time PDs are projected using a model selection technique[25] with macro variables - such as GDP growth, unemployment rate, exchange rate, asset and commodity prices and interest rates - as independent variables. The risk-neutral PDs for sovereigns, banks, and NBFIs are generated using a Merton approach which translates credit spreads under stress to PDs, according to the following formula, using the credit spreads for sovereign, bank and NBFI exposure linked to the scenario $S^i_{t,T}$, time to maturity (T-t), and assuming an LGD of 50 percent.

$$PD^i_{t,T} = \frac{1 - exp^{-S^i_{t,T^*}(T-t)}}{LGD^i_t}$$

The results are then used to generate new flows of NPLs and associated provisions of each type of loan portfolio held by individual banks.

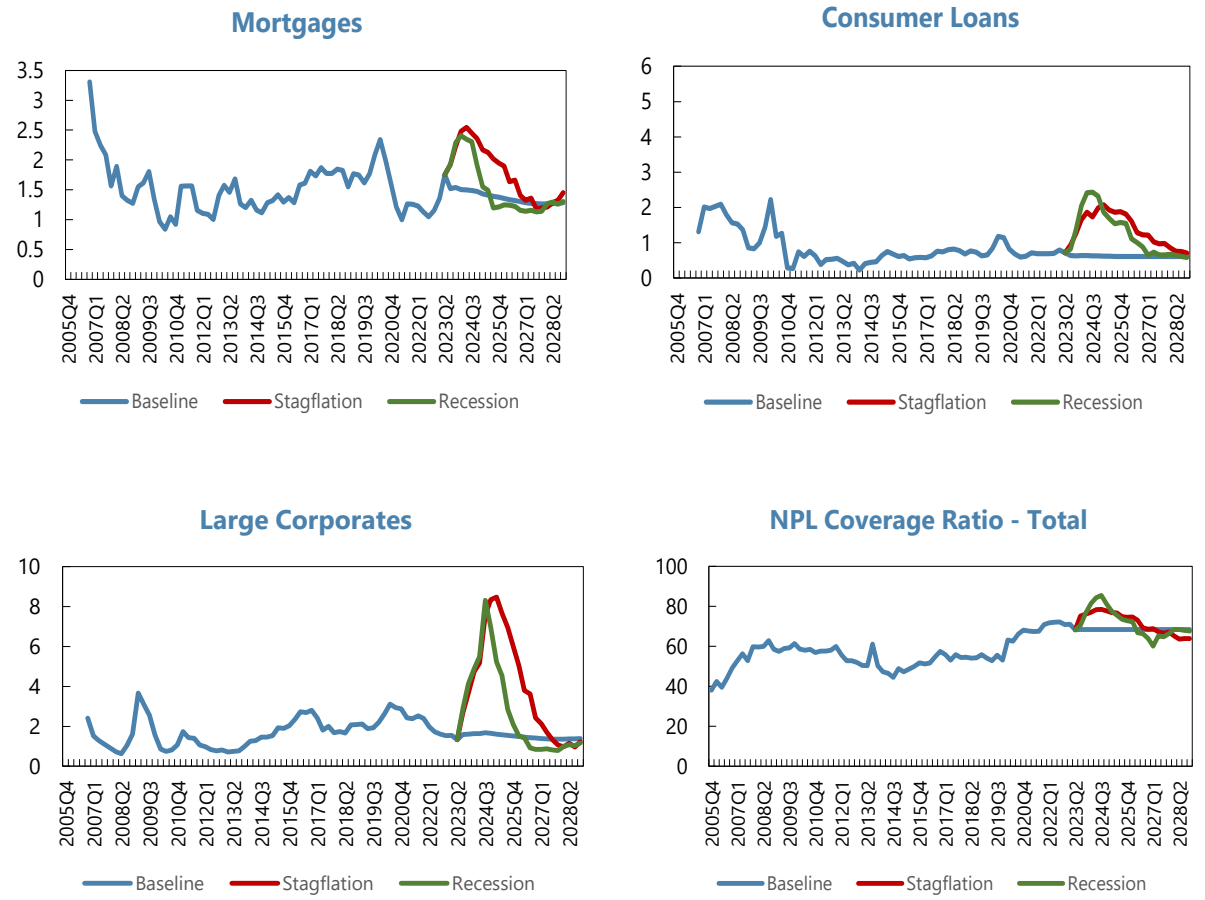
23. A logit transformation is applied before conducting model estimations to address the truncated nature of default rate distribution. This transformation addresses biases and ensures that the projected rate is contained within the 0-1 bound once the logit forward path is applied to the forecast.

24. Conditional PD forecasts, which indicate larger impact on corporate than household portfolios, were generated based on the estimated model parameters (Figure 15). Given a stable macroeconomic outlook in the baseline, the PDs in both segments are projected to remain flat in the baseline scenario and to notably increase in the adverse scenario. The impact under the adverse scenario displays idiosyncrasies across segments, with the impact on corporate more sizable than those on household mortgages. The magnitudes of the projected PD shocks under the adverse scenario are in general milder than those observed during the Asian Financial Crisis in accordance with the calibration of scenario severity.

25. GDP growth, unemployment rate, interest rates as well as asset prices prove to be relevant for the buildup of credit risk (Appendix IV). This is reflected in the level of significance of included explanatory variables. For instance, GDP growth and short-term interest rate appear to be significant drivers of PDs of household mortgages and large corporates, whereas unemployment rate appears to be significant for PDs of consumer loans. Asset prices, such as housing and stock prices, are significant drivers of coverage ratio and PDs of large corporates, respectively. The type and number of significant variables however vary distinctly across segments, as manifested by the individual characteristics of their historical PDs.

[25] See Burnham, K. P. and Anderson, D. R. 2002 Model selection and multimodal inference: a practical information-theoretic approach. 2nd ed. New York, Springer-Verlag.

Figure 15. Indonesia: Projections for PDs and Coverage Ratio
(In percent)



Source: IMF staff.

26. The projections for point-in-time LGDs rely on an econometric approach. Point-in-time LGDs paths under the baseline and adverse scenario are projected using historical time series on coverage ratio for the total loan portfolio provided by the authorities. The stressed coverage ratio under the adverse scenario is applied to household and corporate portfolios separately, taking into consideration their differences in the level and quality of collateralization at the starting point. The forward paths under the baseline and adverse scenario are then attached to the bank specific Point-in-Time (PiT) LGDs, with a floor imposed on the adverse scenario at the starting point LGDs.

27. Credit risk affects banks' capital ratios both through loss provisions (numerator) and risk weights (denominator). The credit risk analysis is based on an incurred loss approach. The calculation of loan loss provisions relies on PiT PDs and the PiT LGDs under stress. The capital requirement is subject to regulatory approaches used by banks. For Indonesia, since all banks adopt the standardized approach, the RWA densities at the starting point of the stress test are assumed to remain the same over the scenario horizon with a differentiation between performing and non-performing loans, as below.

$$\rho_e^{PE\ or\ NPE}[0] = \frac{RWA(STA)_e^{PE\ or\ NPE}[0]}{EAD(STA)_e^{PE\ or\ NPE}[0] - PROV(STA)_e^{PE\ or\ NPE}[0]}$$

$$RWA(STA)_e^{PE\ or\ NPE}[t] = \rho_e^{PE\ or\ NPE}[0] * (EAD(STA)_e^{PE\ or\ NPE}[t] - PROV(STA)_e^{PE\ or\ NPE}[t])$$

28. The assessment of interest rate risks can be decomposed into two main components: base effect and gains or losses under stress. The base effect is defined as the change of interest income or expense due to changes in the outstanding amount of interest earning assets or liabilities, in the absence of interest rate shocks. It is computed as the product of the effective interest rate on each relevant balance sheet item and their outstanding amount under the stress horizons. Gains or losses due to interest rate shocks are treated as an add-on component, using a gap-analysis to assess the cash-flow effects from a general increase in interest rates that affects banks' banking books. The impact of interest rate shocks is felt on interest income and funding cost of the banks through their cash-flow structure comprised of interest sensitive assets and liabilities and repricing buckets. Throughout the stress horizon, interest rate shocks are applied to the interest rate-sensitive assets and liabilities as the positions reach their time of repricing, from less-than-1-year to the 5-year buckets, consistent with the stress testing horizon. Funding risks are considered as part of the interest rate risk assessment which prevails in the repricing of the sensitive liabilities subject to rising funding rates, such as deposit rates or interest rate on debt securities. Projection of net interest income is computed as the sum of the base component and the gains and losses due to interest rate shocks.

29. Interest payments are assumed to accrue only on performing exposures under both the baseline and adverse scenarios. The interest revenue on performing exposures is calculated on the gross carrying amount. While accounting rules allow banks to accrue interest income on non-performing exposures with provisioning required on the more delinquent and uncollectible assets, the stress test exercise takes a more conservative approach which does not allow banks to collect income on non-performing exposures.

30. The assessment of interest rate risks for Indonesia uses as input the historical time series of aggregated interest rates as well as interest rate sensitive asset and liabilities reported by the authorities. The evolution of the cost of funding and lending rates are treated as a function of the macroeconomic variables projected under the different scenarios, such as short- and long-term interest rates. The projection uses aggregate quarterly bank rates for new business (front-book), proxied by lending and funding accounts starting within one quarter to the reporting date, which are mapped into two main categories on the asset side (loans and securities purchased) and four main categories on the liability side (demand deposits, saving deposits, time deposits and securities issued). The projection of interest rates on debt securities on the liability side follows the dynamics of sovereign bond yield, while adding a spread between bank and sovereign bond yield, benchmarked to historical average.

31. Results from satellite models on aggregated interest rates reveal a significant role of short-term rates, long-term rates as well as the unemployment rate. On the asset side, lending rates appear to be highly correlated with the short-term interest rates, which is consistent with the dominant share of floating rate loans in the banking book. On the liability side, the cost of saving and current deposits is largely determined by the short-term rate while time deposits appear to be driven by long-term interest rates. Unemployment rate, a proxy of borrower credibility and economic conditions, appears to be a strong determinant of lending rates, saving as well as current deposits. The pass-through of short-term interest rate, proxied by the size of coefficient, on lending rates appears to be larger than funding rates, at around 0.36, whereas those for saving and current deposits are around 0.1.

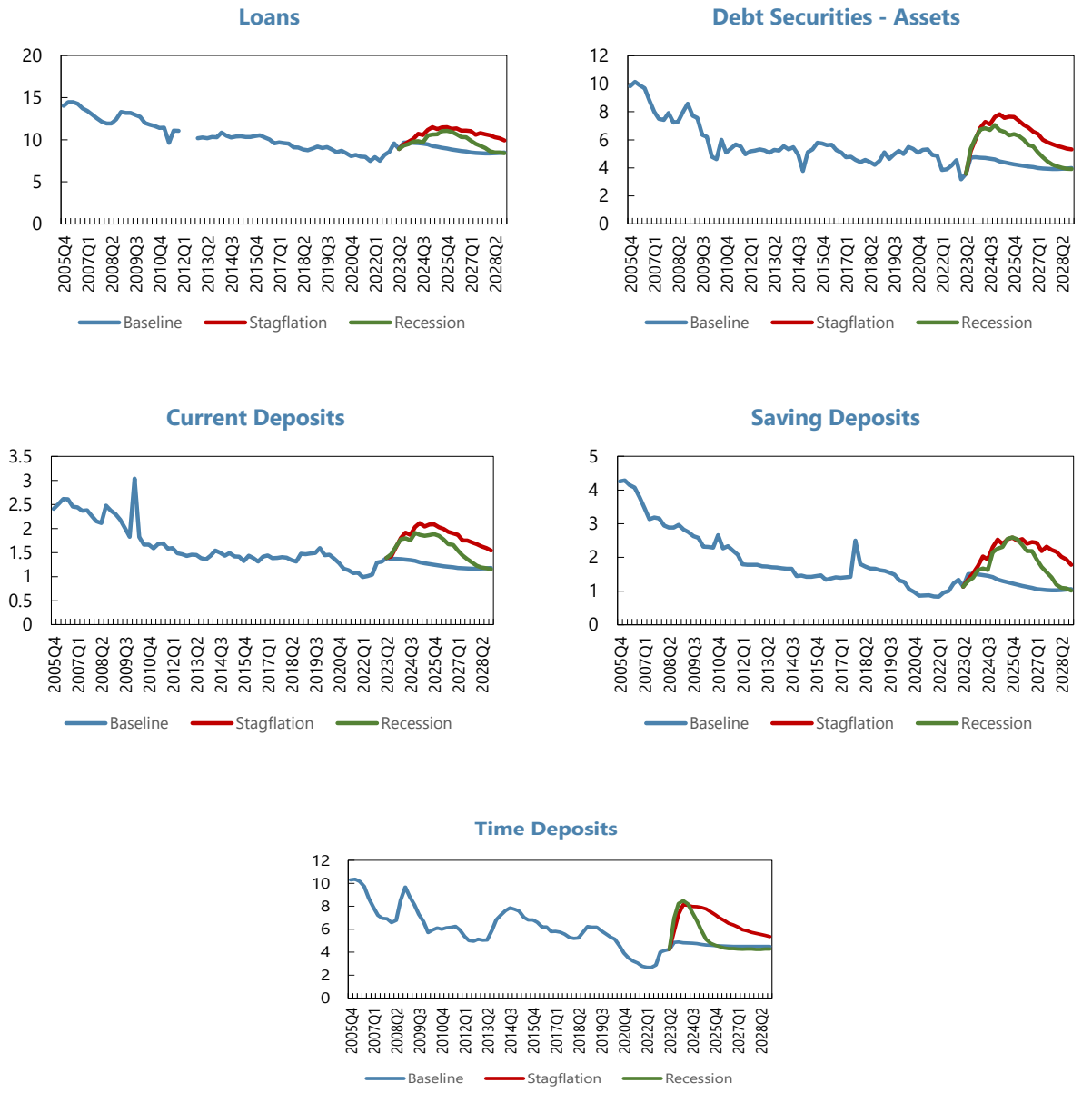
32. The projected interest rates paths are broadly in line with banks' portfolio characteristics (Figure 16). On the liability side, this is reflected by a more severe impact on the time deposits as opposed to highly liquid short-term funding such as current and saving deposits. On the asset side, the increase on the lending rate appears to be moderate to reflect the constrain faced by the banks in increasing lending rates under stress. As a result, relative to the baseline, net interest margin declines in both adverse scenarios by about one percentage point on average at the trough for the sample banks, relative to a historical net interest margin of the total banking sector at around 5 percent.

33. A discounted cashflow-based approach is used to measure gains or losses in the value of fixed income securities, due to changes in bond yield-to-maturity. Securities holdings by types of securities and the corresponding remaining maturities for each bank are provided by the authorities. The discounted cashflow-based method calculates the present value of all expected future cashflows generated by a debt security and thus is better suited to capture the non-linear impact of large interest rate changes on the market value of debt securities, often referred to as convexity, thus preventing potential over-estimation of valuation losses (or under-estimation of valuation gains) in response to rising (or declining) yields. Specifically, the valuation takes the following form:

$$P_t = C * \frac{1-(1+r_t)^{-n}}{r_t} + \frac{Par\ value}{(1+r_t)^n}$$

Where P_t refers to bond price at time t, C refers to annualized coupon payments which were provided by the authorities, r_t refers to the yield-to-maturity at time t, n refers to number of years until maturity (or proxied by duration). As r_t changes as a result of the yield shock, the bond price is calculated by using the updated yield-to-maturity and then compared to the initial price. The shock to yield-to-maturity would be calibrated by interpolating linearly the yield curve that is specified by the short- and long-term yield in each year over the 5-year horizon, under both the baseline and the adverse scenario. The analysis covers the impact on the debt securities accounted in the categories of fair value through profit and loss (FVTPL) and fair value through other comprehensive income (FVOCI), and separated into sovereign, banks, NBFIs and corporate bonds. Rebalancing of the portfolio is not allowed throughout the horizon.

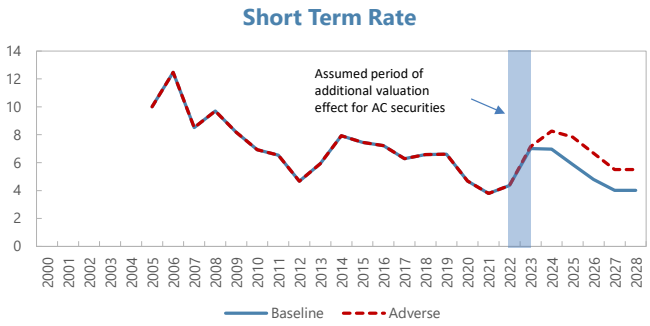
Figure 16. Indonesia: Interest Rate Projections
(In percent)



Source: IMF.

34. The FSAP also takes an in-depth view on the potential risks associated with securities booked under the amortized cost (AC) category. Although these securities are not required to be marked to market on a continuing basis, they are assumed to be revalued once they are sold for liquidity purpose, especially under a severe liquidity stress scenario where all liquid assets are exhausted to meet large withdrawals. Therefore, under the scenario-based analysis and for conservative purpose, they are revalued both at the starting point of the stress test (to account for any unrealized gains or losses in the past up to the starting point) and under the stress testing horizon, using the same cashflow-based approach and compared against the book value, and the

differences can lead to further decline in capital ratio of the banks. The unrealized gains or losses at the starting point was adjusted to reflect market valuation changes since the onset of the interest rate hikes after the pandemic up to the starting point (text figure), to take into account the recent migration of securities from fair value category into the amortized cost category.



35. Valuation changes due to other market risks are assessed for banks' FX exposures and their equity holdings. Specifically, information on net positions of FX and equity holdings with trading intent are provided by the authorities via confidential supervisory reports. Subsequently, the fair value impact of each market risk factor on bank profitability follows the evolution of their corresponding market prices projected under the baseline and the adverse scenarios. For instance, gains or losses associated with banks' FX risk can be computed by multiplying the FX net open position at the starting point by the shocks to the nominal exchange rate under each scenario. Similarly, valuation gains or losses associated with banks' equity exposure would be the product of their net equity position (long minus short position) and shocks to stock prices, respectively.

36. Net income (profit and loss) is projected using all the risk factors in the stress test. Net profits are mainly driven by the gains and losses from credit risks, market risks and interest rate risks.[26] Remaining items on the income statement, such as net fee and commission income and other non-interest income, are projected to grow in line with nominal GDP growth under both scenarios. Operational and administrative expenses are assumed to be constant over the risk horizon. Extraordinary income and loss are assumed not to recur during the projection period. The corporate income tax is factored in the profit and loss calculations and is set at banks' effective tax rate of 20 percent.

37. The distribution of profits is subject to a prespecified dividend policy. Dividends are assumed to be paid out at a rate of 50 percent of current period profits after taxes by banks that are making profits (i.e., only if profits are positive) and in compliance with supervisory capital requirements. Banks are not allowed to issue new shares or make repurchases during the stress test horizon.

38. In addition to the conventional scenario-based stress test, a number of sensitivity analyses are carried out to gauge a further rise in interest rates and concentration risks, as well as potential credit losses stemming from the unwinding of the supervisory forbearance measures. The following sensitivity analyses are considered:

[26] Since the stress test starts at 2023:Q2, the profit and loss items are annualized to avoid underestimation of bank profit pre-shock.

- *Parallel shift in yield curve*. The analysis assumes parallel increases in both short- and long-term rates to assess the sensitivity of bank solvency positions to a range of plausible rate shocks, with a focus on market risks. The impact of rising interest rates could immediately affect banks' trading portfolios, such as marketable debt securities, due to either realized or unrealized valuation losses through the categories of fair value through profit and losses (FVTPL) and fair value through other comprehensive income (FVOCI). Holdings of securities booked under amortized cost could also lead to market losses, especially when they need to be liquidated at market value to meet rapid liquidity outflows, as book values could overstate their real-time market value in turbulent markets.

- *Credit deterioration of restructured loans and loans under COVID forbearance*. This analysis assumes a range of percentage migrations of restructured loans from the performing category to the non-performing category, with higher provisions (as NPLs are subject to higher coverage ratio). Alternatively, bank reported capital ratio in absence of the forbearance measures can be used in lieu of the sensitivity analysis to compare capital impact pre- and post- forbearance measures under the scenario-based stress test.

- *Bank concentration risks on top lending exposures*. This analysis assesses banks' resilience under the assumption of a simultaneous hypothetical default of five largest corporate borrowers. The resulting impacts on capital of the banks are reported separately for each experiment. The analysis also assumes the failure of SOEs within the top 20 corporate exposures to allow for the distinction of large exposures across segments (SOEs vs non-SOEs, etc.) to assess risks associated with sovereign-bank nexus and identify idiosyncratic vulnerabilities.

Result of the Scenario-Based Stress Test

39. The result of the scenario-based bank solvency stress test confirms the sector's resilience to severe macroeconomic shocks, while revealing tail risks in small banks.

- *The baseline scenario* confirms banks' strong capital positions, with capital accumulation for large banks. The systemwide CET1 ratios remain at a high level above 22 percent over the five-year horizon with marginal capital depletion of 72 basis points. Among the total banks, large state-owned banks outperform small banks with strong capital accumulation supported by high profitability. Small banks[27] are affected more due to lower NIM and higher operating cost, as well as initial effects from credit[28] and market losses and increase in RWAs due to balance sheet growth.

- *The adverse scenario* supports the overall resilience of the banking system, while revealing variation across banks by size and business models (Figure 17). On aggregate and under the

[27] There are some small banks that already had negative profits and high cost to income structure at the starting point of the stress test which contributed to additional losses across all scenarios.

[28] To address the initial gap observed between the actual impairment and the estimated impairment based on NPL flows via the back-testing approach, the team made a starting point adjustment by allocating the gap into each portfolio based on their NPL share for each bank, constantly over the 5-year horizon.

stagflation scenario, the fully loaded CET1 ratio declines by about 5 percentage points at the trough relative to the baseline for all banks, before stabilizing and slightly rebounding to 19 percent by the 5th year. When aggregating at banking group level, capital depletion is higher in the small banking groups, at between 6.4 and 9.4 percentage points at the trough relative to the starting point, compared to large banking groups at between 3.5 and 4.9 percentage points. In terms of business models, regional banks see smallest capital decline at 1.9 percentage points at trough due to limited credit exposure to the risky corporate portfolios, followed by state-owned banks and private banks (5 and 5.3 percentage points). Capital impact under the recession scenario appears to be more benign as CET1 ratios on aggregate experience smaller initial shock at 2.6 percentage point before swiftly rebounding to a level similar to the baseline, at 22.4 percent. Variation of results among banking groups is also observed under the recession scenario, with small banks experiencing larger shocks. Under both stagflation and recession scenarios, only a small number of banks (9 for stagflation and 6 for recession), fall below the CET1 hurdle rates[29], with asset ranging from 2.9 to 7.4 percent of total banking system assets, and capital shortfall from 0.2 to 0.3 percent of GDP, respectively. Small banks also display wider variation of capital depletion under the stagflation scenario, ranging from 0 to 35 percentage points drop, further confirming large heterogeneity and tail risks within the group (Figure 17 bottom panel). Leverage ratios, starting at a high level at 14 percent, are not binding under either scenarios and only experience marginal decline at two and one percentage point at the trough relative to the starting point, under the stagflation and recession scenario, respectively.

- The scenario-based stress test considers a full repricing of the securities booked under the Amortized Cost category. Without such effect, the aggregated CET1 ratio under the adverse scenario would be improved by about 120 and 30 basis points in the first year and over the five-year horizon, respectively, without significant changes in the number of failing banks.

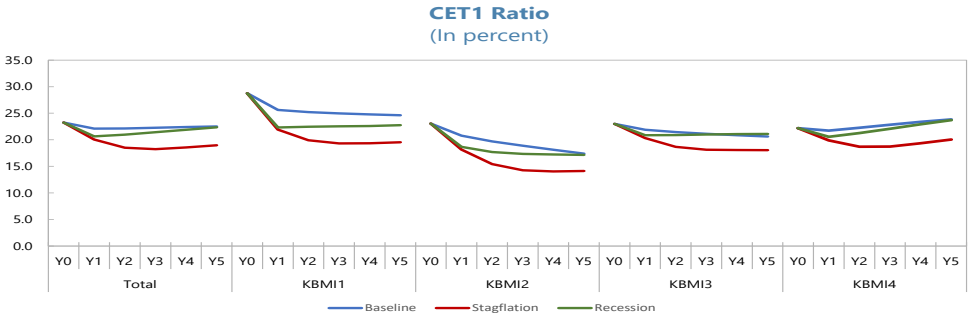
- The capital declines under the adverse scenarios are mostly driven by credit losses, followed by market and interest rate risks (Figure 18). Credit losses dominate loss drivers with cumulative decline of 9.4 and 19 percentage points under the stagflation scenario over a two-year and five-year horizon, respectively. Within credit losses, MSMEs experience the largest credit losses reaching up to 30 percent of total MSME loans cumulatively over a five-year horizon, followed by large corporates, banks and NBFIs (ranging from 16 to 18 percent), and household mortgages and retail loans at about 11 percent. Losses from market and interest rate risk follow credit losses with cumulative impact on CET1 ratio at 3.6 and 0.8 percentage points at trough respectively. Within market risks, domestic sovereign securities experience highest value drop at around 12 percent. The net interest margin declines by about 1 percentage point across banking groups, with slightly higher drop for KBMI1 and KBMI2 groups, reflecting their existing higher funding cost and therefore higher pressure on NIM under stress. The decline can be driven by losses associated with interest rate risks as banks reprice their funding and lending instruments under stress, as well as forgone interest income associated with rising NPLs. The effects on NPLs

[29] CET1 hurdle rates are bank specific and composed of minimum CET1 ratio (4.5), plus capital conservation buffer, bank specific D-SIB buffer and Pillar II surcharge. Banks are allowed to use capital conservation buffer under stress.

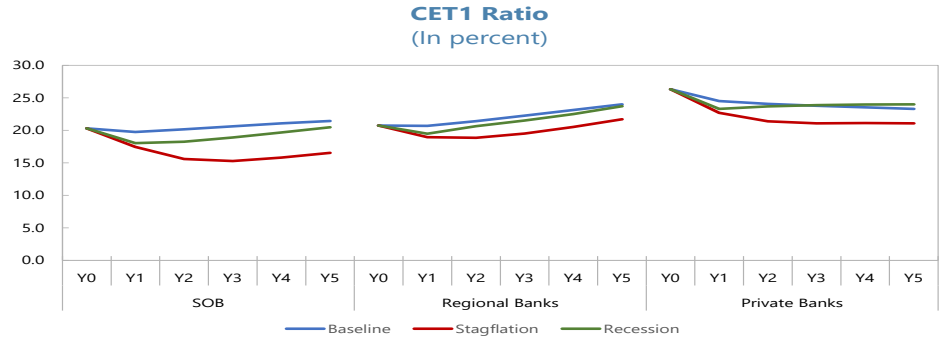
appears to be persistent over 5 years, whereas those of the interest rate risks recovers after the 3rd year after the initial negative impact on NIM in the first two years due to rising interest rates.

