



THAILAND

FINANCIAL SECTOR ASSESSMENT PROGRAM

TECHNICAL NOTE—RISK ASSESSMENT

This Technical Note on the Risk Assessment for Thailand was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed as of February 2019.

October 2019

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Prepared By
**Monetary and Capital Markets
Department, IMF**

This Technical Note was prepared by Pierpaolo Grippa and Suchitra Kumarapathy, with collaboration of Moses Kitonga (all IMF staff) in the context of a joint IMF-World Bank Financial Sector Assessment Program (FSAP) mission in Thailand during November 1–16, 2018 and February 6–22, 2019 led by Alejandro Lopez-Mejia, IMF and Brett Coleman, World Bank, and overseen by the Monetary and Capital Markets Department, IMF, and the Finance, Competitiveness and Innovation Global Practice, World Bank, World Bank. The note contains the technical analysis and detailed information underpinning the FSAP assessment's findings and recommendations. Further information on the FSAP program can be found at <http://www.imf.org/external/np/fsap/fssa.aspx>.

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- I. Stress Test Matrix (STeM) for the Banking Sector: Solvency, Liquidity, and Contagion Risks ___ 67

Glossary

AFS	Available for Sale
AMC	Asset Management Company
AUM	Assets Under Management
BoT	Bank of Thailand
CAR	Capital Adequacy Ratio
CCB	Capital Conservation Buffer
CET1	Common Equity Tier 1
CNY	Chinese Renminbi
CU	Credit Unions
D-SIB	Domestic Systemically Important Bank
EA	Euro Area
EAD	Exposure at Default
ELA	Emergency Liquidity Assistance
EUR	Euro (currency)
EVE	Economic Value of Equity
FI	Fixed Income
FSAP	Financial Sector Assessment Program
FSGM	Flexible System of Global Models
FSI	Financial Soundness Indicators
FX	Foreign Currency
GDP	Gross Domestic Product
GFC	Global Financial Crisis
HFT	Held for Trading
HQLA	High-Quality Liquid Assets
IMF	International Monetary Fund
IRB	Internal Ratings-Based Approach
IRRBB	Interest Rate Risk in the Banking Book
JPY	Japanese Yen
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
LTV	Loan to Value
MCM	Monetary and Capital Markets
MMF	Money Market Fund
NAV	Net Asset Value
NII	Net Interest Income
NOP	Net Open Position
NPL	Nonperforming Loans
OLS	Ordinary Least Squares
PD	Probability of Default
RAM	Risk Assessment Matrix
RCR	Redemption Coverage Ratio
RWA	Risk-Weighted Assets
SEC	Securities and Exchange Commission
SET	Stock Exchange of Thailand

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SFI	Specialized Financial Institution
SME	Small and Medium Enterprises
SML	Special Mention Loan
ST	Stress Test
TA	Technical Assistance
THB	Thai Baht (currency)
T1	Tier 1 (capital)
TCC	Thrift and Credit Cooperatives
US	United States
USD	U.S. Dollar
VaR	Value at Risk
VAR	Vector Auto Regression
WB	World Bank
WEO	World Economic Outlook

EXECUTIVE SUMMARY

The Thai banking system shows a substantial resilience to severe shocks. The solvency stress tests indicate that the largest banks can withstand an adverse scenario broadly as severe as the Asian financial crisis. While three banks would deplete their capital conservation buffer (CCB) under the adverse scenario, recapitalization needs would be minimal. A battery of complementary sensitivity stress tests, which allows to cover in more detail certain risk factors, also confirmed the overall picture of a resilient banking system: no particular vulnerability emerged from the analysis of the bond portfolio to an increase in government and corporate spreads, exposure to foreign exchange risk, and concentration risk in the loan portfolio, with the possible exception of one entity with a particular concentration on single-name exposures. From a systemic risk perspective, certain risk concentrations can act as shock amplifiers in case of stress, and hence highlight the importance of improving and expanding the range of analytical tools to detect them. The BoT's solvency stress test exercise, conducted independently based on the same macro scenarios, showed very similar results despite some fundamental differences of approach, providing a mutual check on the overall robustness of the results.

Banks also appear to be resilient to sizable withdrawals of liquidity, though some would face increased funding pressures. Thai banks' funding maturity structure is front-loaded mostly to sight deposits in the near-term. Under the current regulatory regime, banks have sufficient liquidity buffers to withstand a one-month risk horizon. The aggregate Liquidity Coverage Ratio (LCR) remains above the hurdle rate of 100 percent under the severe scenario, with three banks falling below the hurdle rate with the aggregate liquidity shortfall of 0.7 percent of total assets (1.5 percent of GDP). The cash-flow-based analysis results were broadly consistent with the LCR test over a one-month horizon.

The liquidity stress test on investment funds (IFs) showed that they would be able to withstand a severe redemption shock and its impact on the banks and the bond market would be limited. The exercise covered open-ended daily fixed income funds (daily FI) and money market funds (MMF), accounting for 33 percent of net asset value (NAV). Their cash positions were mostly sufficient to meet redemption demands under the waterfall strategy, while a majority of the IFs retains a good amount of liquid assets under the pro rata strategy despite more aggressive sale of government bonds required. Of the eight individual funds that would see a significant depletion of their liquidity reserves, all except one would be able to withstand the shocks when the liquidation of corporate bonds is included. Credit lines between banks and asset management companies (AMCs) would provide an additional layer of liquidity buffer. The impact on the bond market could be substantial depending on the type of liquidation strategy.