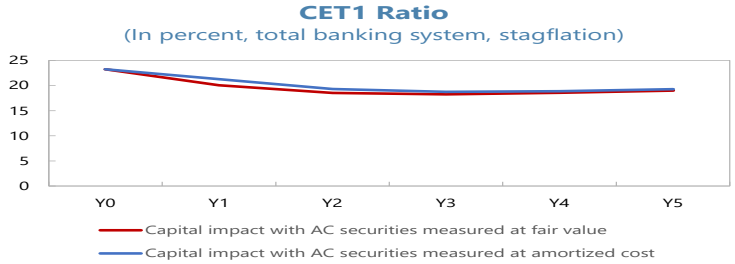
Figure 17. Indonesia: Results for Solvency Risk Analysis

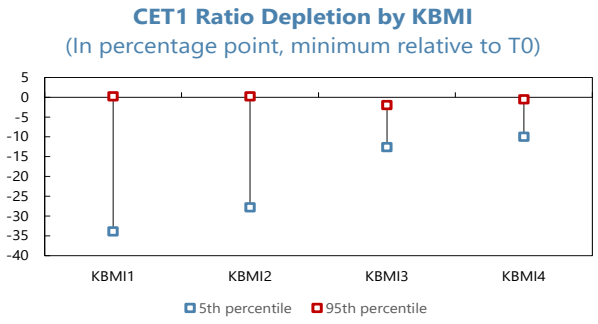
Result by Size

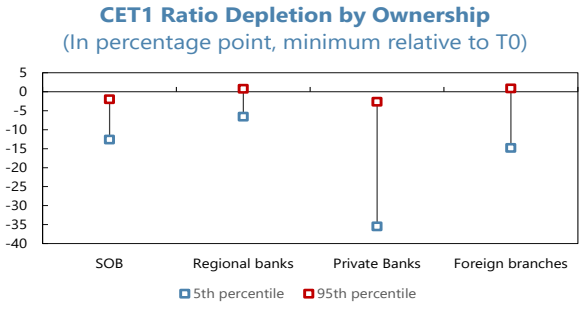


Result by Ownership







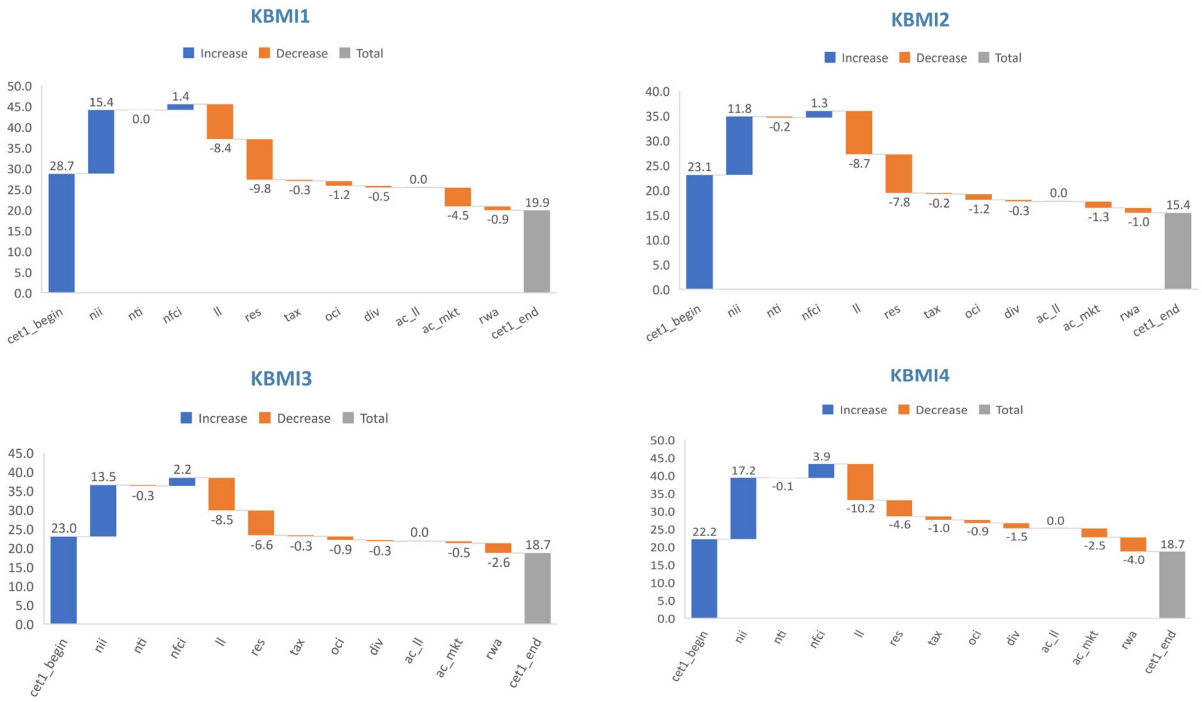


Source: IMF staff.
Note: Foreign branches are not subject to capital ratio requirement and thus excluded in the results.

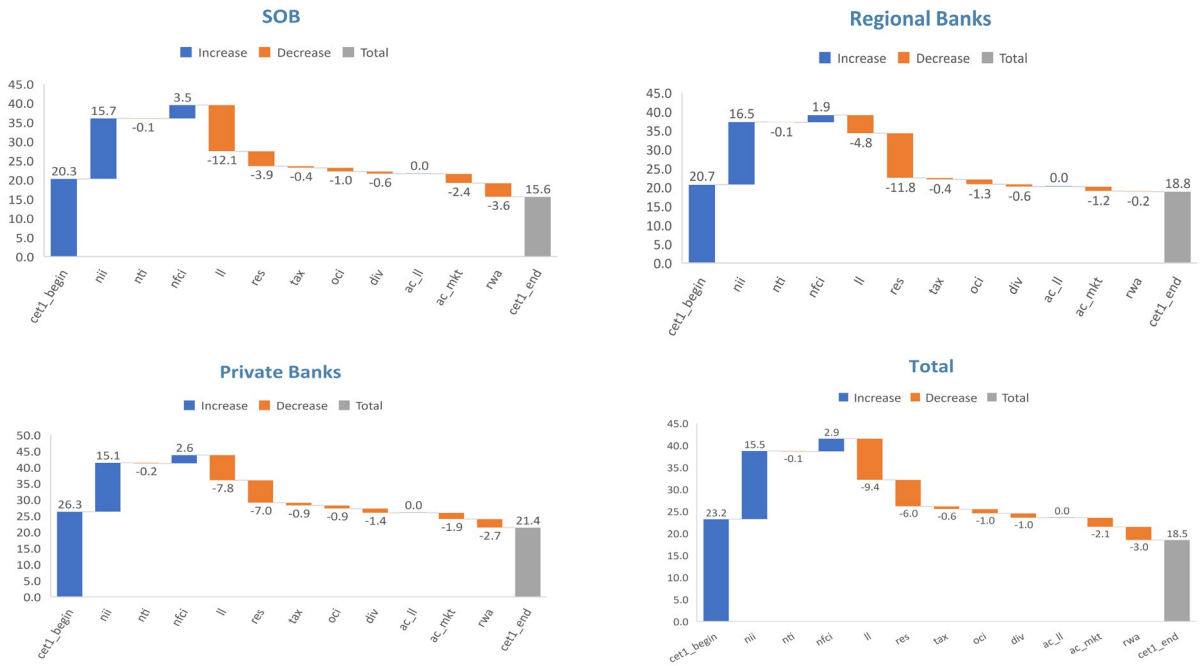
Figure 18. Indonesia: Contribution to CET1 Ratio Changes

(Up to year 2, stagflation scenario, in percentage points)

By Size



By Ownership

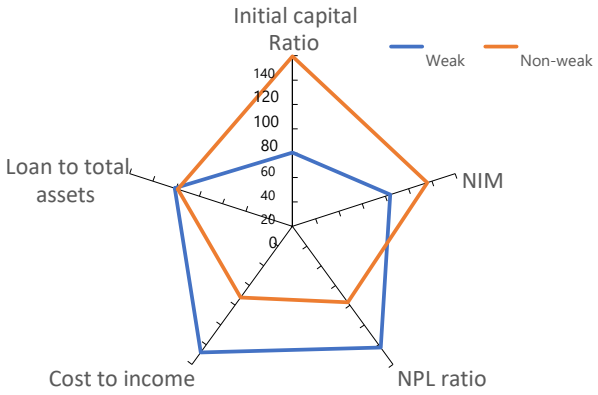


Source: IMF staff.

Note: nii = net interest income, nti = net trading income, nfci = net fees and commission income, ll = loan impairment, res = residual, oci = other comprehensive income, div = dividend, ac_ll = credit impairment for AC securities, ac_mkt = fairvalue impact on AC securities, rwa = risk-weighted assets. Foreign branches are not subject to capital ratio requirement and thus excluded in the results.

40. Assessment of weak banks reveals some commonality in capital position, profitability, and bank specific risk profile (Figure 19). Weak banks—defined as those with total capital ratio falling below CET1 requirement under the stagflation scenario (including pillar II and D-SIB surcharge and excluding capital conservation buffer)—account for about 9 banks and 7.4 percent of total banking sector assets and mostly are small banks. Common characteristics, such as lower initial capital ratio, lower NIM, higher cost to income ratio, and higher NPL ratio, explain the higher drop in capital, hence amplifying the likelihood for these banks to fall below the hurdle rates.

Figure 19. Indonesia: Weak Bank Characteristics



Source: IMF Staff.
Note: Value for each indicator is standardized for comparative purpose.

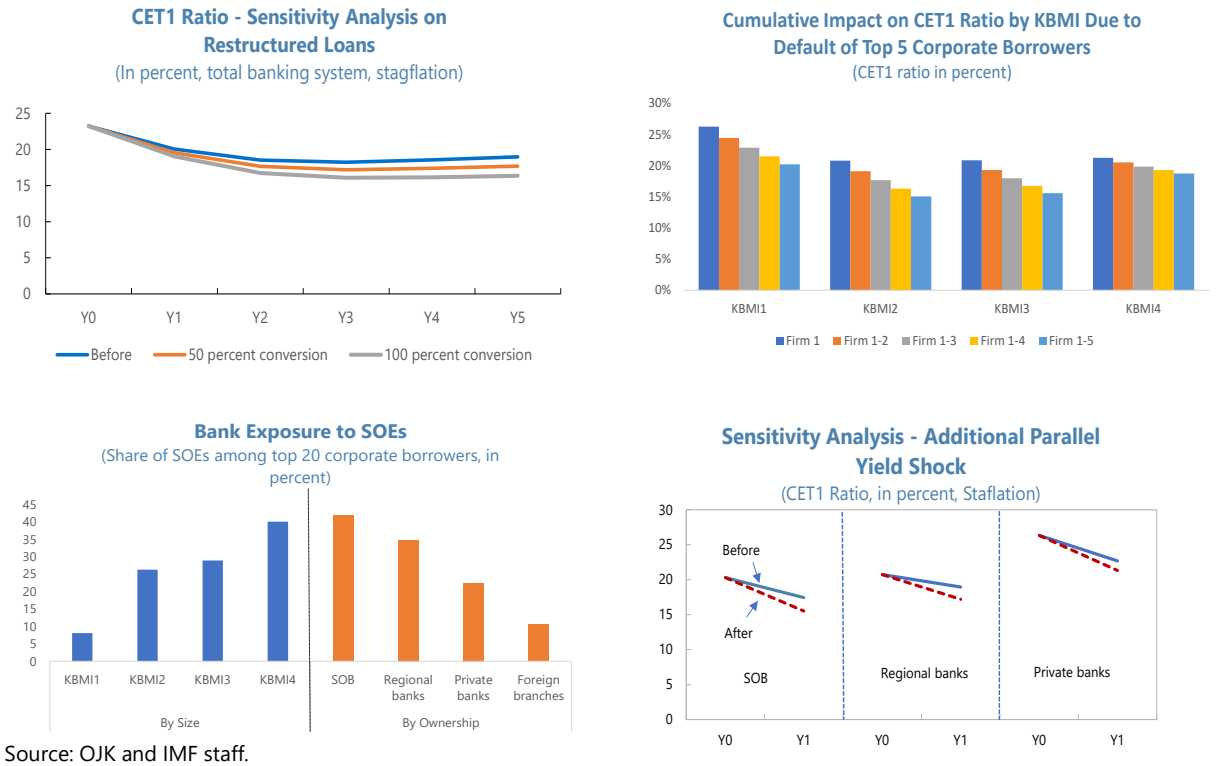
Sensitivity Analysis

41. A further rise in yields does not lead to material losses on bank balance sheets (Figure 20). The impact of rising interest rates could be immediately felt on bank trading portfolios, such as marketable debt securities due to either realized or unrealized valuation losses through the categories of fair value through profit and losses (FVTPL) and fair value through other comprehensive income (FVOCI). Holdings of securities booked under amortized cost could also lead to market losses, especially when they need to be liquidated at market value to meet rapid liquidity outflows, as book value could overstate their real-time market value in turbulent markets. Such market risks could be hedged using interest rate derivatives. Over time, higher rates may also increase or decrease net interest income (NII) depending on the time-to-repricing of assets versus liabilities and increase loan defaults and loan-loss provisioning (LLP) costs. Given the non-negligible share of sovereign securities held by the banks and recent migration of fair-value securities into amortized cost category to shield the banks from large market price fluctuation, a sensitivity analysis was performed to focus on the impact of further rising yield on valuation losses of the banks. The exercise simulates 400 percent points parallel upward shift on both short- and long-term yield on top of the initial shock under the stagflation scenario. Such additional shock leads to additional capital depletion of about 1.7 percentage points. This depletion is due to the market repricing for both fair-value and amortized cost securities. Repricing impact is higher on SOBs at 1.9 percentage

points than regional banks and domestic private banks at 1.8 and 1.4 percentage points, respectively. Only one additional small bank falls below the hurdle rate.

42. The capital impact of potential credit deterioration of the restructured loans is so far broadly contained but warrants close monitoring as the OJK's forbearance measure unwinds. As of June 2023, restructured loans account for about 10 percent of total loans—of which 8 percent are targeted at performing loans—and subsequently decline to 8 percent in December 2023. MSMEs, large corporate and mortgage loans stand out with higher share at around 10–12 percent within their respective loan category. Within the corporate sector, the accommodation, construction, and energy sector have higher share of restructured loans, at 75, 37, and 26 percent of loans in their respective categories. As of June 2023, the coverage ratios for non-performing and performing restructured loans are at 73 and 23 percent respectively and are considered broadly sufficient. Nonetheless, to gauge the risks associated with the restructured loans as they exit the OJK's forbearance measure, a sensitivity analysis simulates credit deterioration of these exposure by converting a certain percentage of the performing restructured loans into the non-performing category. Such analysis simulating credit deterioration of restructured loans suggests a further capital ratio decline by about 1.3 and 2.6 percentage points compared to the stagflation scenario, assuming 50 and 100 percent of performing restructured loans migrating to non-performing loans, respectively (Figure 20). Under both assumptions, only 3 to 4 additional small banks see their CET1 ratios fall below the hurdle rates, and capital shortfall remains low at 0.4 and 0.5 percent of GDP, respectively.

Figure 20. Indonesia: Results from Solvency Sensitivity Analysis



Source: OJK and IMF staff.

43. Bank exposure associated with credit insurance appear to be limited, thus mitigating the direct spillover risks from the potential pressure from the insurance companies to meet existing claims. The share of loans contracted with credit insurance stands at around 1 percent of total loans[30] and mostly cover performing loans, with the coverage for KBMI1 and regional banks at the highest at around 1.2 and 1.7 percent of total loans. Within sectors, MSME loans rank the highest coverage at around 3.5 percent of total MSME loans, followed by retail and interbank loans.

44. Bank concentration analysis confirms bank resilience against the simultaneous default of the top five corporate loans, however large exposure to state-owned companies appears to be higher for state-owned banks (Figure 20). The simultaneous default of top 5 corporate loans, when assuming a 100 LGD, leads to a CET1 ratio depletion of 5.5 percentage points, with higher impact for small banks than large banks. As a result, ten banks—mostly small banks—would fall below the CET1 hurdle rates. An exploratory exercise also simulates default of state-owned companies (SOEs) within the top 20 corporate exposures and reveals higher exposure to large SOEs of the state-owned and regional banks than private banks, at 42 and 35 percent, respectively. Nonetheless, the simultaneous default of these SOEs would have a limited impact, an about 3.6 percentage points drop of CET1 ratios and the failure of 4 small banks due to the limited size of individual SOEs within the top 20 firms.

E. Recommendations

45. Key recommendations drawing from the bank solvency risk analysis focus on enhanced monitoring of small banks, timely and full recognition of NPLs, and monitoring of corporate sector risks. The FSAP recommends that the authorities, to the extent possible, to require banks to recognize NPLs in a timely and full manner[31], increase intensity in the scrutiny of restructured loans and use multiple benchmarks—such as loan-at-risk or loan impairment with a split between performing and non-performing loan impairment—to capture problem loans properly and promptly in top-down stress tests. Furthermore, given the implementation of the IFRS9 accounting standards across all banks, it would be opportune to start asking banks to compile and report transition matrices between asset stages, to allow for IFSR9-consistent forward-looking credit monitoring and provisioning for all asset stages based on the expected credit loss approach. Authorities do not collect or analyze firm-level data on MSMEs beyond bank reporting and generally rely on commercial data vender (such as Capital IQ) on data on large corporates. Enhanced data collection on the corporate sector, especially on MSMEs and informal segment, and allowing disaggregation by sectors and ownerships (SOEs vs non-SOEs), would facilitate targeted credit risk mitigation in vulnerable and concentrated segments in the market. Drawing from findings on the large variation across banks in terms of business models and risk profiles, the exercise also

[30] The coverage could be understated as it only covers exposure which treats the credit insurance as its first collateral which is embedded in the calculation of provisions.

[31] This is in line with the expiration of the OJK's loan restructuring policy relaxation in March 2024, which requires banks to apply prudent loan restructuring principles as stipulated in the OJK regulation No.40/POJK.03/2019 regarding Commercial Bank Asset Quality Assessment.

recommends authorities to enhance risk monitoring and stress testing (both top-down and bottom-up) for small and weak banks, as identified in regular stress tests.

BANKS LIQUIDITY RISK ANALYSIS

A. Introduction

46. Two distinct liquidity stress tests are conducted to assess banks' capacity to withstand large withdrawals of funding and market liquidity shocks. The FSAP team performed cash-flow based stress test for 105 commercial banks and NSFR stress test for 51 commercial banks which are subject to the NSFR reporting.[32] The cash-flow based stress test leverages information on maturity profile up to a 3-month horizon to investigate potential maturity mismatches and assess the availability of bank counterbalancing capacity to offset net-cash outflows. Contrast with cashflow analysis which focuses on liquidity mismatch over the short-term, the NSFR stress test is conducted to gauge structural long-term refinancing and funding risks of the banks. Currently, all banks report their maturity ladder information and 51 banks (mainly constitute KBMI2 to KBMI4 banks) report their LCR and NSFR position. Also, banks report their foreign currency position through the maturity ladder template used for cashflow analysis but not through LCR or NSFR reporting. There is currently no LCR requirement on foreign currency position of the banks. Given such limitations, the cashflow-based stress test is preferred over the LCR stress test to assess the liquidity capacity across all banks and by currencies.

47. The liquidity stress test relies on multiple data sources. The cash-flow based stress test and NSFR stress test are based on regulatory reports as of 2023:Q2. To complement the main stress test, a comparison of liquidity positions since 2017 is performed to assess the evolution of liquidity buffers over time. NSFR stress test is assessed in total currency due to data limitation by currencies and the cash-flow based stress test is assessed separately in Rupiah and US dollar. Data input for cash-flow based stress test is also combined with bank reporting on holdings of fair-value and amortized cost securities to allow for liquidity-solvency interaction when banks need to tap into their AC securities to meet large liquidity outflows, thereby incurring additional capital losses. Finally, a split between encumbered and unencumbered liquid assets is requested to gauge liquidity capacity of the banks.

48. The liquidity stress test uses different thresholds. The cash-flow based stress test uses the amount of counterbalancing capacity as the threshold to assess the resilience of banks, with negative amounts indicating bank failure in the test. These thresholds are applied homogenously across all banks in the stress testing sample. The NSFR based stress test uses a 100 percent threshold, which is the minimum regulatory requirement.

49. Similar to the solvency stress test, the liquidity stress test aims to address several important types of liquidity risks facing the Indonesian banking sector. Specifically, the focus of

[32] The following banks are subject to LCR and NSFR reporting: (i) non-Islamic banks; (ii) banks under KBMI 2–4; and (iii) foreign branch and or private banks owned by foreign investors under KBMI1.

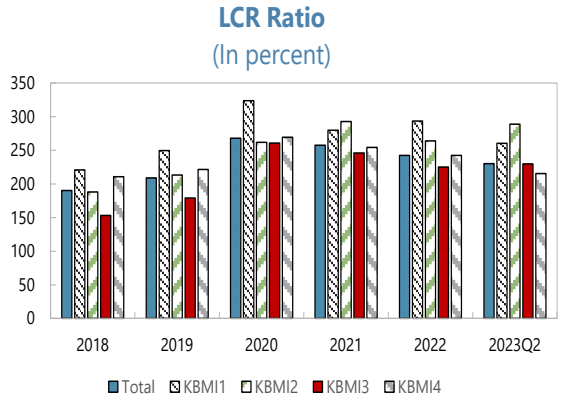
the analyses would be to: (i) identify any vulnerabilities associated with any liquidity mismatches due to different maturity structures on the asset and liability side of banks' balance sheets; (ii) assess the adequacy of liquidity buffers of banks' given the recent reversal of the expansion of their liquid assets; (iii) assess potential concentration risks stemming from large single-named funding sources of banks; and (iv) assess the stability of funding of banks or banking groups given their varying exposure to various funding categories with different run-risks, and potential stabilizing effects from existing deposit insurance coverage. Motivated by recent liquidity distresses observed in the advanced economies, a reverse stress test was implemented to tackle the scenario uncertainty of the outflow rates. Finally, depending on whether banks sell or pledge their liquid assets, haircut on collateral could be informed by those calibrated under the solvency stress test and previous FSAPs, and existing collateral framework implemented by the BI.

B. Cashflow-Based Liquidity Stress Test

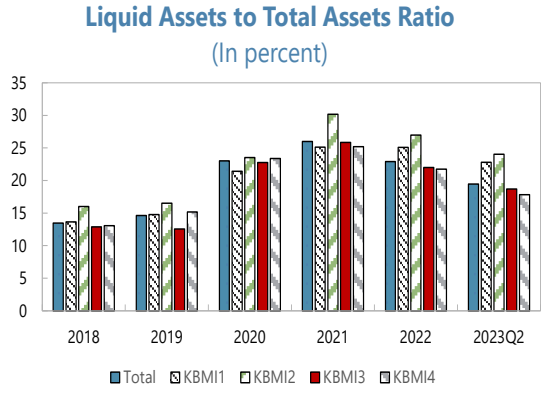
50. Banks liquidity position has seen improvement since the pandemic, followed by moderate retrenchment driven by economic recovery (Figure 21). Liquidity metrics, such as the LCR, NSFR and liquid asset to total asset ratio, have improved since 2020 by a series of government stimulus programs accompanied by an influx of deposit funding. At the same time, banks have increased their holdings of sovereign securities as a form of high-quality liquid assets amid weak loan demand during the pandemic. This has increased the level of counter-balancing capacity of the banks, which peaked in 2021, before moderate decline due to the recovery of economic activities and domestic consumptions which reduced deposit funding in the banking system.

Figure 21. Indonesia: Banking Sector—Liquidity Condition

LCR ratios have improved during the pandemic before marginally reversing post-pandemic…



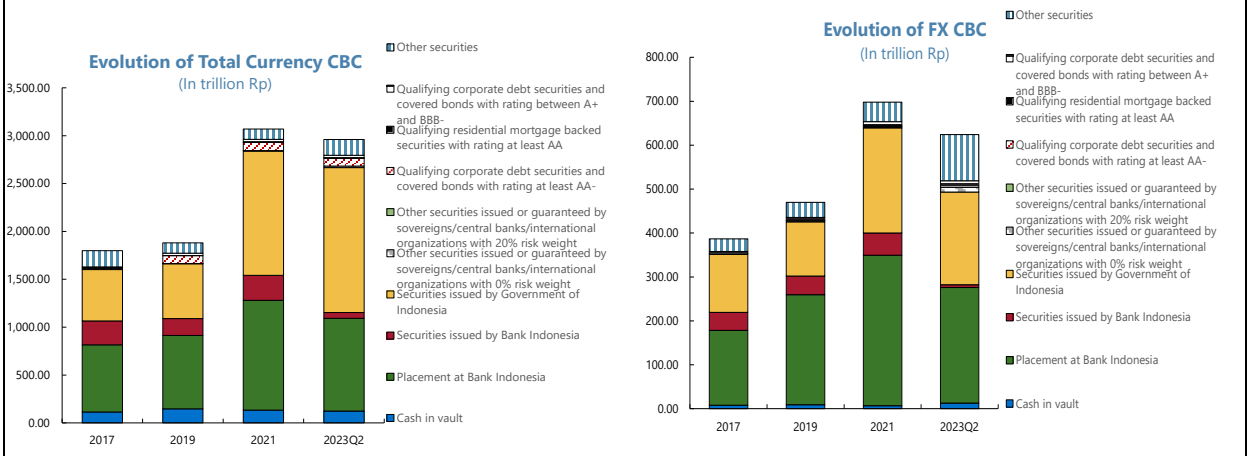
…So do liquid assets to total assets ratios…



…which are mainly supported by increase in central bank reserves and sovereign securities holdings…

…as well as in foreign currencies.

Figure 21. Indonesia: Banking Sector—Liquidity Condition (concluded)



Source: BI and IMF staff.

51. Maturity mismatches may expose banks to liquidity strains in a sustained liquidity stress environment (Figure 22). On aggregate, banks obtain most of their funding via retail and wholesale deposits, of which 100 and 90 percent were placed within the overnight bucket, which can reduce banks' liquidity position over short term. On the asset side, over 85 percent of cash inflows, mostly comprised of maturing loans, would materialize beyond the first three months. This has led to a maturity mismatch characterized by more frontloaded cash outflows and backloaded cash inflows,[33] potentially leaving banks vulnerable to liquidity gaps under sustained liquidity stress over the longer term. Such mismatch can be observed for both domestic and foreign currencies, although FX constitute a moderate portion of asset and liabilities on bank balance sheet. These observations underscore the need for continued monitoring of banks' maturity structures to promptly identify and address potential liquidity strains over both short- and long-term horizon.

Figure 22. Indonesia: Contractual Obligation as Share of Assets

(In percent)

Total Currency

	Open maturity	Overnight	Greater than overnight up to 2 days	Greater than 2 days up to 3 days	Greater than 3 days up to 4 days	Greater than 4 days up to 5 days	Greater than 5 days up to 6 days	Greater than 6 days up to 7 days	Greater than 7 days up to 2 weeks	Greater than 2 weeks up to 3 weeks	Greater than 3 weeks up to 4 weeks	Greater than 4 weeks up to 5 weeks	Greater than 5 weeks up to 2 months	Greater than 2 months up to 3 months	Greater than 3 months up to 6 months	Greater than 6 months up to 9 months	Greater than 9 months up to 12 months	Greater than 12 months up to 2 years	Greater than 2 years up to 3 years	Greater than 3 years up to 5 years	Greater than 5 years up to 10 years	Greater than 10 years
Counter-balancing capacity	26.41	0.00	0.00	0.22	0.14	0.05	0.10	0.03	0.08	0.02	0.04	0.00	0.02	0.03	0.00	0.00	0.00	0.05	0.12	0.08	0.00	0.00
Cash in vault	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Placement at Bank Indonesia	8.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unencumbered securities	15.92	0.00	0.00	0.22	0.14	0.05	0.10	0.03	0.08	0.02	0.04	0.00	0.02	0.03	0.00	0.00	0.00	0.05	0.12	0.08	0.00	0.00
Other eligible collaterals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Existing credit/liquidity lines	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash inflows	0.00	0.14	0.00	1.01	0.39	0.15	0.13	0.18	0.48	0.21	1.61	3.18	2.17	2.34	5.09	4.20	4.36	4.57	5.83	11.40	11.43	10.18
Other Maturing Mutual Fund	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.15	0.04	0.03	0.21	0.14	0.01
Maturing secured lending	0.00	0.05	0.00	0.61	0.29	0.09	0.08	0.13	0.30	0.10	0.19	0.06	0.25	0.23	0.64	0.89	0.61	0.00	0.00	0.00	0.00	0.16
Maturing loans	0.00	0.06	0.00	0.32	0.09	0.05	0.04	0.04	0.12	0.05	1.21	3.08	1.79	1.97	4.18	3.27	3.59	4.53	5.80	11.20	11.29	9.46
Inflows from derivatives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.08
Interest income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
Other contractual inflows	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.01	0.05	0.04	0.06	0.04	0.11	0.13	0.25	0.02	0.01	0.00	0.00	0.00	0.00	0.01
Cash outflows	77.86	0.10	0.00	0.64	0.38	0.14	0.15	0.07	0.25	0.19	0.77	0.11	0.26	0.42	0.73	0.37	0.80	0.87	0.49	0.64	0.43	2.27
Own securities issuance due	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.07	0.02	0.00	0.01	0.05	0.02	0.00	0.20	0.00	0.00	0.00	0.00	0.56
Due secured borrowing	0.00	0.01	0.00	0.30	0.27	0.05	0.10	0.03	0.07	0.03	0.03	0.01	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Customer deposits - individuals	35.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - SMEs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - Other entities	26.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other deposits and unsecured borrowing	10.93	0.08	0.00	0.30	0.10	0.08	0.03	0.04	0.13	0.05	0.67	0.06	0.10	0.16	0.34	0.11	0.35	0.00	0.00	0.00	0.00	1.34
Outflows from derivatives transactions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.09
Interest expense	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undrawn committed credit/liquidity lines	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other contractual outflows	0.00	0.01	0.00	0.02	0.00	0.00	0.01	0.01	0.04	0.03	0.04	0.04	0.12	0.17	0.35	0.24	0.24	0.87	0.49	0.64	0.43	0.06

[33] Banks typically use historical data and business insights to calculate the run-off rate of contractually overnight funds with an effort to mitigate the impact of the maturity mismatch characterized by frontloaded cash outflows and backloaded cash inflows.

Figure 22. Indonesia: Contractual Obligation as Share of Assets (concluded)

IDR

	Open maturity	Overnight	Greater than overnight up to 2 days	Greater than 2 days up to 3 days	Greater than 3 days up to 4 days	Greater than 4 days up to 5 days	Greater than 5 days up to 6 days	Greater than 6 days up to 7 days	Greater than 7 days up to 2 weeks	Greater than 2 weeks up to 3 weeks	Greater than 3 weeks up to 4 weeks	Greater than 4 weeks up to 5 weeks	Greater than 5 weeks up to 2 months	Greater than 2 months up to 3 months	Greater than 3 months up to 6 months	Greater than 6 months up to 9 months	Greater than 9 months up to 12 months	Greater than 12 months up to 2 years	Greater than 2 years up to 3 years	Greater than 3 years up to 5 years	Greater than 5 years up to 10 years	Greater than 10 years
Counter-balancing capacity	18.54	0.00	0.00	0.22	0.14	0.05	0.05	0.03	0.08	0.02	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.04	0.00	0.00
Cash in vault	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Placement at Bank Indonesia	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unencumbered securities	13.04	0.00	0.00	0.22	0.14	0.05	0.05	0.03	0.08	0.02	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.04	0.00	0.00
Other eligible collaterals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Existing credit/liquidity lines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash inflows	0.00	0.08	0.00	0.91	0.39	0.13	0.08	0.17	0.37	0.13	0.31	2.47	1.71	1.89	4.26	3.83	3.81	3.76	5.10	9.30	9.98	9.19
Other Maturing Mutual Fund	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.14	0.04	0.03	0.21	0.14	0.01
Maturing secured lending	0.00	0.05	0.00	0.61	0.29	0.09	0.04	0.13	0.30	0.10	0.17	0.06	0.25	0.23	0.64	0.89	0.61	0.00	0.00	0.00	0.00	0.03
Maturing loans	0.00	0.01	0.00	0.24	0.09	0.04	0.03	0.03	0.05	0.00	0.10	2.39	1.40	1.58	3.46	2.91	3.06	3.71	5.07	9.10	9.84	9.12
Inflows from derivatives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
Interest income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other contractual inflows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.03	0.02	0.05	0.07	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Cash outflows	66.36	0.06	0.00	0.56	0.38	0.10	0.10	0.07	0.16	0.06	0.50	0.03	0.10	0.16	0.37	0.23	0.32	0.60	0.30	0.25	0.14	0.98
Own securities issuance due	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.05	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.42
Due secured borrowing	0.00	0.00	0.00	0.29	0.27	0.05	0.07	0.03	0.07	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Customer deposits - individuals	32.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - SMEs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - Other entities	19.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other deposits and unsecured borrowing	10.66	0.05	0.00	0.23	0.10	0.04	0.03	0.03	0.06	0.01	0.44	0.00	0.02	0.02	0.10	0.02	0.10	0.00	0.00	0.00	0.00	0.46
Outflows from derivatives transactions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Interest expense	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undrawn committed credit/liquidity lines	3.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other contractual outflows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.05	0.08	0.23	0.21	0.18	0.60	0.30	0.25	0.14	0.01

USD

	Open maturity	Overnight	Greater than overnight up to 2 days	Greater than 2 days up to 3 days	Greater than 3 days up to 4 days	Greater than 4 days up to 5 days	Greater than 5 days up to 6 days	Greater than 6 days up to 7 days	Greater than 7 days up to 2 weeks	Greater than 2 weeks up to 3 weeks	Greater than 3 weeks up to 4 weeks	Greater than 4 weeks up to 5 weeks	Greater than 5 weeks up to 2 months	Greater than 2 months up to 3 months	Greater than 3 months up to 6 months	Greater than 6 months up to 9 months	Greater than 9 months up to 12 months	Greater than 12 months up to 2 years	Greater than 2 years up to 3 years	Greater than 3 years up to 5 years	Greater than 5 years up to 10 years	Greater than 10 years
Counter-balancing capacity	5.98	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.04	0.11	0.04	0.00	0.00
Cash in vault	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Placement at Bank Indonesia	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unencumbered securities	2.88	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.04	0.11	0.04	0.00	0.00
Other eligible collaterals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Existing credit/liquidity lines	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash inflows	0.00	0.06	0.00	0.10	0.00	0.02	0.05	0.01	0.11	0.08	1.30	0.71	0.46	0.45	0.84	0.37	0.56	0.81	0.73	2.12	1.46	0.99
Other Maturing Mutual Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Maturing secured lending	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Maturing loans	0.00	0.04	0.00	0.09	0.00	0.02	0.01	0.00	0.07	0.05	1.10	0.69	0.40	0.38	0.72	0.35	0.54	0.81	0.73	2.12	1.45	0.34
Inflows from derivatives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Interest income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
Other contractual inflows	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.01	0.03	0.02	0.03	0.02	0.06	0.06	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Cash outflows	11.50	0.04	0.00	0.09	0.01	0.04	0.04	0.01	0.09	0.13	0.28	0.07	0.16	0.25	0.37	0.14	0.48	0.26	0.20	0.38	0.30	1.29
Own securities issuance due	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.15
Due secured borrowing	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Customer deposits - individuals	2.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - SMEs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Customer deposits - Other entities	7.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other deposits and unsecured borrowing	0.27	0.02	0.00	0.07	0.00	0.04	0.01	0.00	0.07	0.04	0.24	0.05	0.07	0.13	0.24	0.09	0.25	0.00	0.00	0.00	0.00	0.89
Outflows from derivatives transactions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Interest expense	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undrawn committed credit/liquidity lines	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other contractual outflows	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.07	0.09	0.12	0.04	0.06	0.26	0.20	0.38	0.30	0.04

Source: BI and IMF staff estimates.

52. The cashflow based analysis assesses the adequacy of banks' liquid assets to offset large cash inflow and outflow shocks over time. The cash-flow based analysis, building on maturity ladder data in the regulatory report as of 2023:Q2, focuses on net liquidity positions, which are defined as the differences between the cumulated net funding gap (sum of inflows minus outflows across maturity buckets) and the cumulated counterbalancing capacity (sum of liquid assets across maturity buckets). If the net liquidity position becomes negative after utilizing the counterbalancing capacity, a liquidity shortfall is recognized, and banks won't be able to meet further funding withdrawals.

53. Outflow and inflow shocks are calibrated based on several assumptions. First, higher run-off rates for wholesale funding than retail funding are applied to reflect the first mover advantage of better-informed, sophisticated depositors compared to retail depositors. Second, run-off rates on secured funding sources—such as those covered under the deposit insurance—are lower than unsecured funding sources. Third, the inflow parameters can in principle allow a maximum 100 percent of contractual inflows, except for the assumption of no inflows from loans to retail and corporate customers. This replicates recent policy responses that allowed the

postponement in repayment (debt moratoria) from distressed household and corporate borrowers amid the COVID-19 stress episodes and is consistent with the assumptions that banks are not allowed to deleverage (i.e., maturing loans are replaced by new loans) under stress testing scenarios. Finally, the outflow rates, tailored to Indonesia specific funding composition, is set to be higher for current and time deposits than the saving deposits, given the inherent high stability and stickiness of the retail deposits for saving purpose.

54. The cashflow liquidity stress test runs a set of embedded scenarios of increasing severity, for 5-days, 4-week, and 3-months horizons. Three stress scenarios with increasing severity (mild market stress, medium market stress and severe market stress) are applied to all banks with the assumptions on counterbalancing capacity for mild and severe market stress as below.

- Full CBC (under mild market stress): fully endogenous liquidity supply by the BI as long as banks have unencumbered eligible collateral to pledge at BI haircut rate and no additional market haircut is assumed.

- CBC with market haircuts (under severe market stress): a full CBC is assumed but is subject to market specific haircuts when pledging or liquidating assets to meet funding run-offs. The liquid assets haircuts could draw on market value declines from the solvency stress test (e.g., stagflation scenario) or past FSAPs, and are also informed by the additional haircut (on top of the market decline) when banks need to repo the liquid assets to the BI.

- Detailed stress parameters for the cashflow based stress test can be found in Table 2. The calibration of the scenarios weighs past stress episodes drawing from historical time series, previous FSAP stress parameters, while also taking into account recent liquidity episodes observed in several advanced economies. Therefore, the size of the shocks, especially for the severe scenario, are considered more conservative than those used in authorities' stress tests. Market haircuts to CBCs draw from the outcome of market revaluation shock under the solvency stress test and are also informed by the valuation haircut when banks need to repo the liquid assets to the BI. Finally, given the importance of the banking system in intermediating and providing FX liquidity in the financial system, the cashflow analysis also assessed bank liquidity capacity for foreign currencies separately, using the same assumptions as the total and IDR based stress test, to gauge potential liquidity pressure stemming from banks' US dollar fundings.

55. As additional sensitivity analysis, the liquidity stress test also assesses concentration risk of funding, performs reverse stress test of selected funding items and explores liquidity-solvency interactions via the selling of AC securities at market price to meet large liquidity drawdowns. Given the fact that large individual depositors (deposit >IDR 2 billion) account for 60 percent of total deposit, a standalone exercise assumes a loss of top 5 largest deposits from government, corporates, financial institutions, and individuals, and computes the remaining CBCs to assess concentration risk of single-named funding sources to bank liquidity conditions. Similarly, a reverse stress test attempts to identify bank specific outflow rates over which certain types of funding sources, such as uninsured deposits or total deposits, would fully deplete the CBCs. The resulting bank specific outflow thresholds collectively form a distributional view of the variations

across banks and outliers in the system due to potential run risks at the funding instrument level. Finally, in light of the increasing share of AC securities on bank balance sheet, the exercise also assesses potential capital impact due to the market repricing of the AC securities which are sold, subsequent to the fair-value securities, to meet large liquidity outflows.

Result of Cashflow-Based Liquidity Stress Test

56. The total currency and IDR-based cashflow analysis confirms overall resilience of the banking system to withstand severe outflow shocks over the short-term, while suggesting moderate liquidity gaps when extending the analysis beyond 30-days (Figure 23). On aggregate and for the total currency assessment, the banking system can withstand severe outflow shock up to 3 months, with positive CBCs balance at around 6 percent of total assets. At individual bank level, the asset share of banks experiencing liquidity shortfalls appear to be small at only 0.2 percent of total assets up to 30 days, before reaching to 13.3 percent of total assets up to 3 months. They are mostly composed of small and medium sized banks, which no liquidity shortfall observed in the KBMI4 group. The size of the liquidity shortfall relative to total assets are also small at only around 0.3 percent of total assets. Similar findings apply to the IDR-based assessment, with asset share of failing banks at 15.7 percent and liquidity shortfall at 0.5 percent of total asset, only slightly above those observed under the total currency analysis. Consistent with the bank solvency stress test, the results also reveal large variations of liquidity position post shocks, especially in the small banking cohorts.

Table 2. Indonesia: Cashflow Stress Test Parameters

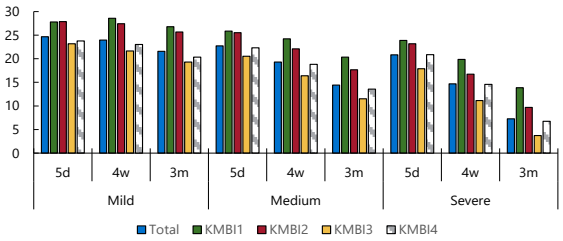
Type	Item	Range of Run-off Factors (In Percent) across Mild, Medium and Severe Scenarios
Outflows	Own securities issuance due	40-100%
	Regulated covered bonds	25-70%
	Securitisations and others	100%
	Repos across all asset classes	100%
	Retail deposits (households CASA, etc)	3-20%
	Insured	3-10%
	Uninsured	6-20%
	Corporate deposits (Large corporates and MSMEs)	6-40%
	Insured	6-20%
	Uninsured	12-40%
	Other deposits and unsecured borrowing (non-resident, banks, NBFIs, government)	20-100%
	Derivatives	100%
	Committed facilities	10-100%
	Other contractual outflows	0-100%
Inflows	Reverse repos across all asset classes	100%
	Loan inflows from retail and corporates (performing and non-performing)	0-30%
	Loan inflows from central banks	100%
	Loan inflows from banks and NBFIs	0-100%
	Loan inflows from others	0-30%
	Derivatives	100%
Type	Item	**Haircut Based on Market Price**
Counterbalancing Capacity	Cash	100%
	Central Bank exposures	100%
	0% RW securities	95-85%
	20% RW securities	85-75%
	Covered bonds	85-75%
	Corporate bonds	85-70%
	RMBS	80-70%
	Other CB elig. Assets (including credit assets under ELA)	50-40%
	Non-CB elig. equities	0%
	Other non-CB elig. assets	0%
	Undrawn committed credit lines	100-0%

Source: IMF staff.
Note: Under the FX cashflow analysis, FX bonds issued by foreign government, such as the US treasuries, are subject to a lower haircut than domestically issued FX bond by the Indonesian government.

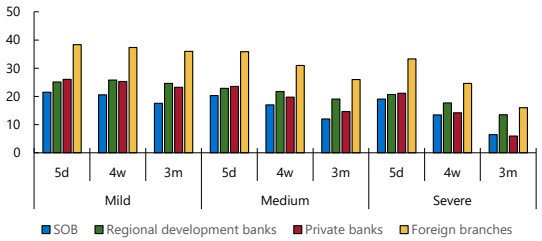
Figure 23. Indonesia: Result for the Liquidity Risk Analysis

Total Currency

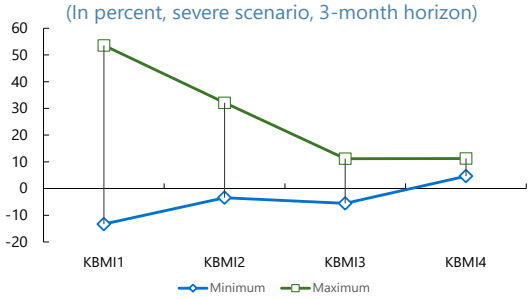
Remaining CBC as Share of Assets
(In percent)



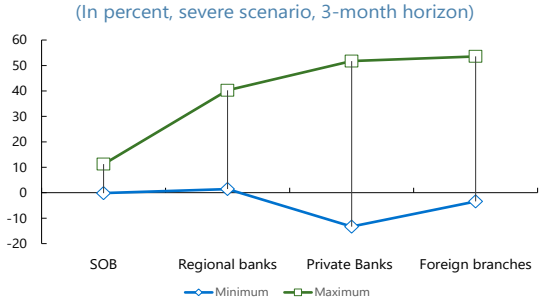
Remaining CBC as Share of Assets
(In percent)



Remaining CBC as Share of Assets
(In percent, severe scenario, 3-month horizon)

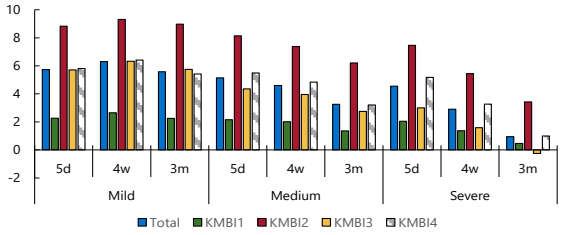


Remaining CBC as Share of Assets
(In percent, severe scenario, 3-month horizon)

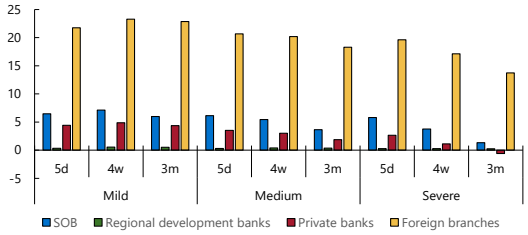


Foreign Currency—US Dollar

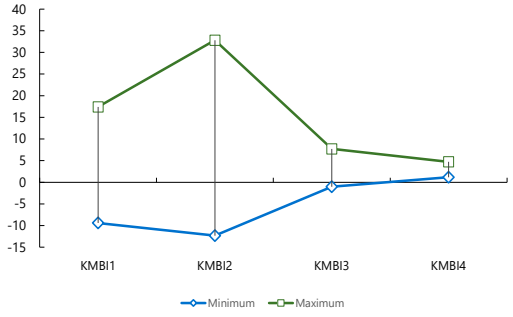
Remaining CBC as Share of Assets
(In percent)



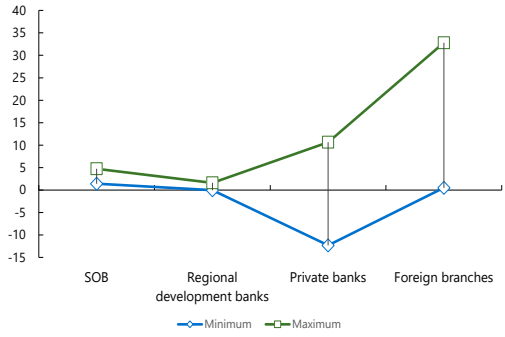
Remaining CBC as Share of Assets
(In percent)



Remaining CBC as Share of Assets
(In percent, medium scenario, 3-month horizon)



Remaining CBC as Share of Assets
(In percent, medium scenario, 3-month horizon)



Source: IMF staff.

57. The drivers of bank outflows are mainly wholesale deposits from corporate, banks, and NBFIs entities, and more so in the uninsured segments (Figure 24). For total currency and up to 3-month horizon, deposits from corporate entities and NBFIs contribute to about 6 and 4 percentage point of the changes in the CBCs as a share of total assets, followed by undrawn credit lines and retail deposit at 3.5 and 2.2 percent, respectively. The total uninsured deposits, subject to a higher outflow rate, contribute to about 9 percentage point of the CBC changes, higher than insured deposits at about 1.3 percentage point.

58. The dollar-denominated cashflow analysis paints a more adverse picture beyond 30 days than domestic currency, although shortfalls are broadly contained due to limited FX exposure on bank balance sheet (Figure 23). The CBCs post-shock on the system level remain positive up to 3-month horizon, with only small liquidity gaps for the KBMI3 group composed mostly of private banks. On individual bank level, the share of banks facing liquidity shortages appear to be notably higher than those observed under the domestic currency analysis and include a few large banks,[34] reaching to 47 percent of total asset by the 3-month horizon, however the size of liquidity shortfalls remains manageable at 0.7 percent of total assets, mainly due to limited FX exposure on bank balance sheet, constituting around 17 percent of assets and 18 percent of total liabilities. Nonetheless, the higher share of banks experiencing liquidity strains underscore the importance of continued monitoring of foreign currency liquidity conditions to promptly identify potential liquidity gaps across all banks over the short- and medium-term horizon.[35]

C. NSFR-Based Liquidity Stress Test

59. Most banks are well above the NSFR limit (Figure 25). As of mid-2023, the aggregate NSFR of sample banks stood at 136 percent, comfortably above the minimum requirement of 100 percent with no single bank below the threshold. A volume-based approach was considered in the NSFR-based stress test. The aggregate NSFR has been increasing since 2019, supported by increasing share of stable retail deposits (mostly treated as stable funding under NSFR regulatory standards). The high share of HQLA assets with short duration also reflects lower needs of stable funding (RSF). Comparing across banking groups, retail deposits account for a larger share of stable funding of large banks such as KBMI3 and KBMI4, whereas for small banks including regional banks, long term wholesale deposits and capital dominate.

60. The NSFR stress test adopts a volume-based technique to simulate a migration from long-term to short-term funding. The focus of the stress test is to assess the risks associated with the overreliance on short-term unstable funding and excessive maturity transformation, and to test the resilience of banks to manage funding risks over a long-term horizon by financing their activities with sufficiently stable sources of funding. To this end, the exercise applies pre-defined migration rates from long-term to short-term funding for the following available stable funding (ASF)

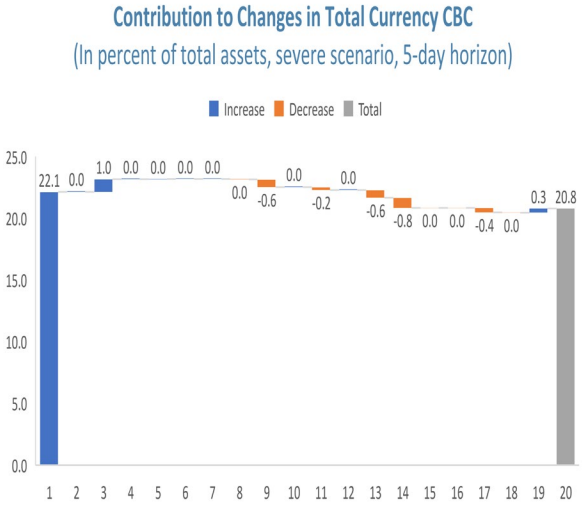
[34] Large banks are defined as those classified under KBMI3 and KBMI4 groups.

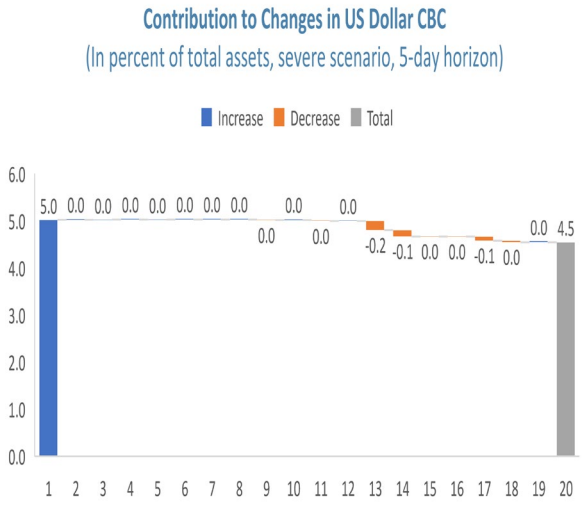
[35] Currently, the BI does not accept collaterals denominated in FX to provide FX liquidity to banks. There are however several alternative options for the banks to receive needed FX liquidity from the market, such as FX money market, FX repo transactions, and FX swap transactions. Besides that, banks could also issue bonds in FX.

instruments to simulate shocks on funding stability: deposits from individuals, MSMEs and other corporates, and funding from interdependent liabilities such as relevant credit and liquidity facilities, and other liabilities such as trade payables. Equity instruments are not stressed, assuming banks do not issue or repurchase equity.

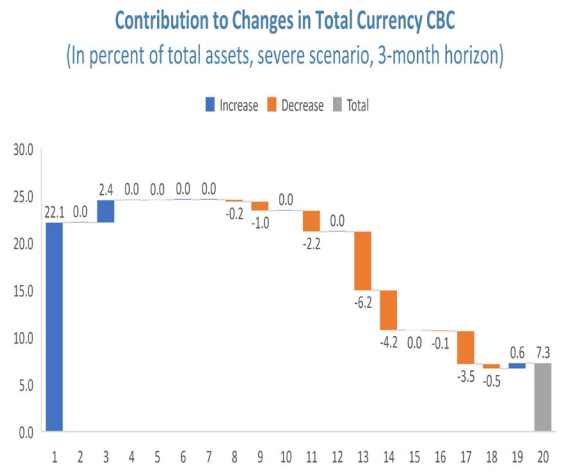
Figure 24. Indonesia: Contribution to Change in CBCs
(In percent of total asset)

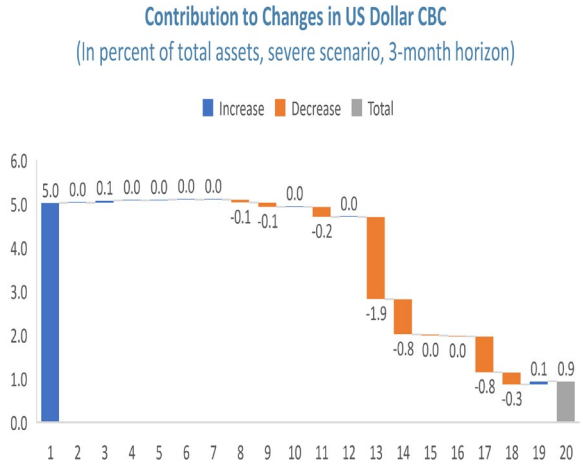
5-Day Horizon





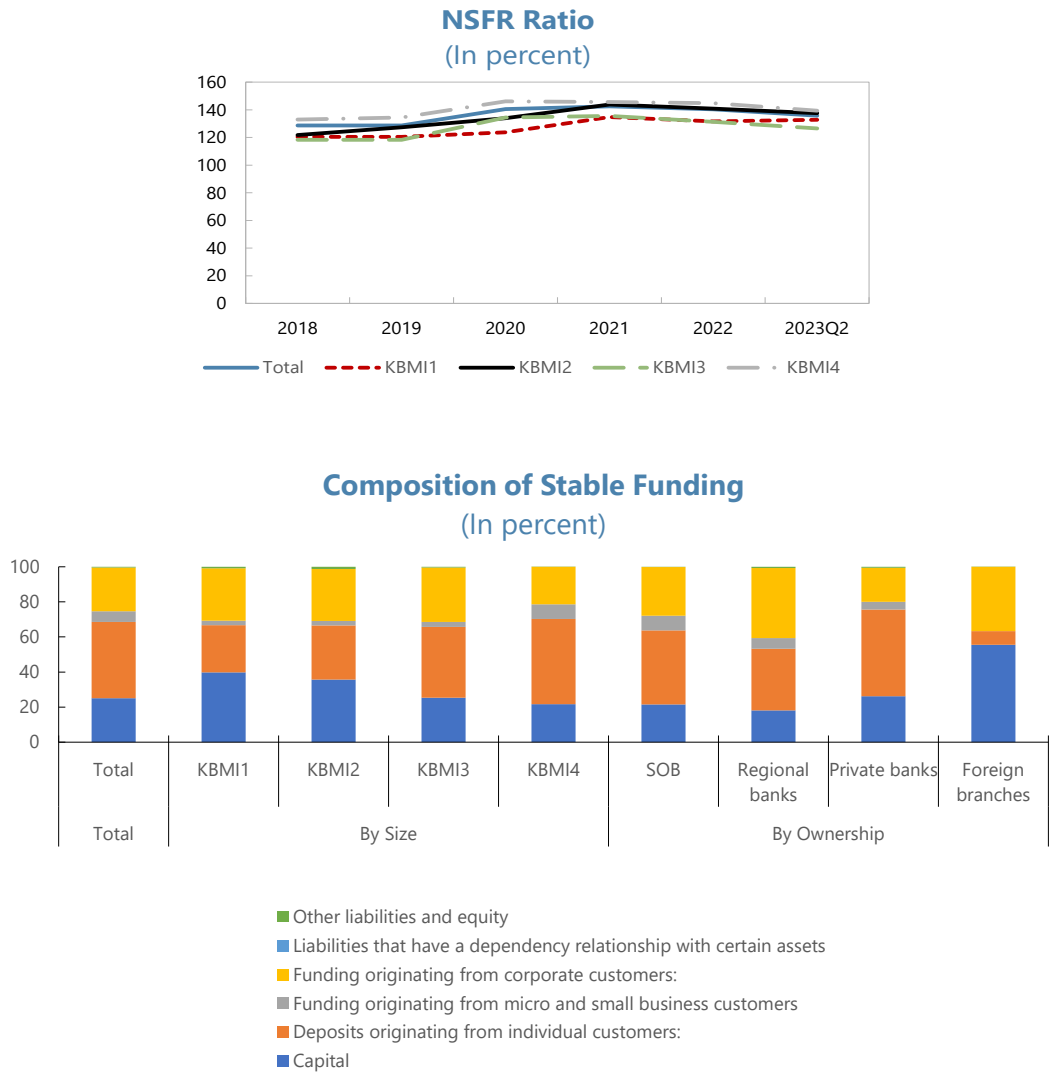
3-Month Horizon





Source: IMF staff.
Note: 1= Beginning CBC, 2= Other Maturing Mutual Fund, 3= Maturing secured lending, 4= Maturing loans, 5= Inflows from derivatives transactions, 6= Interest income, 7= Other contractual inflows, 8= Own securities issuance due, 9= Due secured borrowing, 10= Securities owned by Bank obtaining after secured borrowing due, 11= Customer deposits - individuals, 12= Customer deposits - Nonfinancial legal entities - Qualifying SMEs, 13= Customer deposits - Nonfinancial legal entities - Other entities, 14= Other deposits and unsecured borrowing, 15= Outflows from derivatives transactions, 16= Interest expense, 17= Undrawn committed credit/liquidity lines, 18= Other contractual outflows, 19= CBC flows, 20= Ending CBC.

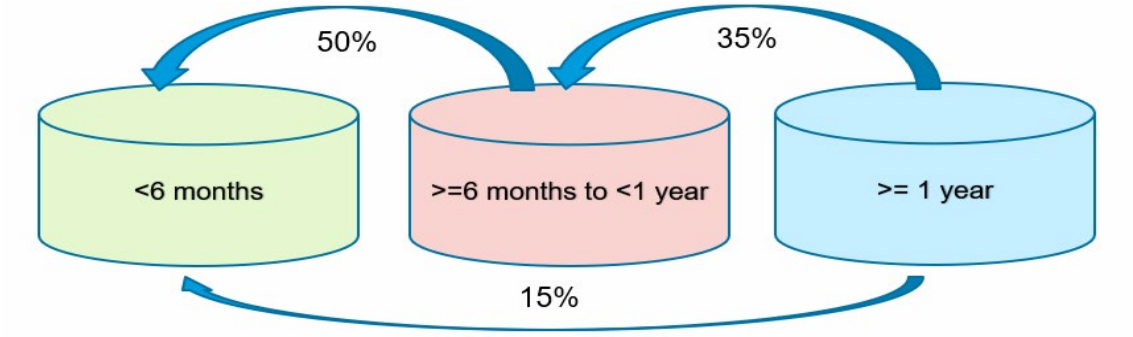
Figure 25. Indonesia: Banking Sector—Net Stable Funding Ratio



Source: OJK and IMF staff.

61. The stress test assumes part of the long-term funding sources are replaced by short-term funding (Figure 26). This would require a flow of funding from long-term to short-term maturity buckets, while also allowing a higher migration of funding that is already close to the short-term time bucket. Therefore, the stress test assumes that 50 percent of the funding within the six- to twelve-month bucket would flow to the less than six-month bucket, 35 percent of the funding with more than one year maturity would migrate to the six- to twelve-month bucket, while applying a 15 percent flow rate from the over one-year bucket to the less than six-month bucket. The applicable required stable funding (RSF) and ASF factor, on the other hand, are maintained under the stress scenario.

Figure 26. Indonesia: Methodology—NSFR Stress Test

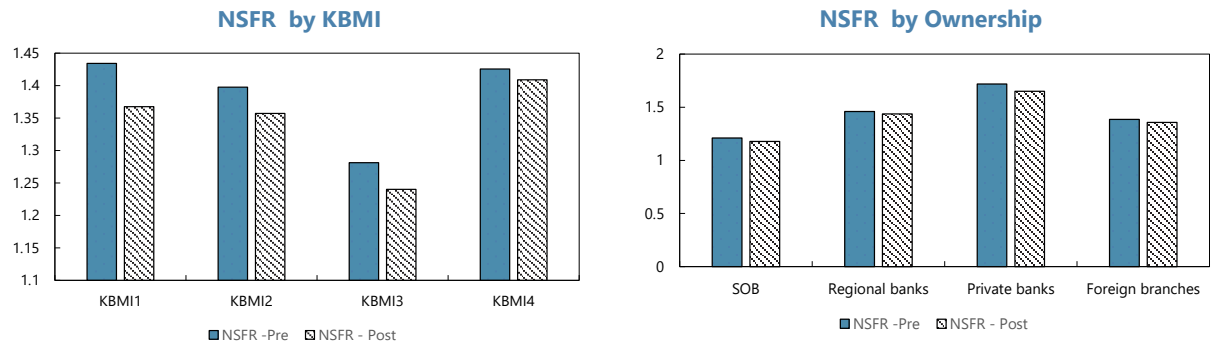


Source: IMF staff.

Result of the NSFR-Based Stress Test

62. The results of the NSFR stress test suggest most banks would be able to maintain a stable funding profile under stress (Figure 27). The adverse scenario, which simulates a migration of ASF from long term to short term buckets, leads to only two small banks finding its NSFR marginally below the 100 percent threshold. Comparison across banking groups shows a larger decline of NSFR for small banks, while the large banks enjoy a high level of stable funding both before and after the shock.

Figure 27. Indonesia: Results of NSFR-Based Stress Test



Source: IMF staff.

D. Sensitivity Analysis

Funding Concentration

63. Sensitivity analysis simulating withdrawal of top depositors is conducted to assess potential funding concentration risks on bank balance sheet. The analysis assesses the loss of top five individual funding sources by sectors—such as nonfinancial corporates, financial corporations, government, and individuals—and subsequent impact on bank liquidity positions. Banks that are deemed unable to meet these liquidity drawdowns are those that experience liquidity shortfall after the loss of top fundings.

64. Funding concentration is characterized by large variation across banking groups, with regional banks more exposed to large funding withdrawals from financial corporations and public entities. Almost all large funding sources for regional banks are wholesale deposits, from public entities, financial corporations, and nonfinancial corporations. Moreover, the top five funding sources are sizable relative to their liquid assets. Funding from public entities reaching up to 55 percent of their liquid assets, 45 percent for financial corporations and 20 percent for nonfinancial corporates. In comparison, state-owned banks have lower dependency on fundings from public entities than regional banks but more reliance from large fundings from nonfinancial corporates. Private banks rank the last with moderate funding concentration from nonfinancial corporates and individuals. Small banks in general are more exposed to concentrated fundings than large banks. Finally, about 15 banks in total would have difficulties meeting top five funding withdrawals from all sectors, mostly composed of small banks (Figure 28).

Liquidity-Solvency Interactions

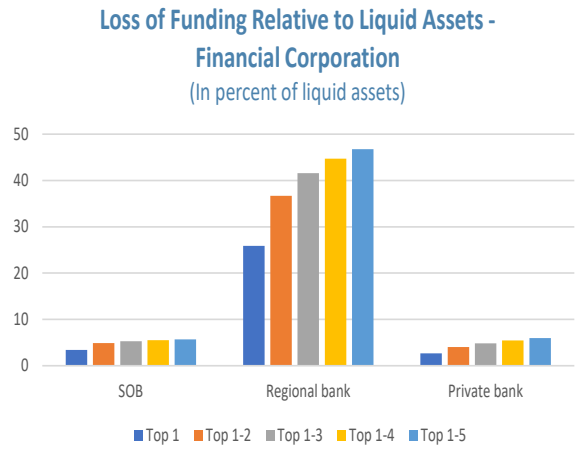
65. Liquidity-solvency interactions can intensify when large liquidity outflows result in material capital losses, especially when assets marked under amortized cost need to be liquidated rapidly to realize market prices. In response to the recent liquidity stress episodes in the advanced economies, we simulate a liquidity-solvency interaction by identifying banks that need to utilize their AC securities at market price when they experience large liquidity outflows, across different liquidity stress scenarios. This would result in capital depletion equivalent to a percentage of valuation losses of AC securities under the stagflation scenario, depending on how much they need to be sold or marked to market under stress. The exercise leverages information from both the maturity ladder templates and bank balance sheet information to proxy the share of the CBCs that are booked under amortized cost, therefore allowing the estimation of potential market losses as banks start to liquidate the share of AC securities within their CBC limit.

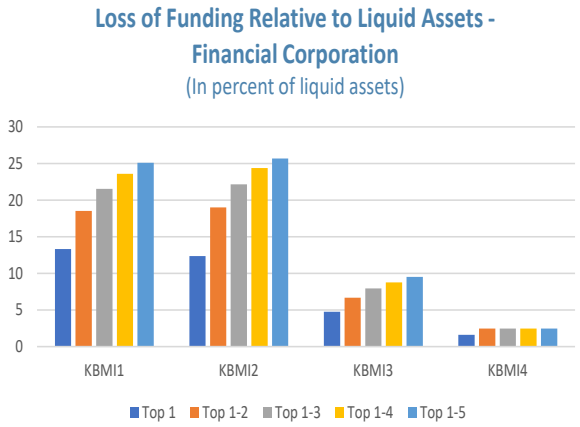
66. Results from the liquidity-solvency interactions suggests a non-negligible share of banks would need to utilize their AC securities to meet severe liquidity drawdowns, but the overall capital impact is contained (Figure 28). Under the severe scenario, consistent with the cashflow-based liquidity analysis, when assuming banks prioritize cash and fair-value securities over the AC securities to meet liquidity outflows up to 3 months, about 35 banks would need to resort to their AC securities to meet severe cash outflows. However, consistent with the size of valuation losses for AC securities under the solvency stress test, the capital impact of the valuation losses is broadly contained, with KBMI1 and KBM4 experiencing higher CET1 ratio depletion, at 2.3 and 1.6 percentage points, due to their higher holdings of sovereign securities under the AC category with longer duration, relative to other groups.[36]

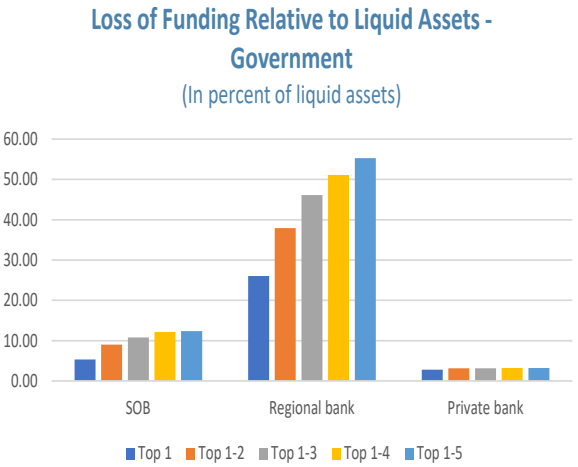
[36] The solvency impact would be smaller if the banks—instead of selling AC securities at market price—use them as collateral to seek additional funding from the central bank.

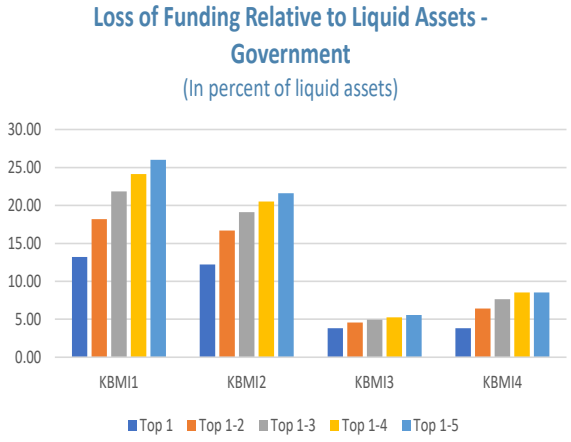
Figure 28. Indonesia: Results from Liquidity Sensitivity Analysis

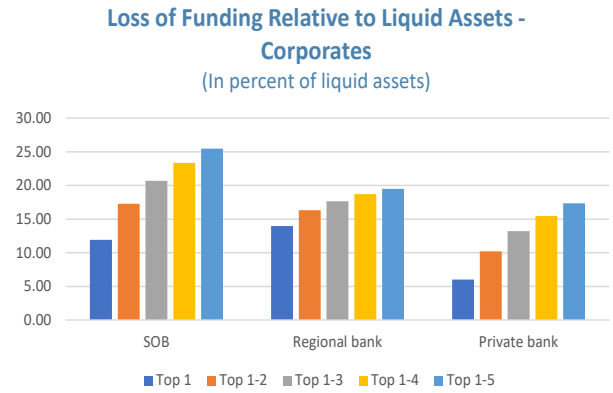
Funding Concentration











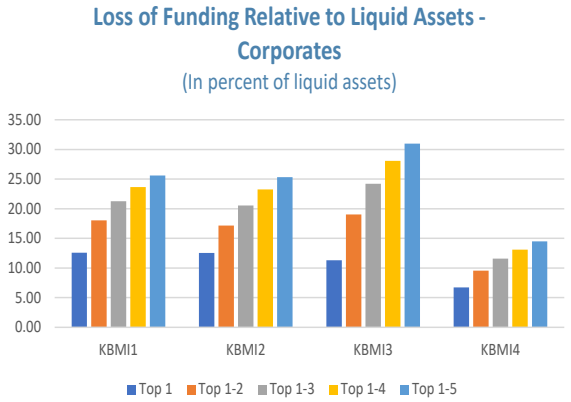
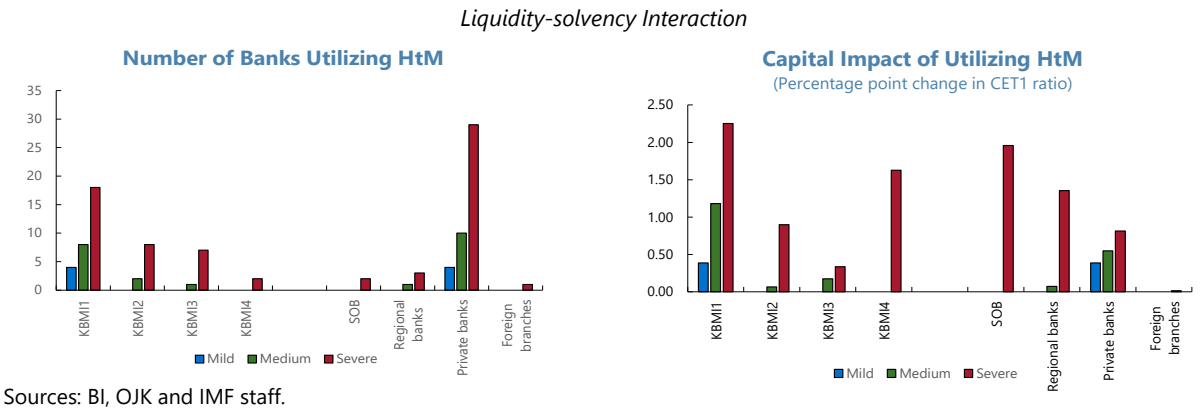


Figure 28. Indonesia: Results from Liquidity Sensitivity Analysis (concluded)



Sources: BI, OJK and IMF staff.

Reverse Stress Test

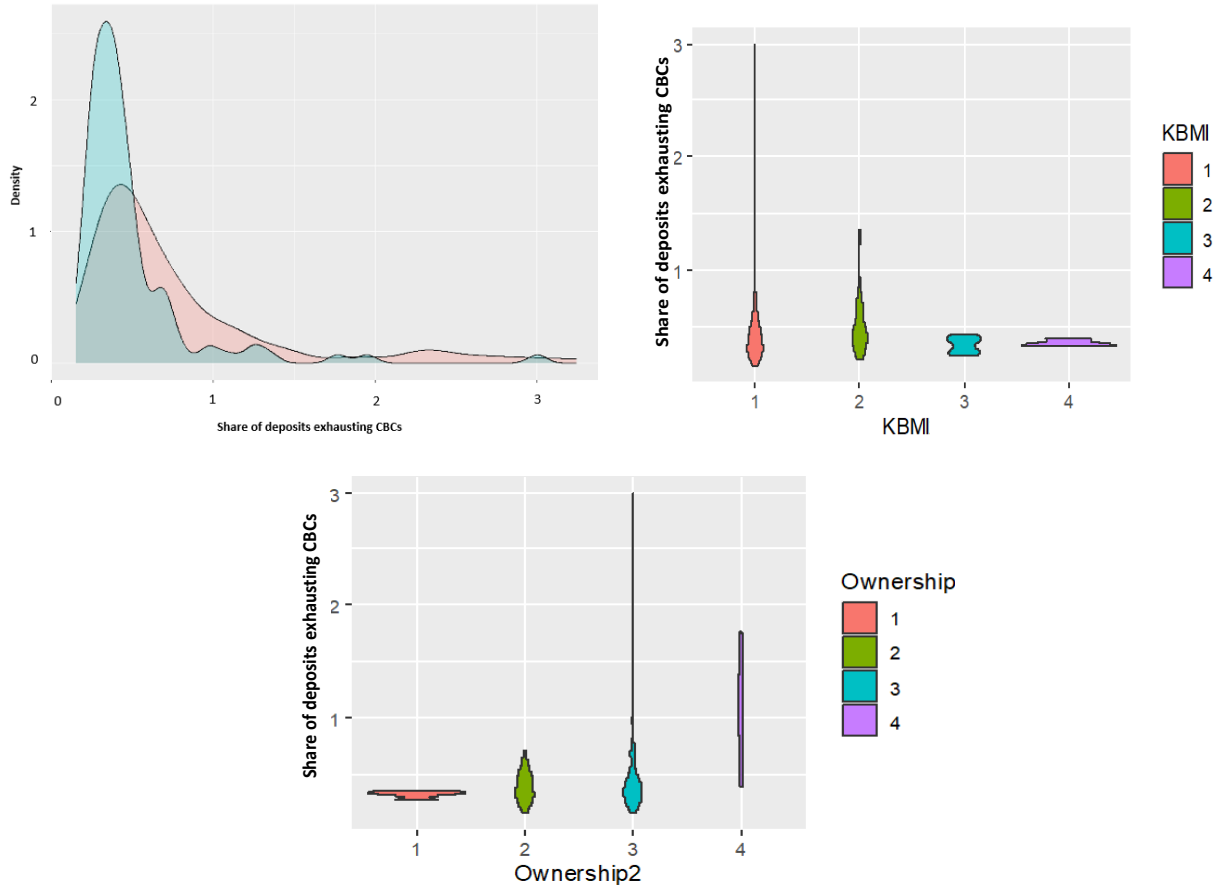
67. To overcome scenario uncertainties, a reverse stress test is conducted to identify the size of the liquidity outflows that can fully exhaust the CBCs of the banks. Reverse stress test can be another effective way to gauge the liquidity capacity of banks to withstand funding drawdowns, especially when there are large uncertainties surrounding the outflow rates under stress. Different from a scenario-based stress test which specify the size of the outflow rates ex-ante, the exercise attempts to identify the threshold where a certain level of liquidity outflows would fully exhaust the CBCs of the banks. Using the same data template as the cashflow-based stress test, the exercise assumes two types of reverse stress test as below:

- Type 1 test—Percentage of unsecured (or uninsured) deposits withdrawal that depletes the liquidity assets (with BI haircut), up to 3-month horizon.
- Type 2 test—Percentage of total deposits withdrawal that depletes the liquidity assets (with BI haircut), up to 3-month horizon.

The resulting thresholds are identified at the bank level and then presented as a distribution across banks to better visualize common patterns (e.g., mean, mode, median) as well as potential tail risks (e.g., skewness, extreme values/outliers) in the banking system.

68. The result of the reverse stress test suggests that most banks would be able to sustain the outflow rates of about 35 percent of total deposit and 45 percent of uninsured deposits, before fully running out of their liquid assets (Figure 29). There is also large variation across banks at both sides of the distribution, as some banks can only withstand 15 percent of outflows while others can withstand more than 100 percent of outflows without the possibility of running out of their liquid assets, when the share of deposits over total liability is relatively small. When comparing across banking groups, although large banks (including SOBs) appear resilient in the cashflow analysis due to higher share of stable deposits, their large deposit base and large loan portfolios (illiquid assets) may render them vulnerable to large deposit outflows. Finally, variation is large for small banks and private banks with higher tail risk.

Figure 29. Indonesia: Results of Reverse Stress Test



Source: BI and IMF staff.
Note: For top left chart, the x-axis denotes the fraction of deposits (total or uninsured) that would fully exhaust the CBCs of the banks over a 3-month horizon. The vertical axis denote density of the distribution, with higher value indicating higher likelihood. Ownership categories: 1=SOB, 2=regional banks, 3=private banks, 4=foreign branches. For top right and bottom charts (violin plots), the x-axis denotes groups of banks, the vertical axis denotes the fraction of deposits (total or uninsured) that would fully exhaust the CBCs of the banks over a 3-month horizon, and the width denotes the density of the distribution.

E. Recommendations

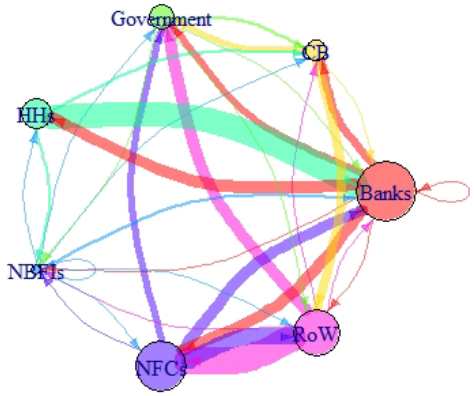
69. Key recommendations drawing from the bank liquidity risk analysis focus on expanding the scope of LCR and NSFR reporting and enhancing stress testing approaches. First, the FSAP emphasizes the importance of implementing LCR and NSFR across all banks and monitoring LCR for significant foreign currencies. Second, the FSAP recommends authorities to regularly conduct cashflow stress tests for significant foreign currencies to promptly identify banks with weak FX position. Finally, to complement the existing stress test methodology which focuses on bank-specific outflow parameters, the FSAP suggests authorities to apply an array of unified liquidity stress scenarios with different levels of severity and time horizons across all banks to allow the identification of weak banks in a more comparable way.

INTERCONNECTEDNESS ANALYSIS

A. Introduction

70. The domestic interbank exposure appears to be smaller relative to cross-sector exposures. The Indonesian financial sector is relatively small, comprising approximately 73 percent of GDP, and it is primarily dominated by the banking sector. Although interbank exposure appears to be low at only 3 percent of total assets, the banking system has substantial exposures to non-financial corporates (NFCs) and households, primarily through loans and deposits, making up approximately 60 percent of the total banking sector assets and liabilities. Domestically, government debt is mainly held by corporates, banks, and foreign investors. Bank holdings of government debt obligations account for about 13 percent of total banking sector assets. It's important to note that NFCs have strong connections with the global economy on both sides of the aggregate balance sheet. Foreign investors hold a substantial portion of NFC assets through foreign direct and portfolio investment, and they also hold a considerable amount of Indonesian sovereign bonds. These signal the potential for risk transmission between sectors (Figure 30).

Figure 30. Indonesia: Domestic Sectoral Exposures (2022)



Sources: IMF Balance Sheet Approach (BSA), OJK and IMF staff.

B. Methodology

71. The purpose of the interconnectedness and contagion analysis is to understand how an initial shock propagates through a network of banks and to assess the impact on banks. The interbank network and contagion analysis is assessed using a model developed by Espinosa-Vega and Sole (2010).[37] The exercise applies pairwise exposures data to construct the network topology among domestic banks and cross-border banks and capture the inter-bank linkages. The domestic contagion analysis uses confidential interbank exposure data from the authorities as of

[37] "Cross-Border Financial Surveillance: A Network Perspective." IMF Working Paper, Macro Espinosa-Vega and Juan Sole, 2010.

2023Q2. The cross-border analysis uses the BIS locational banking statistics data, which provides information on the geographic composition of resident banks' balance sheets 2023:Q1, complemented by regulatory data provided by the OJK on bank specific cross-border exposure.

72. Based on the inter-bank network, the model simulates the cascading effect of the failure of a network of banks due to credit and funding shocks (Figure 31). The stress test assumes the hypothetical default of each bank within the banking system, one at a time. A bank is at default if it fails to meet the minimum capital requirements (8 percent capital adequacy ratio in this case). There are two types of shocks we consider. For credit shock, the default bank defaults on its debt obligation to its creditors. These creditor banks, by assumption, use their capital to absorb such unexpected losses. If insufficient, they become default and cause their creditors to suffer from losses. Such iterations continue until there are no more banks that default in the system. To model such a scenario, we need to assume the parameter λ, which stands for the loss given default.

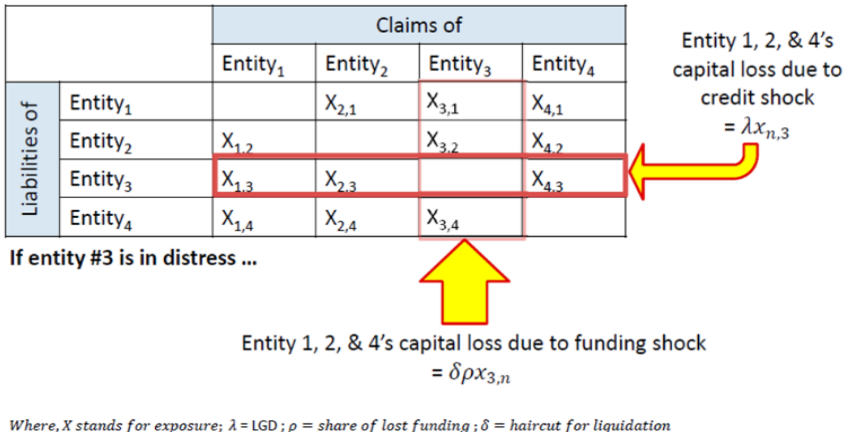
73. In the case of a funding shock, the market exhibits a liquidity shortage, a distressed bank can no longer provide funding to its previous debtors. In our model, a ρ fraction of the fund is lost so the debtor bank is only able to replace (1- ρ) fraction of the funding with alternative sources. To meet the shortfall, they fire sell their assets at a discount δ, which causes an additional asset worth δ*ρ loss in the book value term. The loss is then absorbed by the bank's capital. Once insufficient, it defaults.

74. This exercise presents banks that are the most vulnerable to shocks from other banks. It also helps identify the banks that cause the most significant impact to the system. The results are quantified by two main indices, they are:

- **Index of contagion** measures the average loss of other banks due to the failure of bank i. The index is computed as:

$$Cont_i = 100 * \frac{1}{N-1} \Sigma_{j=1, j \neq i}^{N} \frac{Lji}{Kj}$$

Figure 31. Indonesia: Illustrative Example: A Network of 4 Banks



Where, X stands for exposure; λ = LGD ; ρ = share of lost funding ; δ = haircut for liquidation

Source: IMF staff.

Where N denotes the total number of banks in the banking system, Lji is the total capital loss of bank j due to the bank i's default, and Kj denotes the capital of bank j.

- **Index of Vulnerability** measures the average loss of bank i due to the failure of all other banks in the system. The index is computed as

$$Vuln_i = 100 * \frac{1}{N-1} \Sigma_{j=1, j \neq i}^{N} \frac{Lij}{Ki}$$

where N denotes the total number of banks in the system, Lij is the total capital loss of bank i due to the default of bank j, and Ki denotes the capital of bank i.

C. Domestic Interbank Contagion and Interconnectedness Analysis

75. The domestic interbank analysis is based on a matrix of bilateral domestic interbank total exposures and unsecured exposures. The data include bilateral exposures among 4 state-owned banks (SOE), 27 regional development banks, 67 private banks, and 7 branches of foreign banks, totaling 105 commercial banks. Two types of spillover scenarios are tested, including i) a simple credit shock scenario, and ii) a credit and funding shock scenario. Several sensitivity analyses are conducted within each scenario. The model requires a set of predetermined parameters. This note presents results from simulation 2 (a single credit shock) and simulation 5 (a credit plus a funding shock). All the simulations and corresponding parameters are included in Table 3.

Table 3. Indonesia: Interconnectedness Analysis—Parameter Table

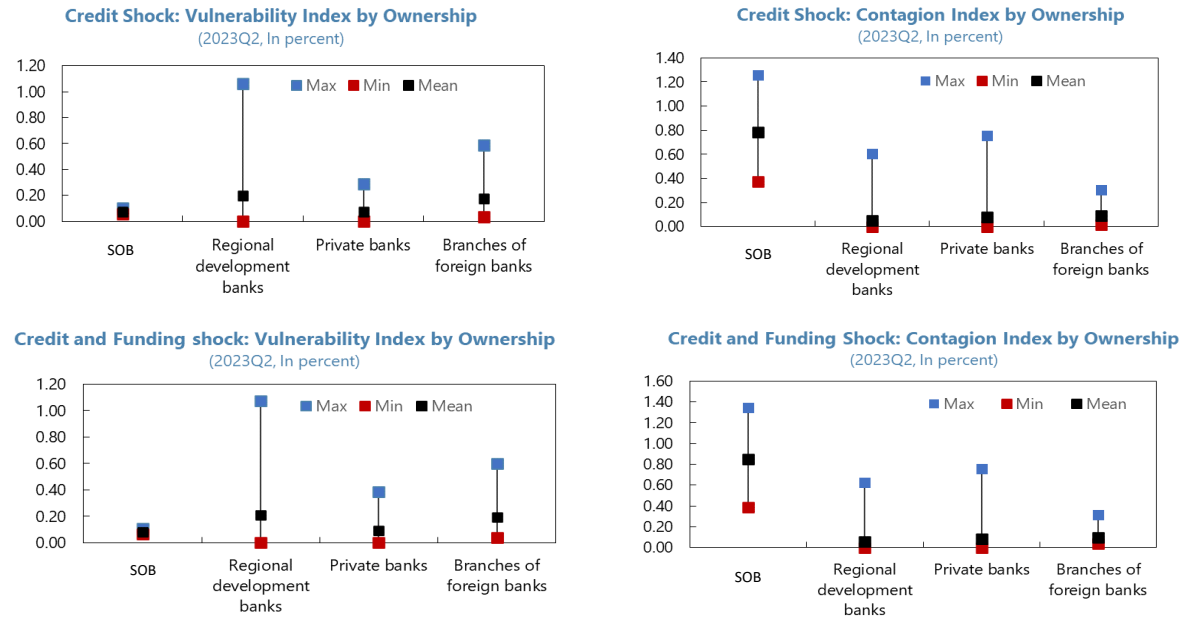
simulation	risk	Unsecured exposure lambda1(λ1)	Remaining Exposure lambda2(λ2)	rho(ρ)	delta(δ)
1	credit	0.5	0.2		
2	credit	0.6	0.3		
3	credit	0.7	0.4		
4	credit + funding	0.5	0.2	0.2	0.15
5	credit + funding	0.6	0.3	0.3	0.2
6	credit + funding	0.7	0.4	0.4	0.25

Source: IMF staff.

76. The analysis reveals that the contagion risks stemming from domestic interbank exposures are limited. In Indonesia, domestic interbank positions are small, especially compared to banks' capitalization. As of 2023:Q2, the sum of total bank gross exposures relative to their total regulatory capital stands at 18.9 percent. This represents a decrease since the 2017 at 24 percent, primarily driven by an increase in regulatory capital. It's important to note that the results are consistent in both simulations considered, as there is no indication that a single failure of a domestic bank would trigger the failure of another bank in the network. Therefore, no cascading effect would take place in the banking sector. This demonstrates the overall resilience of the banking sector through interbank contagion.

77. While the overall contagion risks are under control, the test results exhibit high heterogeneity across different types of banks (Figure 32). SOBs emerge as the least vulnerable, with the lowest vulnerability level (the percentage of loss at a single institution due to the default of all other institutions) in both simulations. Notably, private banks and branches of foreign banks also exhibit lower vulnerability levels than regional development banks. The higher vulnerability of regional development banks can be explained by their higher interbank deposits into and loans from other banks.[38] Besides, the smaller size of regional development banks in terms of total assets and capital relative to other banks in the network make them vulnerable to shocks transmitted from other banks. Additionally, the vulnerability level of regional development banks exhibits large variation among institutions. When it comes to the contagion index, which represents the average percentage of loss of other banks due to the failure of a given bank, SOBs appear to be the most contagious in both scenarios as their average contagion level is notably higher than other bank types. However, the average contagion levels of the other banking groups do not differ significantly. There is also large variation across banks within the private and regional development banking group. The simulation results also reveal a strong correlation between the vulnerability and contagion levels and the size of banks, as measured by KBMI. In general, KBMI 4 banks are the least vulnerable but most contagious, while the opposite holds true for small banks.

Figure 32. Indonesia: Domestic Interbank Contagion Analysis Results



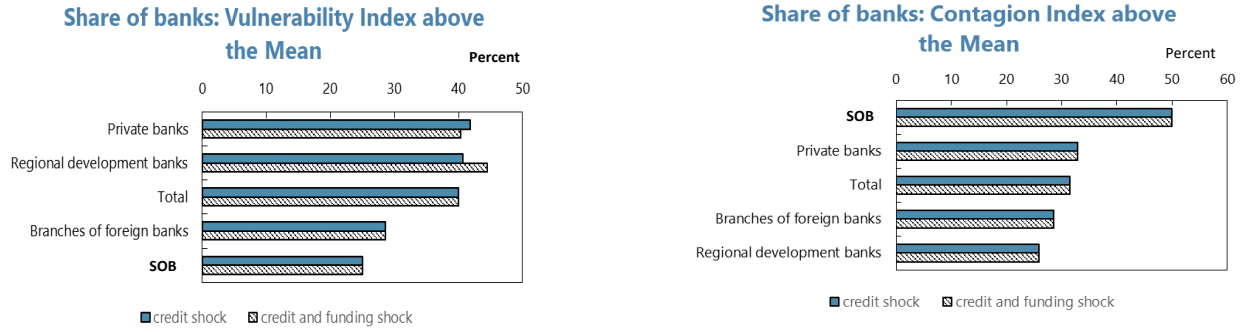
Source: Supervisory data and IMF staff.
Note: Whisker plot shows cross-bank variation within each banking group.

78. A larger share of private banks and regional development banks have vulnerability indices exceeding the average level (Figure 33). In terms of vulnerability indices, approximately

[38] Regional development banks mostly engage in cash management services to regional government, and therefore they place most of the cash as deposits into the other banks, especially the SOBs. On the other hand, they borrow more interbank loans than other banks as a way to increase their source of funding for lending activity.

40 percent of banks have vulnerability indices surpassing the average level in both scenarios. Specifically, 42 percent (40 percent)[39] of private banks and 41 percent (44 percent) regional development banks have vulnerability indices that exceed the average level, respectively. In comparison, in both simulations 29 percent of foreign bank branches and 25 percent of SOBs have vulnerability indices surpassing the average. When considering the contagion index, we observe in both simulations, 50 percent of SOBs exhibit a contagion level exceeding the SOB average. This is followed by private banks at 33 percent, foreign bank branches at 29 percent, and regional development banks at 26 percent. This is consistent with the previous statement that larger banks are more contagious while the small banks are more vulnerable in general.

Figure 33. Indonesia: Domestic Interbank Contagion Analysis—Vulnerability and Contagion Indices



Sources: Supervisory data and IMF staff.

D. Cross-Border Interbank Contagion and Interconnectedness Analysis

79. Cross-border data reveals a strong interconnection between the Indonesian banking sector and the global banking system, particularly with Asia (Figure 34). Based on supervisory data provided by authorities, Indonesian banks' cross-border claims on the United States, Singapore, China, and Japan collectively constitute around 70 percent of total claims. On the liability side, exposures to Singapore, Hongkong, the United States, and China are the most significant, comprising 72 percent of the total liabilities. In terms of asset size, KBMI 4 banks maintain the most cross-border positions with foreign counterparties. Across banks' business models, state owned banks (SOBs) account for more than 50 percent of cross-border exposure, followed by private banks and foreign bank branches.

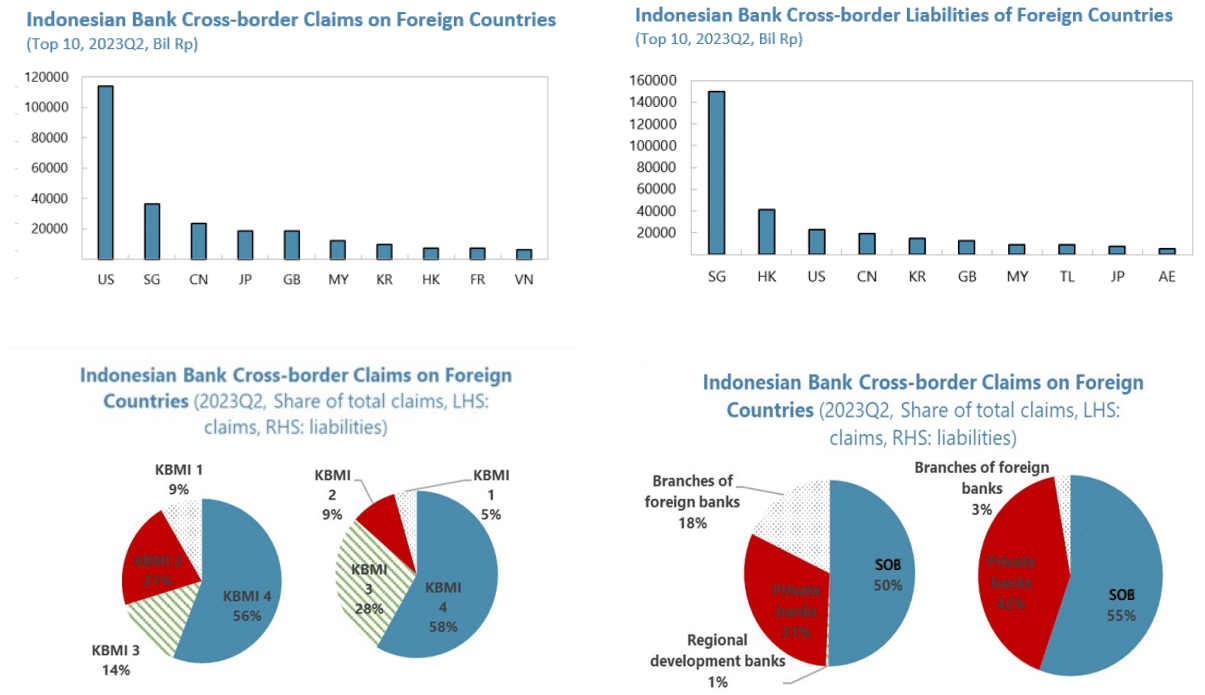
80. The contagion analysis was conducted utilizing the BIS locational banking statistics (LBS). LBS reports banking activities from a residence perspective, focusing on the location of the banking office. The cross-border analysis uses the same methodology as the domestic contagion analysis. That is, hypothetical defaults are assumed on each country's banking sector, one at a time. This allows for evaluation of the cross-border spillover effect on the Indonesian banking sector.

81. Two spillover effects are simulated in the analysis. The first simulation entails a credit shock, with the loss given default (λ) set at 40 percent. In the second simulation, a compounded

[39] Parenthesis indicates the second simulation, i.e., credit and funding shock simulation (simulation 5).

credit and funding shock are considered. On top of the 40 percent loss given default, a fraction of loss funding (ρ) is set to 40 percent, and a haircut (δ) is set to 50 percent. Due to data constraints, the analysis is conducted on total exposures to the banking sector, including claims to banks, non-bank sector, and unallocated amount. The hurdle rate is set at a 6 percent tier one (T1) ratio. The Indonesian banking sector is deemed at default when its aggregated T1 ratio breaches the hurdle rate.

Figure 34. Indonesia: Cross-Border Contagion Analysis Results (I)



Sources: Bank Indonesia, OJK, and IMF staff.

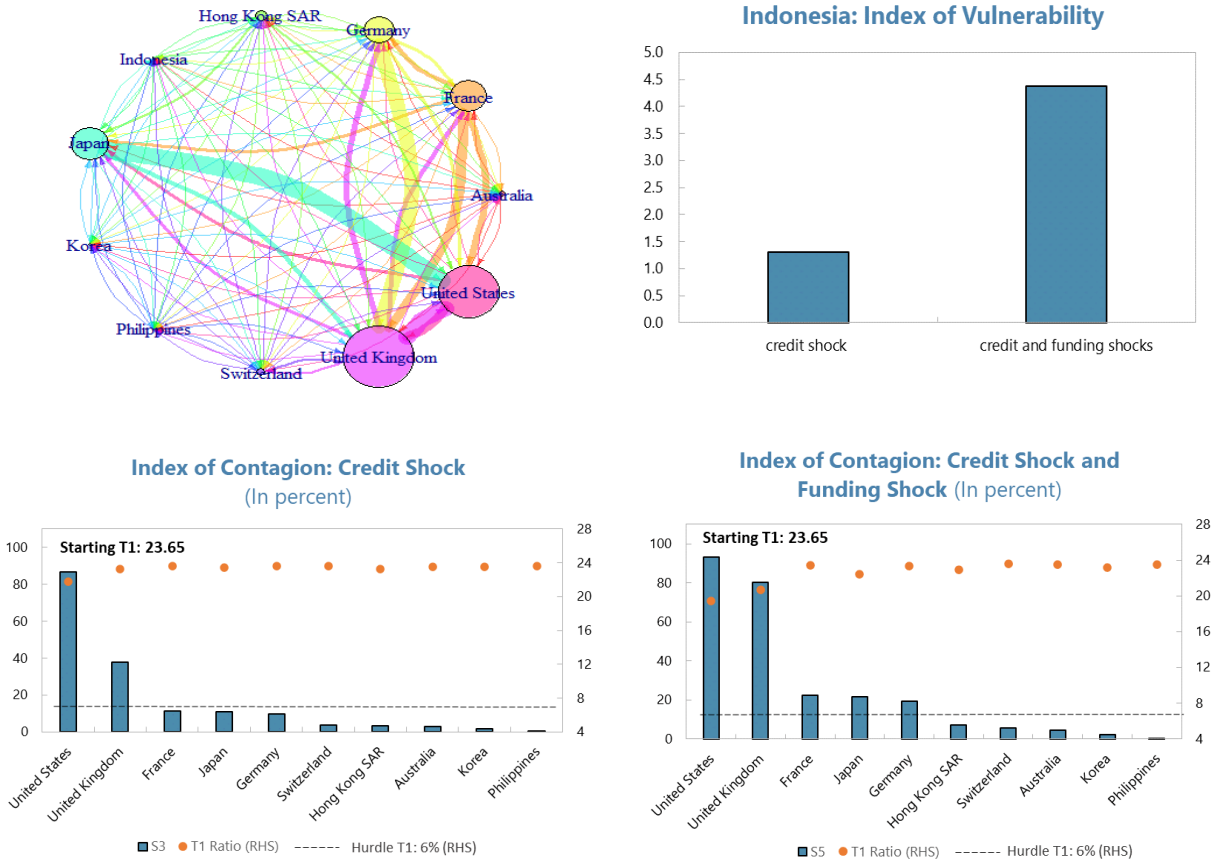
82. The simulation results suggest moderate level of vulnerability of the Indonesian banking sector to external shocks (Figure 35). While the domestic banking sector is highly interconnected with the Asian market, its level of aggregate exposures relative to other major economies, such as the United States, remain quite small. In the first simulation, the vulnerability level of the Indonesian banking sector is notably lower than the second simulation due the severity of shocks. Across countries, the Indonesian banking sector is more vulnerable to the United States and the United Kingdom in both simulations. Despite these vulnerabilities, the post-shock T1 ratios of the banking system remain strong. However, the results should be treated with an important caveat, as data reported by the BIS are limited with missing information on cross-border exposure between Indonesia and other Asian countries, especially with ASEAN countries and China.

E. Recommendations

83. The bank interconnectedness exercise recommends authorities to consider implementing contagion analysis for interbank spillover risk assessment. Currently, authorities

perform limited contagion analysis both on a domestic and cross-border level, with findings only incorporated into the identification of systemically important banks. Going forward, the FSAP recommends the adoption of similar stress testing methodologies used in this exercise to timely identify vulnerable banks through interbank linkages for ongoing risk monitoring purpose.

Figure 35. Indonesia: Cross-Border Contagion Analysis Results (II)



Source: BIS locational banking statistics and IMF staff.

CORPORATE RISK ANALYSIS

84. Corporate sector health is an important pillar of financial stability. Sound fundamentals and adequate buffers against liquidity and solvency risk insulate the economy and the financial sector against adverse shocks. Deterioration in corporate fundamentals may presage rising NPLs and deteriorating bank asset quality in the baseline or present greater vulnerability to external shocks. A complete picture of corporate sector health is vital for assessing financial sector vulnerability.

85. The analysis of non-financial corporates (NFCs) uses a representative sample of 460 NFCs. The dataset is compiled from the Capital IQ database, provided by S&P Global Market Intelligence, and contains annual data up to end-2022. It comprises both publicly listed (441) and

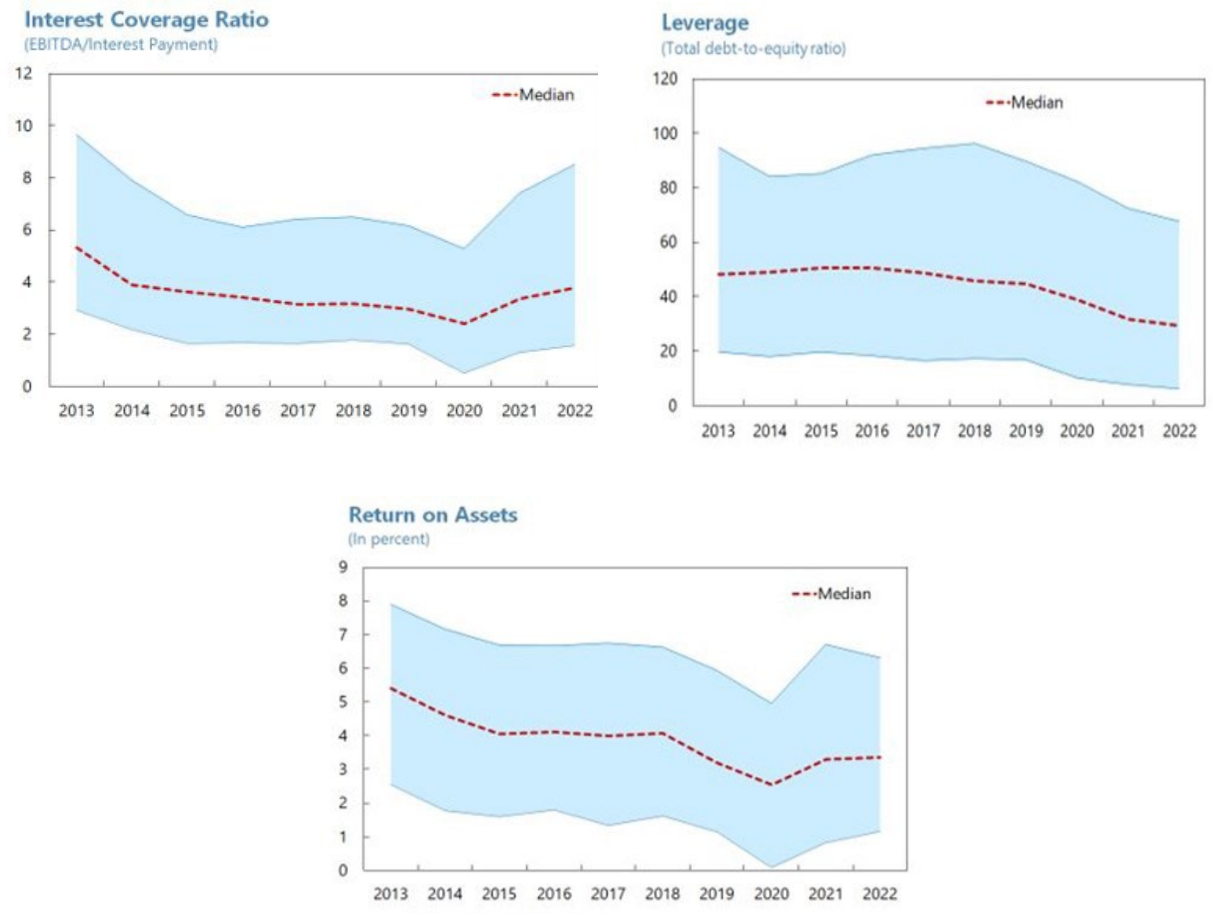
private companies (19), including 21 state-owned enterprises. The debt held by sample firms and their total revenue in 2022 account for about 52.7 percent of total outstanding NFC debt in the economy and 23.1 percent of GDP, respectively.

A. Descriptive Analysis

86. In Indonesia, corporate risk metrics have improved since 2020 (Figure 36). Median debt-to-equity ratios have decreased from 40 in 2020 to 30 in 2022. Median return on assets have increased from 2.5 in 2020 to 3.5 in 2022. Median interest coverage ratios have increased from 2 in 2020 to 4 in 2022.

87. There is heightened debt at risk among small firms in the corporate sector. Among the bottom decile of firms in terms of size (as measured by total assets), the share of debt for firms with an ICR<1 is over 60 percent. Among the top decile of firms, the share is around 10 percent. There is also some variation in the share of debt in vulnerable firms across industries.

Figure 36. Indonesia: Corporate Risk Metrics



Source: Capital IQ and IMF staff.
Note: Shaded areas indicate interquartile range.

B. Stress Test

88. The analysis focuses on firms' debt service capacity, proxied by the interest coverage ratio (ICR). The ICR, defined as the earnings before tax and interest expenses (EBIT) to interest payment (INTP) ratio, measures a firm's capacity to service its debt payments out of its EBIT. To understand the underlying drivers of the ICR dynamics before the pandemic, we decompose the ICR as follows:

$$ICR = \frac{EBIT}{Int.\ payment} = \frac{(EBIT/Assets)}{(Int.payment/Debt) * (Debt/Assets)} = \frac{ROA}{Eff.IR * Leverage}.$$

The evolution of the ICR is then analyzed by examining each of these components in turn.

89. To assess the impact of the adverse economic and financial shocks under the stress test scenarios aligned with the bank solvency stress test, a regression-based approach is adopted. Specifically, this approach involves running separate regressions for each firm's return on assets (ROA), effective interest rate, and leverage (defined as the debt-to-assets ratio) as the dependent variable and a set of macroeconomic ($X_{k,t}$: real GDP growth, bilateral exchange rate against the US dollar, and domestic short term rate), global (W_t: World, US and China GDP growth, commodity and oil prices, VIX, and the US short term rate) and firm-specific variables ($Z_{i,t}$: lagged dependent variable, lagged total assets, and lagged tangible assets-to-total assets ratio) as the explanatory variables. The global forecasts come from the October 2023 IMF WEO forecasts and the October 2023 GFSR global stress test. The macroeconomic forecasts come from the solvency test scenario.

$$y_{i,j,k,t} = \beta_0 + \beta_1 X_{k,t} + \beta_2 Z_{i,t} + W_t + \delta_j + \mu_k + \varepsilon_{i,j,k,t},$$

where $y_{i,j,k,t}$ denotes the dependent variable of interest for firm i in industry j in country k in year t, and δ_j and μ_k denote industry and country fixed effects, respectively. The sample used for this regression analysis comprises a total of 2,532 NFCs from 6 major ASEAN economies as of end-2022, including those from Indonesia.

90. Table 5 presents the regression results. Using the predicted values of the ROA, effective interest rate, and leverage, we then back out the baseline and adverse scenario forecasts of the ICR for each firm as follows:

$$ICR_{t,i} = \widehat{ROA}/\widehat{Eff.IR} \times \widehat{LEV}$$

Table 4. Indonesia: List of Variables in the Regression-Based Approach

Domestic Macroeconomic Variables	Global Macroeconomic Variables	Firm-specific Variables
• Real GDP growth • Exchange rate growth (relative to USD) • Short-term rate	• World GDP growth • Commodity prices • Oil prices • US short-term rate • US GDP growth • China GDP growth • VIX	• Total assets • Tangible assets-to-total assets ratio • Return on assets • Debt-to-assets ratio • Effective interest rate

Sources: IMF staff.

Table 5. Indonesia: Regression Results: ICR

VARIABLES	(1) ROA	(2) Effective Interest Rate	(3) Leverage
Real GDP Growth	0.000753***	-0.000635	-0.000341
	(0.000228)	(0.000502)	(0.000229)
Exch. Rate Growth (USD/LCU)	0.000113	-0.000455*	-5.12e-05
	(0.000104)	(0.000234)	(0.000113)
Short Term Rate	-0.00177***	0.00429***	0.00240***
	(0.000332)	(0.000917)	(0.000362)
World GDP Growth	0.00376***	-2.62e-06	-0.00297***
	(0.000995)	(0.00221)	(0.00109)
Commodity Price Change	0.000255***	0.000512***	8.75e-05
	(5.89e-05)	(0.000146)	(6.18e-05)
Oil Price Change	-6.25e-05***	-0.000143***	-1.97e-05
	(2.41e-05)	(5.42e-05)	(2.61e-05)
US Short Term Rate	-0.00101**	0.00172*	6.22e-05
	(0.000401)	(0.000898)	(0.000390)
China GDP Growth	0.00118***	-0.00148**	-0.000410
	(0.000346)	(0.000705)	(0.000364)
US GDP Growth	-0.00220***	-0.00169	0.00210**
	(0.000772)	(0.00171)	(0.000842)
VIX	5.16e-05	-0.000288	2.72e-05
	(0.000121)	(0.000292)	(0.000136)
Lagged Dependent Variable	0.647***	0.220***	0.857***
	(0.00754)	(0.0198)	(0.00360)
Lagged Assets	0.00186***	-0.00833***	0.00428***
	(0.000344)	(0.000651)	(0.000340)
Lagged Tangibility	0.00497***	-0.0366***	0.00660***
	(0.00186)	(0.00458)	(0.00222)
Observations	37,121	37,121	37,121
R-squared	0.489	0.075	0.779

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

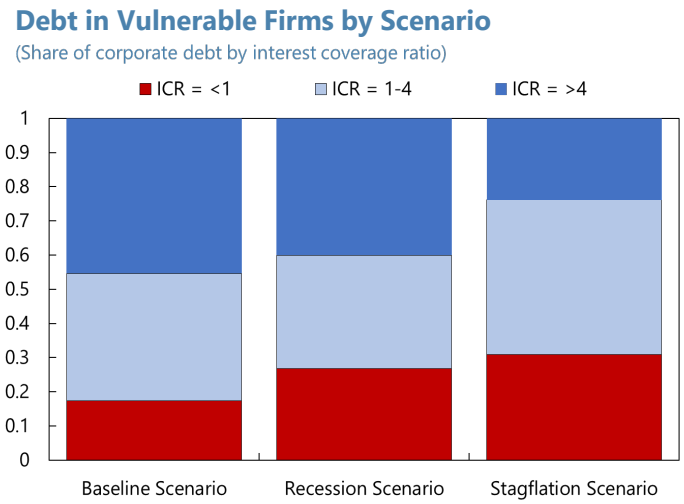
Note: Lagged assets is defined as the log of total assets from the previous year. Lagged tangibility is defined as the ratio of tangible assets-to-total assets from the previous year.

Sources: Capital IQ and IMF staff.

91. The stress test indicates that there may be heightened debt at risk in the corporate sector under the stress conditions. Figure 37 presents the results. In the baseline scenario, the share of debt for firms with an ICR<1 is 17 percent. The share increases to 27 and 31 percent in the recession and stagflation scenarios respectively.

92. A few caveats should be noted. Importantly, the analysis does not consider the effects of policy support measures under the stress scenarios. Moreover, sample firms account for only a small share of non-financial firms in Indonesia and do not include micro-sized firms in the informal sector, which tend to suffer disproportionately in the face of negative economic shocks. To the extent this is the case, the estimated impact of the shocks on Indonesia's NFC sector in the economy is likely to be downward biased.

Figure 37. Indonesia: Non-Financial Corporates Stress Test



Source: Capital IQ and IMF staff.
Note: ICR = Interest coverage ratio.

SYSTEMWIDE LIQUIDITY AND NBFI ANALYSIS

A. Introduction

93. The IMF has developed a novel analytical approach to assess resilience and identify vulnerabilities associated with system-wide liquidity.[40] The system-wide liquidity analysis differs in several ways from traditional liquidity and interconnectedness analyses. First, it brings together the liquidity and interconnectedness approaches by not only looking at a single agent (e.g., commercial banks), but also at the interaction between agents within the entire system, to trace the flow of funding from one agent to another, thereby assessing liquidity resilience and weaknesses in

[40] Ding, X., Laliotis, D. and Toffano. P., 2024. "A Framework for Systemwide Liquidity Analysis." IMF Working Paper No. 2024/104. International Monetary Fund, Washington, DC.

an integrated and holistic way. Second, it combines both domestic and cross-border networks by allowing simultaneous realization of domestic and external shocks to jointly determine the counterbalancing capacity of the system and prevent any potential underestimation of liquidity shocks under a partial analysis where only domestic linkages are considered. Furthermore, the analysis complements traditional contagion analysis—which focuses solely on solvency risks—by targeting the liquidity layer of the network, while also taking into account any second-round effects induced by behavioral responses such as liquidation of assets.

94. The analysis covers a comprehensive set of NBFI and non-NBFI financial agents in the system. The system-wide scope of the analysis ensures the inclusion of the NBFI subsectors (insurance companies, pension funds, finance companies, and investment funds) and all other major market agents, including the central bank and the government, commercial banks, non-financial corporations, households, as well as foreign investors who provide external funding and liquidity to the domestic financial system.

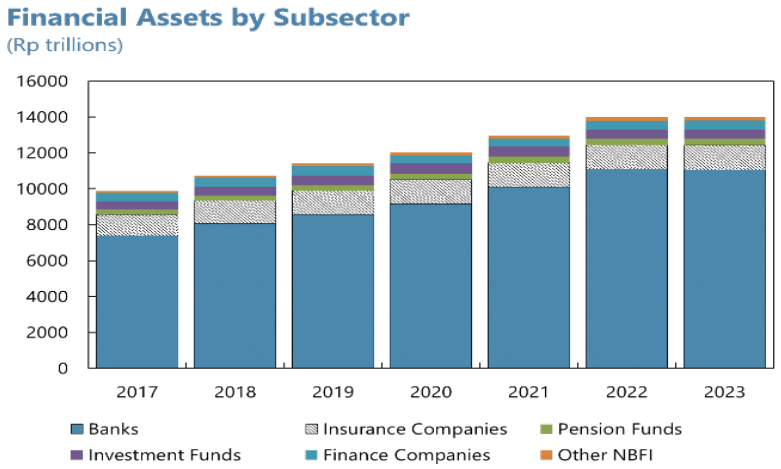
95. The systemwide liquidity analysis leverages aggregate balance-sheet level data by agent type. It includes agent-specific balance sheet composition and bilateral exposures between agents informed by who-to-whom holdings. The data is collected in a data template designed by IMF staff.

96. The objective of the system-wide liquidity analysis is manifold. First, it is essential to understand the extent of the interconnectedness among agents and have a system-wide view of liquidity conditions because the resilience of an individual sector or institution cannot itself assure the stability of the entire system, since they may be transferring liquidity risks to other sectors or segments in the system. Second, an assessment of the contribution of each agent to system-wide liquidity stress can help improve the understanding of the transmission channels of liquidity shocks, as well as any amplification mechanism associated with the willingness and capacity of each agent to intermediate in the market. Third, the analysis aims to assess resilience against various adverse narratives pertinent to the Indonesian financial system, the outcome of which could inform relevant micro- and macroprudential liquidity measures, such as limiting certain asset and funding exposure or build more liquidity buffers, thus contributing to the overall resilience of the financial system.

B. Static Analysis: Financial System Interconnectedness

97. Non-bank financial institutions (NBFIs) remain relatively small with assets making up 24 percent of the overall financial sector (Figure 38). The four subsectors with the largest assets are: Insurance Companies (13 percent), Finance Companies (3.5 percent), Investment Funds (3.5 percent) and Pension Funds (2.5 percent). NBFI growth trails the growth of nominal GDP. FinTech lending companies continue to represent a small portion of the financial system. However, they have experienced significant growth, with assets and lending rising by 51 percent and 63 percent, respectively.

Figure 38. Indonesia: Financial Asset by Subsector



Sources: BI, OJK, and IMF.

98. Commercial banks are highly interconnected and play a key role in providing funds. Commercial banks rely mostly on retail and wholesale deposits. The major debtors of commercial banks are non-financial corporates and households. Pension funds, investment funds and insurance companies are creditors with very small liability exposures to commercial banks, while finance companies have both significant bilateral asset and liability exposures. These NBFI entities have limited risk due to small exposures.

99. Systemic liquidity risks in financial markets can be amplified by NBFI risks (Figure 39). Besides large exposure between households, corporates and banks through lending and funding channel, households also have notable exposure to pension funds. Corporates, households, banks and other NBFIs are all holders of investment fund shares. Finance companies rely on commercial banks for funding. NBFIs have large asset exposures to domestic banks and non-financial corporates through deposits, debt securities, and equities, and banks and NBFIs also have indirect exposure through common holdings of sovereign securities. Therefore, linkages between NBFI and the broader financial system can act as an amplification channel of financial stress. Finally, the non-financial corporate sector is dependent on foreign financing as its debt obligations to foreign investors more than double the size of those to domestic banks.

100. Commercial banks are the largest holder of both sovereign and corporate securities. Domestically, commercial banks hold over 1400 trillion IDR in sovereign securities, tripling the amount held by insurance companies, investment funds, pension funds and finance companies together. Commercial banks also hold almost 60 percent in corporate securities, more than double the size of those held by the investment funds, while pension funds and insurance companies each hold around 8 percent of the market share. Nevertheless, given the small size of the NBFIs, the share of sovereign securities on their balance sheet remains high, at around 30 percent for investment funds and pension funds, and 21 percent for insurance companies (Figure 40).

Figure 39. Indonesia: Financial System Interconnectedness

Network Diagram

Note: The diagram represents bilateral exposures of the Indonesian financial system. The size of the nodes reflects log total claims. The thickness of the edges represents the share of claims in percent of the system-wide total claims.

Bilateral Matrix

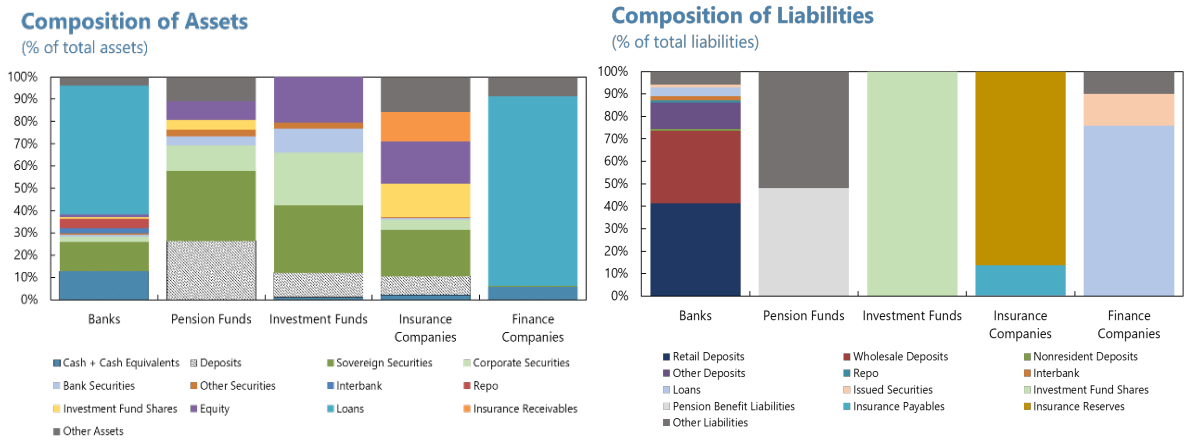
(Percent of GDP)

	Government		Central Bank		Other Depository Corporations		Other Financial Corporations		Nonfinancial Corporations		Households		External	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Government			8	4	9	2	1	0.005	9	-	-	-	17	0.2
Central Bank	4	8			11	0.1	0.01	-	-	-	5	-	1	13
Oth. Dep. Corp.	2	9	0.1	11	2	3	4	2	15	17	33	17	3	2
Oth. Fin Corp.	0.005	1	-	0.01	2	4	2	2	1	3	5	2	0.5	0.4
Nonfinancial Corp.	-	9	-	-	17	15	3	1					36	22
Households	-	-	0.1	5	17	33	2	5						
External	0.2	17	13	1	2	3	0.4	0.5	22	36				

Source: BI, OJK, and IMF.

Note: Other Dep. Corp = Other Depositary Corporation, Other Fin. Corp = Other Financial Corporation. The non-zero value for "Other Dep. Corp." and "Other Fin. Corp." in the main diagonal in the table is driven by the differences in the coverage of firms reported from asset and liabilities side of the balance sheets.

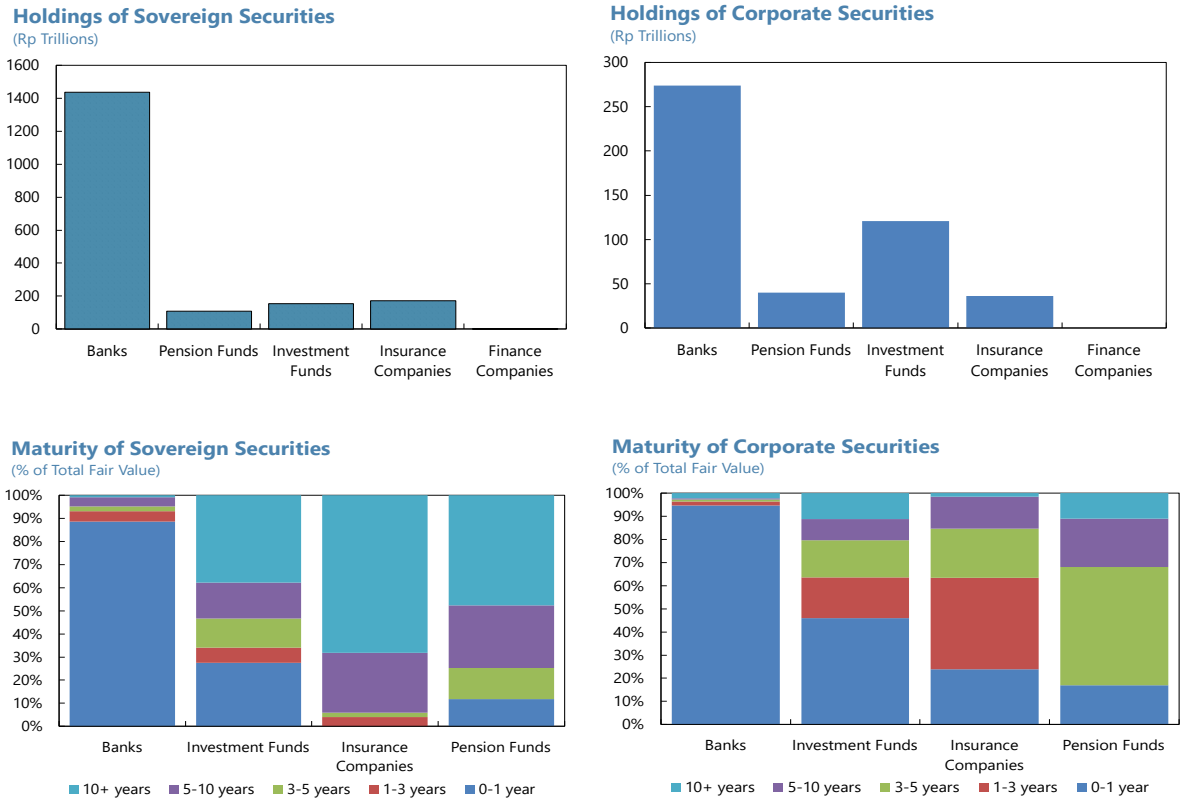
Figure 40. Indonesia: Financial System Assets and Liabilities



Sources: BI, OJK, and IMF.

101. The maturities of sovereign and corporate securities also differ across commercial banks and NBFI sectors. Banks mostly hold securities with shorter duration at around 3.5 years on average, while NBFIs hold securities with longer duration (Figure 41). Specifically, 68, 48, and 38 percent of the sovereign securities held by insurance companies, pension funds and investment funds have maturities exceeding 10 years, respectively.

Figure 41. Indonesia: Holdings of Sovereign and Corporate Securities



Source: BI and OJK.

C. Methodology

102. To address the aforementioned risks, a systemwide liquidity analysis is performed on total currency level to assess jointly banks and NBFIs' resilience against large liquidity shocks and potential externality to the rest of the system. The exercise uses Monte Carlo simulations which attempt to apply several compoundable layers of liquidity stress scenarios onto the system, each tailored to specific type of liquidity risks facing the Indonesian NBFIs and the broader financial system, shown as below and in Figure 42. Correspondingly, each layer requires the generation of a single or multiple relevant liquidity shocks which are assumed to be strongly correlated under stress (Table 6).[41]

Table 6. Indonesia: Systemwide Liquidity Analysis—Shock Calibration

Corresponding Layer of Scenarios	Variable	Range (in percent)
Layer 1	Sovereign bond yield shock	[0,4] with avg shock of 200bps
Layer 1	Corporate bond yield shock	[0,8] with avg shock of 400bps
Layer 2	NFC FX funding shock	[0,50]
Layer 3	Wholesale deposit run-off	[0,50]
Layer 4	Resident retail deposit run-off	[0,20]
Layer 4	Non-resident retail deposit run-off	[0,50]
Layer 5	Share redemption rate	[0,50]
Layer 5	Insurance reserves outflow	[0,50]
Layer 5	Pension withdrawal rate	[0,50]

Source: IMF staff.

- **Layer 1: Sovereign and corporate securities devaluation.** A decline in the market value of tradable securities can affect the liquidity buffers of the market agents in the system.
- **Layer 2: Non-financial corporates funding shock.** When facing funding constraints associated with tighter global financial conditions, firms that used to receive external funding would seek domestic funding from commercial banks.
- **Layer 3: Wholesale deposit run-off.** Wholesale deposit run-offs can be another major source of capital outflows whereby firms move their deposits outside of the banks or financial system on fears of deteriorating domestic financial and economic conditions and weakened currency due to persisting inflationary pressure, further U.S. monetary policy tightening or the need to refinance operations abroad.
- **Layer 4: Retail deposit run-off.** Non-residents move their deposits abroad, and residents may move their deposits into cash, gold, or other cash-like instruments.
- **Layer 5: NBFI liabilities shocks.** Redemption shocks may trigger investment funds' liquidity strains. There may be large scale insurance policyholder surrenders, lapses, and withdrawals.

[41] The correlation factor is assumed to be at 0.9 across all types of liquidity shocks.

Economic stress could trigger a surge in insurance claims. Households may make significant pension fund withdrawals.

The analysis follows a specific pecking order of market clearing that mimics the behavioral response of each agent under stress. A preference for highly liquid assets over less liquid assets is assumed for all agents. The starting assumption is that the utilization of liquid assets is very accommodative, as agents are allowed to freely withdraw liquidity from other agents after they exhaust their own cash buffers with no restriction.

103. Shocks to market value of sovereign and corporate securities follow a modified duration approach. The initial calibration of yield shocks for sovereign and corporates simulates a series of parallel shifts of both yield curves along the maturity buckets, while assuming a higher upper bound shift for corporate securities given their inherently higher risk premium. Granular data on holdings of corporate and sovereign securities by maturity buckets across financial agents are used as input, in conjunction with the calibrated yield shocks, to derive market valuation impacts using the modified duration approach according to the following formula:

$$\Delta P_i = \frac{D_i}{(1 + r_i + s_i)} * \Delta B_i * M_i$$

where P represents bond valuation; D represents the duration of debt securities which is selected at the midpoint within each maturity bucket for a given type of instrument; B represents bond yield; M represents the outstanding amount; r represents the risk-free rate and s represents bond spreads assumed in the shock calibration.

Figure 42. Indonesia: Narratives of Systemwide Liquidity Analysis

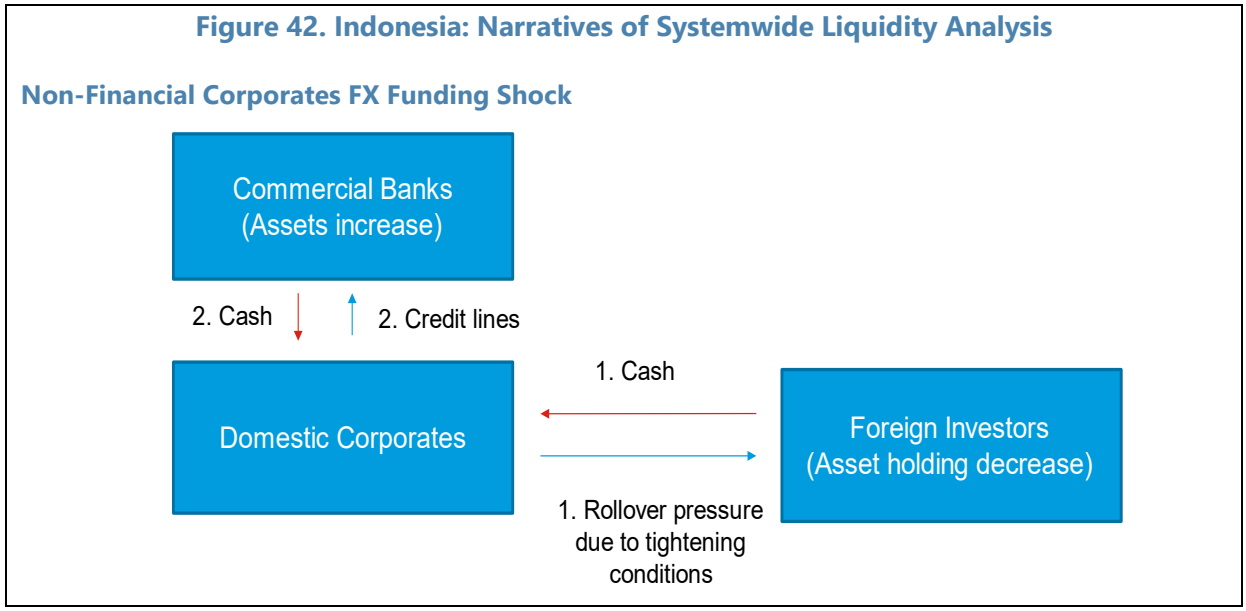
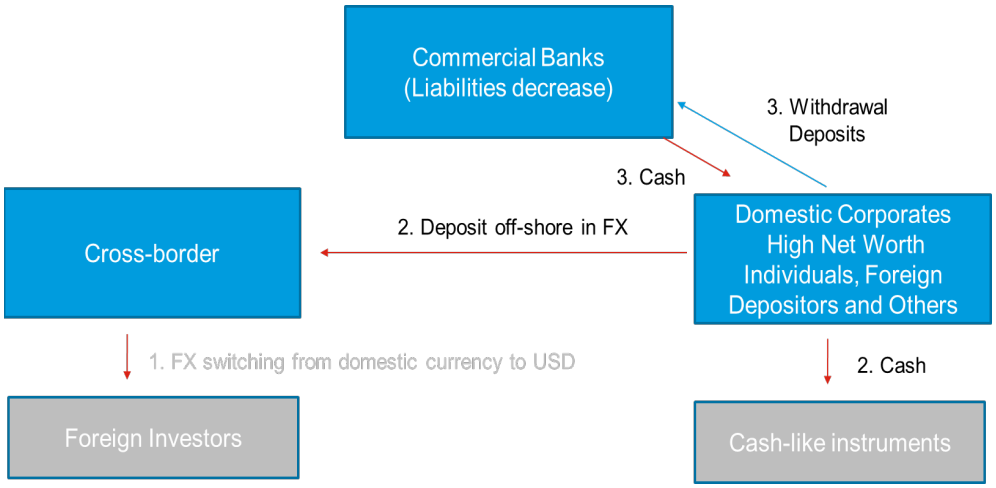
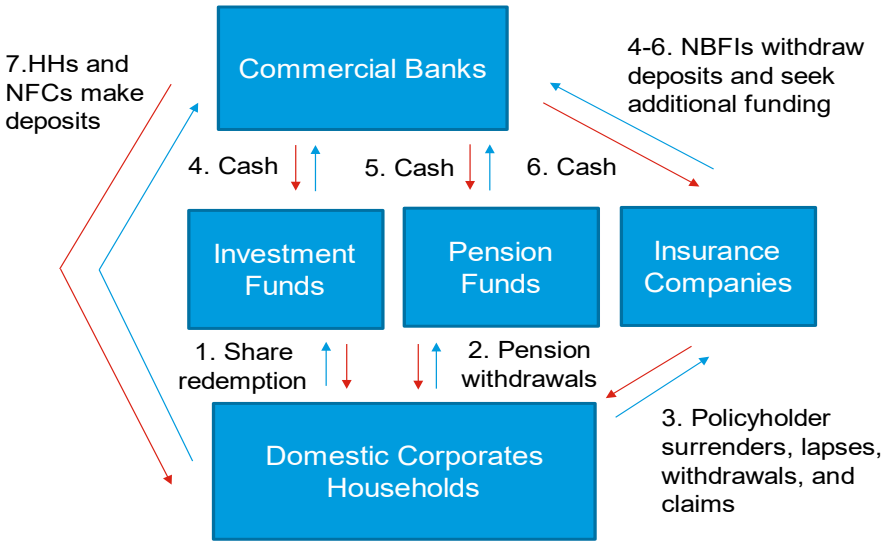


Figure 42. Indonesia: Narratives of Systemwide Liquidity Analysis (concluded)

Wholesale and Retail Deposit Run-Off



NBFI Liabilities Shocks



Source: IMF staff.

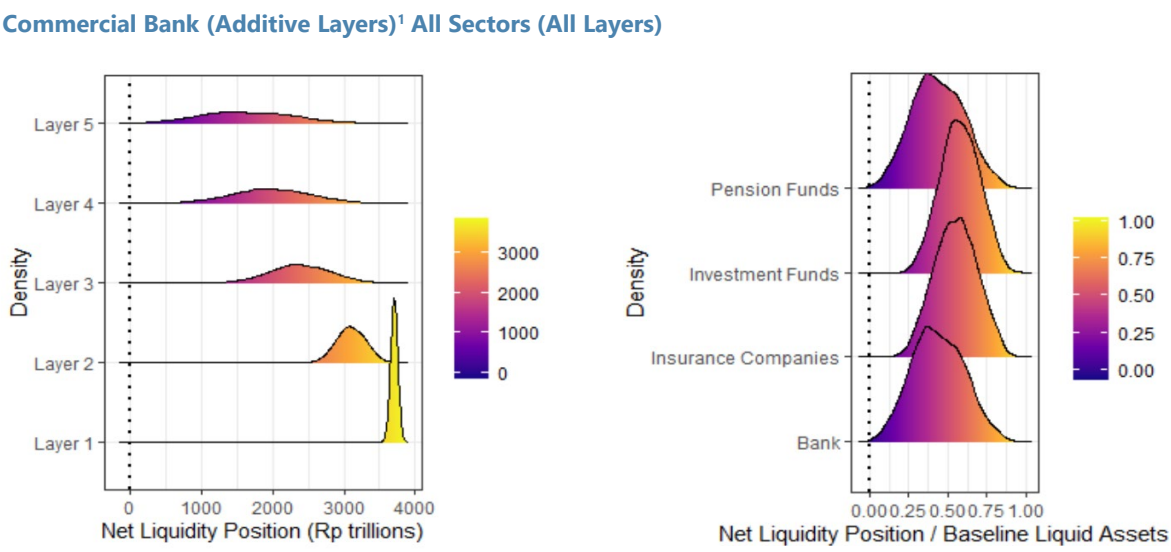
104. The analysis specifies a pecking order of asset liquidation to mimic the likely behavioral response of each agent under stress. A preference for highly liquid assets over less liquid assets is assumed for all agents. The starting assumption is that the utilization of counterbalancing capacity is very accommodative, and agents can flexibly withdraw liquidity from other agents after they exhaust their own buffers.

105. The analysis does not address risks related to interconnectedness arising from conglomerates having both banks and insurers within the same group. Improved reporting and data collection on intra-group flows is needed.

D. Results

106. The results suggest that the system remains resilient against the five narratives with commercial banks backstopping liquidity needs of all sectors in the system (Figure 43). Under the most severe test with combined shocks, commercial banks show only marginal liquidity shortfalls (a thin negative tail in their liquidity distribution), while acting as a shock absorber by providing liquidity to other agents. In only about 2 percent of simulations with all shocks do commercial banks have a small negative net liquidity position. In addition, despite applying large shocks to pension funds, investment funds and insurance companies, the resulting overall liquidity impact stemming from the NBFI sector is limited. This is due to the relatively small size of the NBFI sectors, and because households and non-financial corporates deposit their withdrawals at the commercial bank.

Figure 43. Indonesia: Results of Systemwide Liquidity Analysis



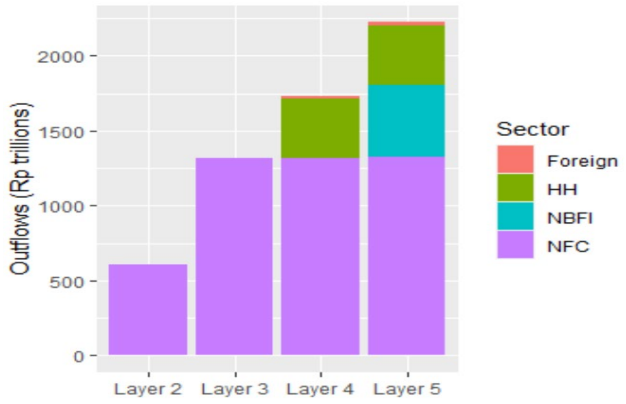
Sources: BI, OJK, and IMF.

[1] Layers are additive. For example, the results for Layer 4 include Layers 1, 2, 3, and 4.

107. A few caveats should be noted, however. First, due to data constraints, the analysis only considers exposure at sector level which may mask important variation and vulnerabilities at the entity level. Second, the analysis considers total currency exposure without a direct split between domestic and foreign currency which may understate the overall impact in the absence of currency frictions in the market. Third, the analysis does not consider the effects of policy support measures under the stress scenarios. Finally, the sample of firms do not include firms (typically MSMEs) in the informal sector, which tend to suffer disproportionately in the face of negative economic shocks.

108. A deeper dive into the contribution to the changes in the net liquidity position of commercial banks reveals the largest contribution of shocks come from non-financial corporate sector (Figure 44). Liquidity outflows from corporates contributes the most to the decline of net liquidity position of commercial banks, particularly given their high exposure to wholesale deposits.

Figure 44. Indonesia: Contribution to Commercial Bank Total Outflows



Source: IMF staff.

E. Recommendations

109. Going forward, the FSAP calls for enhanced data collection on NBFI statistics and their interconnection with banks, on both sectoral and institutional level. Currently, data collection and risk monitoring on NBFIs and their interconnection with the banks are quite limited and not performed on a regular basis. The level of granularity—such as data on the entity level—is also limited which impedes a fuller assessment of the growing importance of NBFIs in the financial system. Correspondingly, the FSAP recommends authorities to improve data collection and risk monitoring on NBFI balance sheet and solvency and liquidity positions, and regularly collect Bank-NBFI exposure matrix at both sectoral and institutional level to facilitate systemwide risk analysis. Furthermore, enhanced data collection on conglomerates, particularly on Banks and NBFIs and including not only asset size on aggregate but also sub-entities and their interconnections (e.g., ownership structure and bilateral balance sheet exposure within the group structure), could facilitate the identification of any large and opaque intra-group exposure and thus potential risk transferring mechanism within and outside the conglomerate structure.

SYSTEMWIDE FX LIQUIDITY ANALYSIS

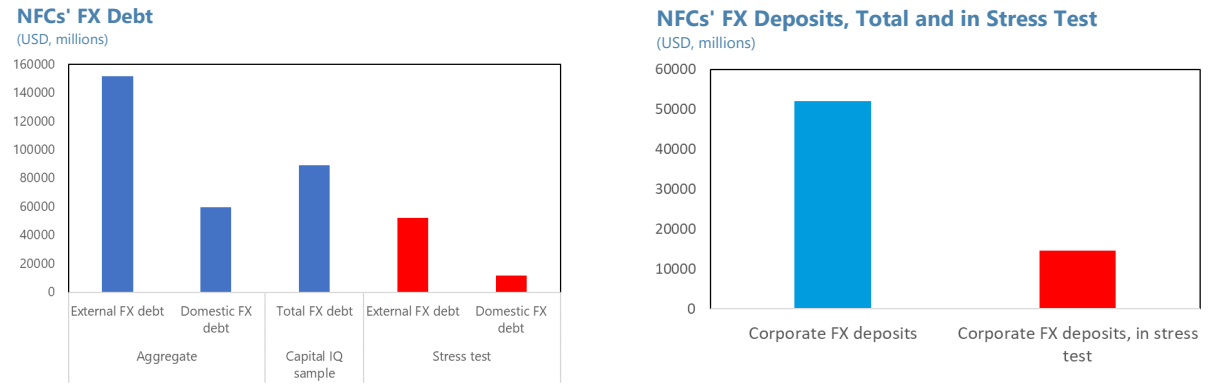
110. To complement the total currency analysis, the FSAP also undertake an assessment of the financial system's capacity in scenarios where NFCs' external financing comes under strain. As of end-2022, Indonesian corporates had about 161 billion USD external debt, 30 billion of which was short-term, and an additional 59.5 billion USD domestic borrowing in foreign currencies.[42] NFCs hold about 52 billion USD in FX deposits in the domestic system, indicating significant sectoral capacity to meet external rollover pressures for short-term debt by drawing on domestic liquid assets. At the same time, the banking system's FX CBC stood at over 40 billion USD, indicating significant scope to meet corporate deposit outflows.

[42] Aggregate statistics shared by authorities, based on datasets of listed and non-listed firms.

111. A granular NFC-bank FX liquidity stress test assesses both systemwide resilience and institutional vulnerabilities from FX liquidity mismatch. The granular, institution-level stress test allows for identifying potential shortfalls at the institution level (i.e., individual firms and banks), even if aggregate liquidity remains, in which case policy could support a redistribution of FX liquidity. The analysis focuses on 15 firms with the largest reported FX debt in a publicly available dataset.[43] The stress test considers scenarios in which firms experience FX debt rollover shocks, which they must meet through a combination of FX revenue, offshore and/or domestic FX deposits, domestic IDR deposits (which need to be converted to FX), and new domestic FX financing (if the domestic systems' remaining FX liquidity permits). Different assumptions regarding firms' pecking order over the above financing options is used to calibrate the severity of the shock. The scenarios test the joint resilience of the banking and NFC sectors by assuming no policy support. Extreme shocks on the sample firms are imposed, to try and partly compensate for the limited granular data on the entire network.

112. The system-wide FX liquidity stress test uses publicly available data for firms, and supervisory data on bank-by-bank CBC. Capital IQ is used to obtain data on outstanding debt instruments (including currency and maturity), FX revenue and total revenue for 2022. Annual reports are used to obtain data on deposits by currency and bank (restricted deposits are not included). Supervisory data is used for institution level FX liquid assets and their composition. The coverage is partial, due to data limitations (Figure 45).

Figure 45. Indonesia: Data Coverage for Systemwide FX Liquidity Stress Test



Source: Capital IQ, company annual reports, BI and IMF staff.

113. The stress testing strategy relies on both macro and proportional shocks, combined in the latter case with additional conservative assumptions to test the systems' resilience. In particular:

- **The macro shock uses the same stagflation scenario used for the bank solvency stress test and for the corporate debt-at-risk stress test.** Firm-level FX debt refinancing shocks are calibrated based on the predicted ICR for each firm in the corporate debt-at-risk stress test for

[43] Based on Capital IQ.

the stagflation scenario. Firms with predicted ICR above 2 are assumed to face no rollover pressures; firms with predicted ICR between 1 and 2 are assumed to face rating downgrade, which dries up external financing to rollover maturing debt over the stress test horizon (1 month); and firms with predicted ICR below 1 are treated as technically in default and need to repay their entire debt immediately.[44] In the results discussed below, firms use the following pecking order: first, available FX revenues are used (assumed to be 1/12th of annual 2022 FX revenue); second, offshore FX deposits; third, domestic FX deposits; and fourth, domestic IDR deposits.

- **The proportional shock scenarios impose refinancing need for uniform shares of firms' short-term and total FX debt.** To test the systems' resilience, the scenarios are assumed to be particularly severe: A 50 percent haircut is applied to FX revenue, and the pecking order assumes firms use domestic FX deposits before offshore ones. While the subset of scenarios where a proportion of all external debt needs to be rolled over are extreme, these are intended to partially compensate for the limited data coverage.

- **Several common assumptions are maintained in all presented scenarios.** On the banks' side: in line with standard liquidity stress testing approach, no inflows are assumed to replenish banks' CBC over the 30-day stress period. When liquidating banks' FX assets, BI's haircut assumptions are imposed. On the firms' side, new FX financing from the domestic banking system is at the bottom of firms' pecking order, and the potential for meeting NFCs' overall FX shortfall through new loans is assessed by comparing the shortfall against the banking system's remaining liquidity. IDR-denominated debt is assumed to face no rollover issues. Finally, there are no policy interventions.

114. The stress test points to significant systemwide and institutional resilience, especially if pockets of strain in the face of severe shocks are managed by redistributing remaining FX liquidity.

- **Stress test based on the macro scenario.** Stressed firms are left with a large portion of their FX refinancing need uncovered, indicating some mismatches between corporate FX debt and liquid assets. However, the banking system retains enough FX liquidity to allow new domestic financing to fill corporates' FX shortfall. Under the assumption of no new cash inflows to CBC, there are some pockets of liquidity strains in the banking system, but could be addressed through reallocating liquidity within the system.

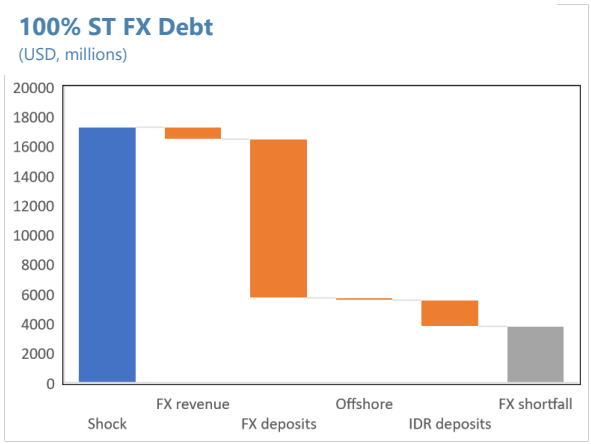
- **Proportional shocks to short term FX debt.** Even in the case where 100 percent of the sample firms' ST FX debt needs to be refinanced, firms are able to significantly close the external financing gap by drawing on their deposits. The simulated total FX outflow of 17 billion USD is over 50 percent of the total short-term debt for all firms. FX shortfalls in the corporate sector, and amongst small banks, could be covered by the remaining FX liquidity in the banking system.

[44] The option of firms to use cash buffers to pay interest and defer default is assumed not available.

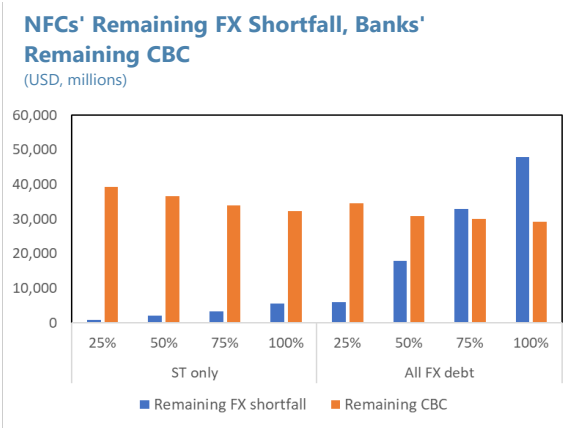
- **Proportional shocks to total FX debt.** In the extreme cases where 75 to 100 percent of the sample firms' total FX debt needs to be refinanced does the remaining counterbalancing capacity of the system fall below corporates' FX shortfall after deposits are used, and several medium to small banks run out of FX liquidity (Figure 46). However, these scenarios reflect extreme cases, where the imposed shock corresponds to over 1.5 to 2 times the short-term debt of the corporate sector.

Figure 46. Indonesia: Systemwide FX Liquidity Stress Test
(Based on proportional shock to ST debt)

FX deposits cover large share of firms' refinancing need.



Banking systems' remaining FX CBC could cover firms' shortfalls, except in the most extreme shock scenarios.



Source: Capital IQ, company annual reports, BI and IMF staff.

115. The results complement the findings of the bank FX liquidity stress test undertaken with comprehensive data. As in the bank FX liquidity stress test, which shocked proportions of the entire FX deposit base, pockets of limited shortfalls appear in severe shocks. As the bank-corporate FX liquidity stress test is based on partial data, increasing the coverage of linkages between firms and banks would allow for a more comprehensive assessment of the transmission of external shocks from NFCs to individual banks.

116. Key policy recommendations focus on increased data coverage and monitoring of FX risk exposures, both for banks and corporates. Expanding the coverage of non-listed large firms, including by integrating data on both domestic and external debt, would enhance surveillance of risks posed by the corporates to financial stability. Regular bank-corporate liquidity stress tests, similar to that undertaken here but with greater coverage, could be used to identify pockets of concentration and changes in FX stress absorption capacity. On the banks' liability side, monitoring FX deposit concentration could help calibrate stress tests accordingly. On banks' asset side, monitor both systemwide and bank-by-bank FX HQLA concentration, and place limits in case of excessive exposures. If FX stress absorption capacity is declining, consider further increasing FX reserve requirements, and/or limiting FX net outflows of in foreign currency LCR.

Appendix I. Risk Assessment Matrix

Appendix I. Table 1. Indonesia: Risk Assessment Matrix[1]

Source of Risks		Likelihood	Expected Impact	Policy Recommendation
Global	**Intensification of regional conflicts.** Escalation or spread of the conflict in Gaza and Israel, Russia's war in Ukraine, and/or other regional conflicts or terrorism disrupt trade (e.g., energy, food, tourism, supply chains), remittances, FDI and financial flows, payment systems, and increase refugee flows.	High	**Medium.** The impact on commodity prices, financial flows, and supply chains are likely to be the key channels of transmission. For commodities, a rise in energy prices and a fall in the price of commodities for which Indonesia is a net exporter (e.g., nickel) would lead to lower growth and worsen the external balance. A sharp increase in energy or food prices may strain the fiscal position to the extent these prices remain subject to administrative measures; price adjustments would reverse the moderation in inflation. Supply chain disruptions could impact production and trade, while also raising inflation. Capital outflows could tighten financial conditions and put downward pressure on the exchange rate vis-à-vis the U.S. dollar.	Use available policy space (e.g., fiscal and monetary policy) countercyclically to stabilize output and inflation. The exchange rate should remain flexible and determined by market forces. FXI could be used to address disorderly market conditions (e.g., a sharp pickup in the UIP premium) while keeping strong buffers.
	Commodity price volatility. A succession of supply disruptions (e.g., due to conflicts, export restrictions, and OPEC+ decisions) and demand fluctuations causes recurrent commodity price volatility, external and fiscal pressures in EMDEs, cross-border spillovers, and social and economic instability.	High	**Medium.** The economic impact will critically depend on whether (and which) commodity prices rise or decline, given Indonesia's net commodity exporter status in a number of key commodities. A rise in the price of oil, of which Indonesia is a net importer, and/or a decline in price of commodities for which Indonesia is a net exporter (e.g., nickel, crude palm oil) would lead to lower growth and worsen the external balance. A sharp increase in energy prices would reverse the moderation in inflation.	Use available policy space (fiscal and monetary policy) countercyclically to stabilize output and inflation. Seek to make progress on reforming energy subsidies. The exchange rate should remain flexible and determined by market forces.
	Deepening geo-economic fragmentation. Broader conflicts, inward-oriented policies, and weakened international cooperation result in a less efficient configuration of trade and FDI, supply disruptions, protectionism, policy uncertainty, technological and payments system fragmentation, rising shipping and input costs, financial stability, a fracturing of international monetary system, and lower growth.	High	**Medium/High.** A weaker global economy would reduce export demand and capital flows, including FDI. Higher uncertainty could weigh on investment and capital flows. Supply chain disruptions could push up inflation. In the long-term, lower productivity gains from the transfer of knowledge and technology embedded in trade and investments from frontier economies could hinder the pace of economic convergence.	Use available policy space (fiscal and monetary policy) to stabilize inflation and output, carefully calibrating the response to a potentially long-lasting shock (or series of shocks) to maintain margin for maneuver. Accelerate horizontal structural reforms to facilitate the transition to a more productive, more diversified, higher value-added and greener economy, including through additional investment in education and infrastructure, and by continuing to support an agile business climate, including through reducing trade restrictions and supporting integration.

Appendix I. Table 1. Indonesia: Risk Assessment Matrix[1] (continued)

Source of Risks		Likelihood	Expected Impact	Policy Recommendation
	Abrupt global slowdown. Global and idiosyncratic risk factors cause a synchronized sharp growth downturn, adverse spillovers through trade and financial channels, and market fragmentation triggering sudden stops in EMDEs.	Medium	**Medium/High.** Lower GDP growth, due to weaker investment and exports, including lower commodity prices; robust domestic demand may offer some offset depending on the size of the shock. The shock could trigger a decline in capital inflows, leading to currency depreciation and tighter domestic credit conditions; higher poverty rate.	Use available fiscal space to provide targeted support, while allowing the exchange rate to act as a shock absorber. FXI could be used to address disorderly market conditions (e.g., a sharp pickup in the UIP premium), while keeping strong buffers.
	Systemic financial instability. High interest rates and risk premia and asset repricing amid economic slowdowns and political uncertainty (e.g., from elections) trigger market dislocations, with cross-border spillovers and an adverse macro-financial feedback loop affecting weak banks and NBFIs.	Medium	**Medium.** Direct transmission of instability to the domestic financial sector is likely to contained amidst strong bank balance sheets and limited interlinkages. However, risk-off sentiment in global financial markets would tighten external financing conditions. Impact on economic activity in major trading partners and/or on commodity prices, if significant, could worsen the external balance.	Monitor spillovers to the domestic financial sector and stand ready to intervene if strains emerge. With inflation within BI's target range, monetary policy could be eased to limit impact output—particularly in case of easing monetary policy in major economies. Allow the exchange rate to act as a shock absorber. FXI could be used to address disorderly market conditions (e.g., a sharp pickup in the UIP premium), while keeping strong buffers.
	Re-emergence of lethal and highly contagious COVID-19 variants. Renewed health crisis and containment measures disrupt economic activity.	Low	**Medium/High.** Health crisis, and lockdown measures, lead to sharp reduction in consumption and investment, including through falling consumer and investor confidence. External demand and capital inflows fall, depreciating the currency and tightening domestic credit conditions. Higher unemployment and underinvestment, and adverse impact on human capital, scar medium term potential output.	Increase spending on health and social protection. With fiscal space available, targeted support measures for firms and households will help mitigate the social and economic costs. Monetary and macroprudential policies should be loosened. The exchange rate should remain flexible, and market driven. FXI could be used to address disorderly market conditions (e.g., a sharp pickup in the UIP premium), while keeping strong buffers.
Domestic	**Extreme climate events.** Extreme climate events driven by rising temperatures cause loss of human lives, severe damage to infrastructure, supply disruptions, low growth, and financial stability.	Medium	**Low.** Disruptions to economic activity are likely to be regional.	Prioritize targeted expenditures to affected households and businesses. Preemptively monitor financial sector risks that have geographical and/or sectoral concentrations that may be particularly vulnerable to climate shocks (e.g., fisheries, or mining complexes in vulnerable locations).

Appendix I. Table 1. Indonesia: Risk Assessment Matrix[1] (concluded)

Source of Risks	Likelihood	Expected Impact	Policy Recommendation
Disorderly energy transition. A disorderly shift to net-zero emissions (e.g., owing to shortages in critical metals) and climate policy uncertainty cause supply disruptions, stranded assets, market volatility, and subdued investment and growth.	Medium	Medium. Impact will depend on nature of transition, given Indonesia's position as a major producer/exporter of fossil fuels (e.g. coal) and critical minerals. An unanticipated acceleration in the pace of transition could raise credit and market risks, and create stranded assets, weighing on financial sector balance sheets given exposures to carbon-intensive firms. However, a sharp increase in prices of critical minerals of which Indonesia is a major producer (e.g. nickel) could boost export values and corporate profits.	Improve approach to climate risk assessment, monitoring of transition risk exposures, as well as disclosure and availability of data. Deploy broad horizontal structural reform to support diversification, value-addition, and green growth.

[1] The Risk Assessment Matrix (RAM) shows events that could materially alter the baseline path (the scenario most likely to materialize in the view of IMF staff). The relative likelihood is the staff's subjective assessment of the risks surrounding the baseline ("low" is meant to indicate a probability below 10 percent, "medium" a probability between 10 and 30 percent, and "high" a probability between 30 and 50 percent). The RAM reflects staff views on the source of risks and overall level of concern as of the time of discussions with the authorities. Non-mutually exclusive risks may interact and materialize jointly.

Appendix II. Stress Testing Matrix

Appendix II. Table 1. Indonesia: Stress Testing Matrix

Domain	Scope and Approaches for the Top-Down Tests by FSAP Team
Banking Sector: Solvency Stress Test	
Institutions Included	1. All regulated 105 commercial banks according to KBMI and ownership classification.
Data and Starting Position	2. Bank-level/Nonconsolidated level supervisory and market data (balance sheet and income statements).
Methodology	3. Satellite models and methods developed by the FSAP team.
Stress Test Horizon	4. Five years (June 2023 - June 2028).
Risks and Scenario Analysis	Macro-financial analyses with a baseline and two adverse scenario(s). 5. Baseline scenario based on the October 2023 IMF WEO projection. Adverse scenario(s) are simulated using the MCM macro-financial model, reflecting risks in the RAM, all of which are triggered by risk factors but amplified by domestic vulnerabilities. The recessionary scenario features a contraction in domestic demand and output, decline in commodity and real estate prices, and lower policy rate in response to lower inflation expectations. The stagflation scenario features persisting inflationary pressure driven by supply-side constraints due to geopolitical fragmentations, thus prompting further monetary tightening and rise in risk-free rates. 6. Both scenarios consider jump in term and risk premia on various types of asset classes.
Sensitivity Analysis	7. Sensitivity analyses evaluate impacts of single risk factors on the existing capital buffers, such as shift in yield curve, concentration risk, sectoral risks, as well as credit losses stemming from the unwinding of the forbearance program.
Risks/Factors Assessed	8. Credit, market, and funding losses from loan portfolios, holdings of debt securities and net open FX and equity position, respectively.
Behavioral Adjustments	9. Quasi-static balance sheet assumption and dividend payout restriction.
Risk Parameters	10. Point-in-time PDs, LGDs, and EADs.
Regulatory Standards	11. National regulatory framework with fully loaded Basel III definitions.
Output Presentation	12. System-wide capital shortfalls.
Banking Sector: Liquidity Stress Test	
Institutions Included	13. All regulated 105 commercial banks according to KBMI and ownership classification.
Data and Starting Position	14. Supervisory data at the reference date (e.g., 2023Q2).
Methodology	15. Cash-flows-based analysis with horizon up to 3 months. 16. NFSR analysis using volume-based approach.
Risks	17. Short-term liquidity outflows, asset price shocks, and fire-sales.
Buffers	18. Counterbalancing capacity in all types of tests includes liquidity obtained from markets through asset sales and from BI's standing facilities.
Banking Sector: Liquidity Stress Test	
Size of Shocks	19. Haircuts are calibrated to be consistent with haircuts from BI's standing facilities and solvency stress test scenarios. 20. Run-off rates are calibrated with hypothetical system-wide runs and dry-up of whole funding and allow for higher outflow rates for uninsured funding than insured funding.
Regulatory Standards	21. National regulatory framework.

Appendix II. Table 1. Indonesia: Stress Testing Matrix (continued)	
Output Presentation	22. System-wide and bank-level liquidity ratio, and liquidity shortfalls.
Banking Sector: Contagion Analysis	
Institutions Included	23. All regulated 105 commercial banks according to KBMI and ownership classification.
Data and Starting Position	24. Supervisory and market data at the reference date (e.g., 2023Q2).
Methodology	25. Interbank and cross-border network model by Espinosa-Vega and Solé (2010).
Risks	26. Credit and funding losses related to bilateral exposures, default of large borrowers.
Buffers	27. Institution's own capital and liquidity buffers.
Size of Shocks	28. Default of institutions or largest borrowers.
Output presentation	29. System-wide and bank-level capital shortfalls and other risk measures.
Climate Risk Analysis	
Institutions Included	30. All regulated 105 commercial banks according to KBMI and ownership classification.
Data and Starting Position	31. Supervisory data at the reference date (e.g., 2023Q2).
Methodology	32. Analysis of transition and physical risks using "Macro" approach. 33. Physical risk: Scenarios based on climate-related damage estimates from World Bank catastrophe risk modelling are simulated using the MCM macro-financial model. 34. Transition risk: Based on climate transition scenarios sectoral output pathways, simulated with a World Bank macro model, are used to generate firm-level probabilities of default which are then used to assess aggregated banking exposures.
Risks and Scenario Analysis	35. Physical risk scenarios based on NGFS climate scenarios. 36. Transition risk scenarios to be determined jointly with World Bank and authorities.
Output Presentation	37. System-wide and bank-level capital shortfalls and other risk measures.
Nonfinancial Corporate Sector Vulnerability Analysis	
Institutions Included	38. About 460 listed and non-listed Indonesian firms
Data and Starting Position	39. Capital IQ—S&P Global Market Intelligence, as of end-2022.
Methodology	40. Solvency risk analysis using ICR as the main indicator of interest. 41. Cash flow analysis.
Risks and Scenario Analysis	42. Baseline scenario based on the October 2023 WEO forecasts. 43. Adverse macroeconomic scenario consistent with other analyses in the FSAP team.
Systemwide Liquidity Analysis	
Institutions Included	44. Banks, NBFIs and Corporates
Data and Starting Position	45. Supervisory and market data (Capital IQ) at the latest reference date (e.g., 2023Q2)
Methodology	46. Sectoral (e.g., bank, NBFI, corporates, households) network analysis and systemwide liquidity shock simulations 47. Simulation of FX outflows from large corporates and spillover to the banks at entity level
Risks	48. Liquidity outflow risks on banks and NBFIs 49. FX debt rollover shocks for corporates and spillover to the banking sector
Buffers	50. Available liquid assets (or counter-balancing capacities) in domestic and foreign currencies for banks, NBFIs and corporates.
Size of Shocks	51. Range of run-off rates calibrated on bank deposit outflows, NBFI share redemptions, Insurance companies' policyholder surrenders, lapses, and withdrawals, and FX debt rollover shocks on nonfinancial corporates.
Output Presentation	52. Net liquidity position and liquidity shortfalls for banks, NBFIs, Corporates.

Appendix III. Growth-at-Risk

1. The Growth-at-Risk (GaR) framework is a macro-financial surveillance tool. The evolution of macro-financial vulnerabilities and changes in domestic and external financial conditions can provide important signals about evolving risks to future economic activity (Prasad et al., 2019). The GaR analysis helps to quantify macro-financial risks to growth, assess the relative importance of the macro-financial factors that impact the entire probability distribution of future GDP growth—rather than only the central forecast, and monitor how risks to economic activity may evolve over time. The analysis thus provides a basis for preemptive policies to mitigate downside risks.

2. The GaR analysis for Indonesia focuses on the likely impact of financial conditions and macroeconomic vulnerabilities on future growth. To reflect the multifaceted risks to growth, a large set of variables is aggregated into three main regressors—also called partitions, using principal component analysis. Data coverage started in 1990, at a quarterly frequency. The partitions are (see Table 1):

- **The financial conditions partition** aims at capturing the price of risks embedded in asset prices, the ease of obtaining financing, the cost of funding, and the degree of financial stress.
- **The macrofinancial vulnerabilities partition** captures macrofinancial imbalances and sectoral balance sheet weaknesses. The partition is conceptually broader than credit aggregates (such as credit growth and the credit-to-GDP gap). Macrofinancial imbalances could potentially emerge in the housing market and in the external sector. Sectoral balance sheet weaknesses of corporates, households, and governments, as well as multifaceted aspects such as leverage, liquidity, and indebtedness are included. Factors other than financial conditions and macrofinancial vulnerabilities are also likely to be relevant for explaining future growth dynamics.
- **The other factors partition** reflects external and domestic conditions**.** Measures of external demand (for example, major trading partners' growth or global growth) and commodity prices are likely to influence growth prospects. Domestic factors such as consumer confidence also tend to significantly affect near-term growth dynamics.

3. Quantile regressions are estimated on the following specification. For a given quantile q in {5%, 25%, 50%, 75%, 90%}, the model estimates the following quantile regressions:

$$y_{t+h}^{q} = \alpha^{q} + \beta_{F}^{q} X_{F,t} + \beta_{V}^{q} X_{V,t} + \beta_{G}^{q} X_{G,t} + y_{t+h-1}^{q} + \epsilon_{t+h}$$

where y_{t+h}^{q} represents the quantiles (q) of the future distribution of GDP growth (y) h quarters ahead; $X_{F,t}$, $X_{F,t}$, and $X_{F,t}$are the predictors of corresponding to financial conditions, macroeconomic vulnerabilities, and other factors, respectively.

Appendix III. Table 1. Indonesia: Summary of Variables Entering Each Partition

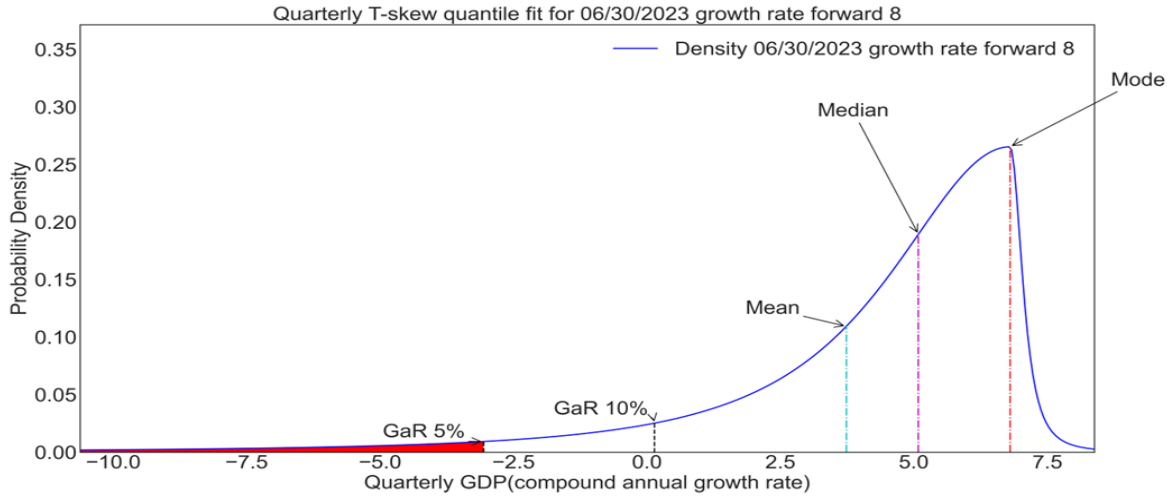
Financial Conditions	Macroeconomic Vulnerabilities	Other Factors
• Term premiums. • Interbank spread. • Corporate spreads. • Sovereign spreads. • Bond returns. • Equity returns. • Real long term interest rate. • VIX. • Exchange rate (relative to USD). • Foreign reserves.	• Credit growth. • Credit-to-GDP gap. • House price growth. • Growth of construction activity. • External debt. • Current account. • Corporate debt. • Household debt. • Government debt. • Liquid assets ratio. • Equity to assets. • Capital adequacy ratio.	• Non-energy commodity prices. • Energy prices. • China GDP growth. • US GDP growth. • Japan GDP growth. • India GDP growth. • Malaysia GDP growth. • Singapore GDP growth. • Consumer confidence index.

Source: IMF staff.

4. A skewed t distribution is fitted on the empirical conditional quantile function for each specific time horizon to estimate the tail risks around the baseline. Further details are discussed in Adrian et al. (2016). Using the skewed t-fitted curve, a probability density function can be derived for future GDP growth at each time horizon.

5. The GaR model suggests moderate risks around the baseline for Indonesia's GDP growth. Based on the financial conditions at 2023:Q2, a severely adverse outcome (given by the 5 percent left tail) is for annualized GDP growth to fall below -3.1 percent over the two-year horizon (Figure 1). This suggests moderate downside risks to growth, considering tightening global financial conditions and a deterioration of macroeconomic conditions in key trading partner countries, such as China.

Appendix III. Figure 1. Indonesia: Probability Densities of GDP Growth Eight Quarters Ahead



Source: IMF staff.

Appendix IV. Satellite Models

Credit Risk Satellite Models

1. Historical probability of default is used in the estimation of the credit risks. Separate satellite models are estimated for the PDs of household mortgage, household consumption and large corporate since 2006 and on quarterly frequency. Due to data limitation, PDs for MSMEs are proxied by that of the large corporate plus a markup based on average historical differences of PDs between MSMEs and large corporates. PDs for sovereign, banks, NBFIs are generated using Merton approach which translate credit spread under stress to PDs according to the following formula:

$$PD^{i}_{t,T} = \frac{1 - exp^{-S^{i}_{t,T^{*}}(T-t)}}{LGD^{i}_{t}}$$

In addition, LGDs are modeled using satellite models on coverage ratio at aggregated level and applied to individual bank starting point.

2. The satellite models for credit risk were estimated using model selection technique to remove model uncertainty. The model selection technique overcomes the issue of over-confident inferences in a single model estimation by averaging over the best models in the model class according to certain information criteria such as the R-square. The framework also enables sign restriction in the estimation process to ensure reasonable relationship among input variables and maximizes the robustness of out-of-sample forecast conditional on a constrained sample size. The satellite models for PDs as a dependent variable were constructed as follows:

- To ensure that the models only produce PD predictions between 0 and 1 (or, equivalently, between 0 and 100 percent) and to capture nonlinearities in the relationship between the dependent and explanatory variables, the following logit transformation was applied to the original PD:

$$Y_{it} = ln\left(\frac{PD_{it}}{1 - PD_{it}}\right)$$

- To estimate impact of shocks of macro-financial variables on PDs, the logit-transformed PDs are modeled as a linear function of different exogenous macroeconomic and financial factors (regressors). Therefore, the estimated model for the PDs can be expressed as: where Yi,t is the

$$Y_{it} = \alpha + \boldsymbol{\beta} Y_{i,t-k} + \boldsymbol{\delta} \boldsymbol{X}_{i,t-s} + \varepsilon_{i,t}$$

logit transform of the PD for asset class i at time t, Xt is a vector of macroeconomic and financial variables, Yi,t-k is vector of the lagged dependent variable (k=1 to N), εi,t is an independent and identically distributed error-term, and α, and vectors β, and δ are parameters to be estimated.

- The projected logit PDs for each of the exposure classes are transformed back to PD space which are then attached to the starting point of each individual bank's PDs to generate full path under both the baseline and the adverse scenarios.

3. GDP growth, unemployment rate, interest rates as well as asset prices prove to be relevant for the buildup of credit risk (Table 1). This is reflected in the level of significance of included explanatory variables. For instance, GDP growth and short-term interest rate appear to be significant drivers of PDs of household mortgages and large corporates, whereas unemployment rate appears to be significant for PDs of consumer loans. Asset prices, such as housing and stock prices, are significant drivers of coverage ratio and PDs of large corporates, respectively. The type and number of significant variables however vary distinctly across segments, as manifested by the individual characteristics of their historical PDs.

Appendix IV. Table 1. Indonesia: Satellite Models—PD Estimation

	PD Mortgage	PD Consumption	PD Large Corporate	Coverage Ratio
	Logit	Logit	Logit	Percent
Real GDP growth, yoy, percent	-0.05*	-0.02	-0.1*	-0.45
L2. Real GDP growth, yoy, percent	0.02	0.01	-0.01	
L4. Real GDP growth, yoy, percent	0.01	0.02	-0.09*	
Unemplyment rate, percent	0.03	0.2*		
Short-term rate, percent	0.06*	0.01	0.08*	
Long-term rate, percent	-0.02	0.05	0.01	
House price growth, yoy, percent	-0.01	-0.07*		-1.52*
Stock price growth, yoy, percent			-0.005*	
Commodity price growth, yoy, percent			-0.005	
Energy price growth, yoy, percent			-0.002	
L4. Exchange rate, period average, yoy, percent			-0.002	
R-square	0.23	0.58	0.47	0.29
Root mean square error	0.23	0.32	0.33	6.54
Number of observations	67	67	67	71

Note: *Denotes p<0.10.
Source: IMF staff.

Interest Rate Risk Satellite Models

4. Bank funding costs and lending rates are estimated based on interest rate for new business (front book) for each bank. The data on interest rates for new business are provided by the authorities and are proxied by lending and funding accounts that start within one quarter, since 2005.[1] Using the model selection technique, the satellite models estimate aggregate funding and lending rates on the portfolio level, which on the asset side include interest rates on loans and securities, and on the liability side include interest rates on current, saving and time deposits and bond issued. Subsequently, the period changes of the aggregate rates in the forecasting horizon are

[1] For funding portfolios that are at open maturity or have short maturity, such as current account or saving account with maturity typically within one year, the exercise uses the bank reported fix interest rate as a proxy of interest rate for the front book.

mapped with outstanding sensitive assets and liabilities reported in the IRRBB template to derive the impact on net interest margins arising from adverse movements in interest rates.

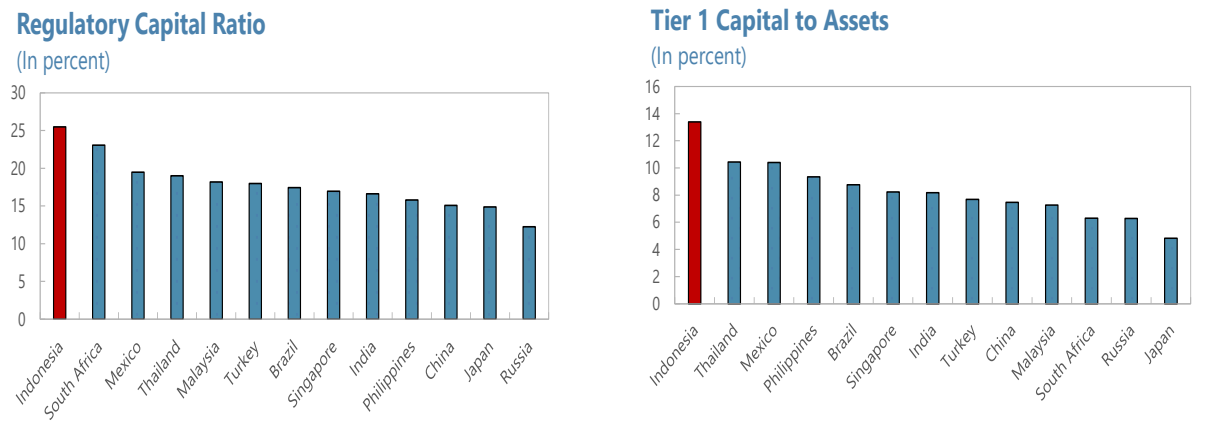
5. Results from satellite models on aggregated interest rates reveal the significant role of short-term rate, long-term rates as well as unemployment rate. On the asset side, lending rates appear to be highly correlated with the short-term interest rate, which is consistent with the dominant share of floating rate loans in the banking book. On the liability side, the cost of saving and current deposits is largely determined by the short-term rate while time deposits appear to be driven by long-term interest rates. Unemployment rate, a proxy of borrower credibility and economic conditions, appears to be a strong determinant of lending rates, saving as well as current deposits. The pass-through of short-term interest rate, proxied by the size of coefficient, on lending rates appears to be larger than funding rates, at around 0.36, whereas those for saving and current deposits are around 0.1.

Appendix IV. Table 2. Indonesia: Satellite Models—Interest Rate Estimation

	Asset		Liabilities			
	Loan	Bond	Current Deposits	Saving Deposits	Time Deposits	Bond
	Percent	Percent	Percent	Percent	Percent	Percent
Real GDP growth, yoy, percent	0.12*	-0.05	0.02	0.06*	0.06	
L2. Real GDP growth, yoy, percent						
L4. Real GDP growth, yoy, percent						
Unemplyment rate, percent	0.58*	0.62*	0.17*	0.36*	0.17	0.21
Short-term rate, percent	0.36*	0.22*	0.06*	0.13*		0.16
Long-term rate, percent	0.01	0.11	0.04	-0.03	0.63*	
R-square	0.85	0.87	0.78	0.88	0.61	0.04
Root mean square error	0.73	0.55	0.22	0.3	1.11	1.75
Number of observations	68	71	71	71	71	71

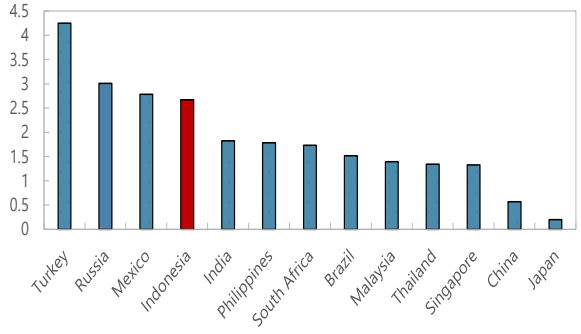
Source: IMF staff.
Note: * denotes p<0.10

Appendix IV. Figure 1. Indonesia: Banking Sector Against Peer Countries
(2023 or latest available)

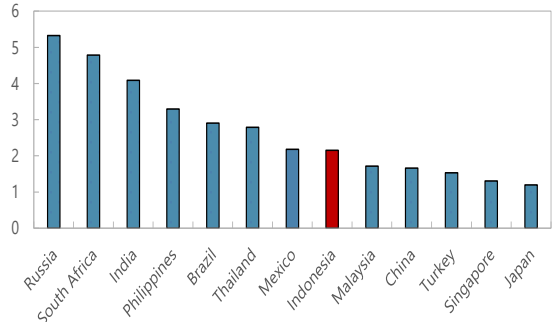


Appendix IV. Figure 1. Indonesia: Banking Sector Against Peer Countries (concluded)

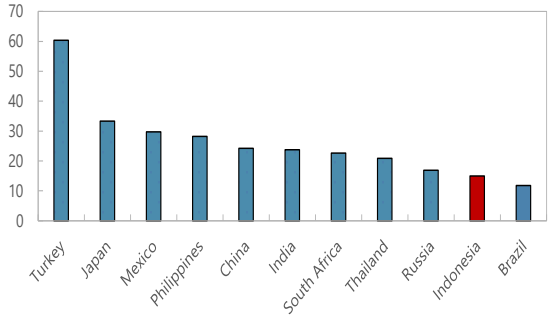
Return on Assets
(In percent)



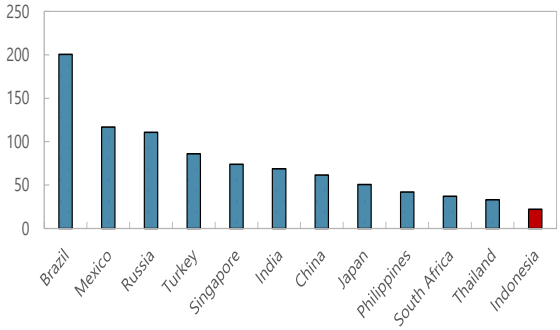
NPL Ratio
(In percent)



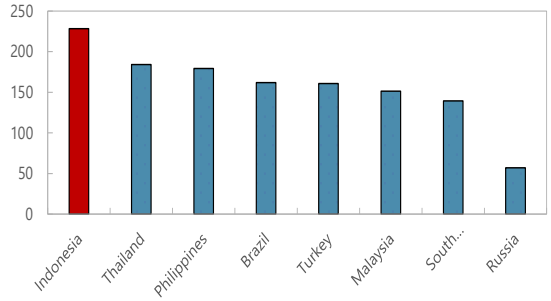
Liquid Assets to Total Assets
(In percent)



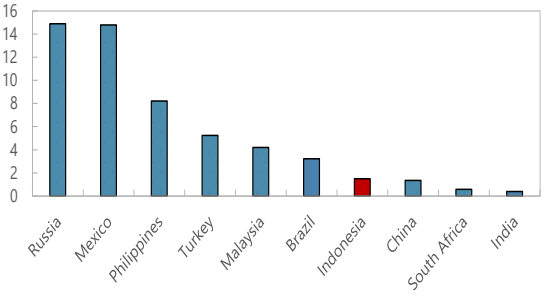
Liquid Assets to Short-Term Liabilities
(In percent)



Liquidity Coverage Ratio
(In percent)



Net Open Position in Foreign Exchange to Capital
(In percent)



Sources: FSI, OJK and IMF Staff.
Note: For Indonesia, liquid assets exclude central bank required reserves and include only cash and deposits.

Appendix IV. Table 3. Indonesia: Macroeconomic Scenarios Used in Stress Test

(In percent)

Real GDP growth	2023Q2	2024Q2	2025Q2	2026Q2	2027Q2	2028Q2
Baseline	5.2	4.9	5.0	5.0	5.0	5.0
Adverse - Stagflation	5.2	-3.0	-3.3	0.2	4.6	8.0
Adverse - Recession	5.2	-3.9	-1.2	6.8	7.5	6.4
Nominal GDP growth						
Baseline	12.3	7.8	7.5	7.6	7.5	7.0
Adverse - Stagflation	12.3	2.4	1.4	4.5	8.6	10.8
Adverse - Recession	12.3	-2.6	-2.3	5.8	7.8	7.3
Inflation						
Baseline	3.9	2.5	2.5	2.5	2.3	1.7
Adverse - Stagflation	3.9	5.2	5.1	4.3	2.9	1.5
Adverse - Recession	3.9	0.8	-0.1	1.9	2.6	2.6
Unemployment rate						
Baseline	5.3	5.2	5.1	5.1	5.1	5.1
Adverse - Stagflation	5.3	8.0	8.8	8.8	7.7	7.0
Adverse - Recession	5.3	8.0	8.8	8.5	6.7	5.3
3-month interbank rate						
Baseline	6.8	7.1	6.0	4.9	4.0	3.9
Adverse - Stagflation	6.8	8.6	8.0	6.9	5.5	5.4
Adverse - Recession	6.8	6.4	4.9	4.1	3.7	3.8
Long term yield						
Baseline	6.3	6.3	6.0	5.9	5.8	5.8
Adverse - Stagflation	6.3	11.5	10.8	9.0	7.8	7.2
Adverse - Recession	6.3	11.7	6.5	5.2	5.2	5.4
Exchange rate						
Baseline	2.3	-1.1	-0.7	-0.4	-0.6	-0.7
Adverse - Stagflation	2.3	21.6	15.7	5.1	-1.9	-5.4
Adverse - Recession	2.3	19.4	-3.4	-9.7	-9.4	-7.8
Housing price growth						
Baseline	1.9	1.9	1.9	1.9	1.9	1.9
Adverse - Stagflation	1.9	-3.5	-2.7	-0.9	2.6	4.8
Adverse - Recession	1.9	-7.2	-2.5	2.8	3.7	1.9
Stock price growth						
Baseline	-4.1	9.0	9.0	9.0	8.8	8.0
Adverse - Stagflation	-4.1	-27.9	20.3	13.0	12.7	10.7
Adverse - Recession	-4.1	-30.6	6.9	10.7	11.1	9.9
Oil price growth						
Baseline	-36.5	3.8	-5.0	-6.8	-6.0	-4.5
Adverse - Stagflation	-36.5	77.0	-2.8	-19.6	-26.0	-16.3
Adverse - Recession	-36.5	-24.9	6.2	-3.6	5.1	-2.4
Commodity price growth						
Baseline	-6.2	-3.0	-0.2	0.1	0.4	0.7
Adverse - Stagflation	-6.2	-27.7	9.1	8.9	9.8	2.4
Adverse - Recession	-6.2	-23.6	7.1	7.2	8.0	2.1

Source: IMF staff.