An analysis of interconnectedness and contagion in the banking sector and in the financial system at large did not find any particular vulnerabilities. Interconnectedness appears to be at its lowest point in the last decade, both within the banking system and across sectors. However, interconnectedness and contagion are inherently difficult to measure and operationalize. In

particular, it is challenging to incorporate the potential channels of contagion identified by the analysis into the scenario-based exercises to test the resilience of the system when shocks travel through those channels and get amplified in the process. In this regard, the BoT's ongoing effort to explore an analysis aimed at capturing the interconnection between the main financial entities and economic sectors as well as across the border is welcome.

The BoT continued to improve its stress testing framework since its first top-down solvency macro stress test in 2017. The activity is based on the joint effort of different units within the BoT, under the coordination and with the active involvement of the Financial Stability Unit. This decentralized, network-like approach appears to be functioning well in ensuring a rich mutual cross-feeding through the exchange between different and complementary skills and 'cultures' across the different areas of the bank. The BoT has also addressed many of the recommendations provided by the 2018 IMF technical assistance (TA). Indeed, the BoT has improved its modeling of credit losses and feedback effects under adverse scenarios and introduction of macroprudential liquidity stress test.¹ The modeling of Net Interest Income (NII) in times of stress is an area that could be strengthened further, as identified by the 2018 TA.²

The BoT should also invest in improving the quality and granularity of certain datasets. While the BoT has a wide range of well-structured data, there is room for improvement, in particular, on the time series of Internal Ratings-Based (IRB) banks' Probability of Defaults (PDs) and Loss Given Default (LGD) and data management for liquidity risk to ensure the availability of more granular data including a finer breakdown by type.

The mission would like to express its gratitude to the management and staff of the BoT for their excellent cooperation, hospitality, and openness during the discussions and for effectively managing the logistics to facilitate the mission's work.

¹ 'Building Financial Stability Analytical Capacity,' Technical Assistance Report, Monetary and Capital Markets Department (MCM), IMF, March 2018.

² "[T]he effect of the stress scenario on NII and other income sources appears to be too moderate."

Table 1. 2019 Thailand FSAP: Key Recommendations

Recommendations	Responsible Authorities	Time¹	Priority²
<i>Solvency Stress Testing</i>			
Ensure the data quality of IRB banks' PD and LGD estimates and their responsiveness to Basel requirement in terms of dynamic characteristics (through-the-cycle vs point-in-time).	BoT	I	M
Revise the modeling of banks' net interest margin under stress to ensure that it is adequately conservative and plausible.	BoT	NT	M
Invest in the development of analytical tool for the estimation of concentration risk in the loan portfolio and other forms of asset concentration.	BoT	NT	H
<i>Liquidity Stress Testing</i>			
Continue to improve and strengthen the liquidity stress testing capacity by expanding staff resources and increased collaboration with banking supervision unit.	BoT	MT	M
Enhance the data management system for liquidity risk analysis to include more granular data by product, frequency, currency, and maturity and to conduct liquidity stress test by currency.	BoT	MT	H
<i>Stress testing on Investment Funds</i>			
Expand the scope of stress testing beyond daily FIs and MMFs.	SEC	MT	M
Implement a coordinated stress testing approach where all parties can have dialogue on the methodology of stress testing, scenario design, and share latest approaches and techniques to stress testing.	SEC	MT	M
<i>Interconnectedness and contagion analysis</i>			
Explore the potential links between balance-sheet-based and market-based interconnectedness metrics as a way to strengthen the analysis of systemic risks.	BoT	NT	M
¹ "I (immediate)" is within one year; "NT (near-term)" is one–three years; "MT (medium-term)" is three–five years.			
² Priorities are: H = High-Priority; M = Medium-Priority; L = Lower-Priority			

INTRODUCTION

1. Thailand's economy has been resilient to several shocks during the last decade. These shocks included severe floods in 2011, supply shocks in global commodity markets, and political instability in 2013–14 leading to subdued economic activity. The resilience of the economy was supported by ample international reserves, a flexible exchange rate, and a prudent fiscal position. Growth started to pick up in early 2018 underpinned by a recovery of domestic demand led by an improving labor market and investment. However, the momentum appears to be faltering due to the weak external demand, especially from China, and the impact of trade tensions on global supply chains. As a result, the economy grew by 4.1 percent in 2018 and is projected to slow down to around 3.0 percent in 2019 and 2020. Core inflation remains subdued, and average headline inflation (which reached 1.1 percent in 2018) is projected to decline to just below the lower end of BoT's target band of 1.0–4.0 percent in 2019 (Figure 1).

2. Financial vulnerabilities appear to be contained, but household indebtedness is relatively high and there are some weaknesses in corporates and Small and Medium Enterprises (SMEs) that the authorities are monitoring closely (Figure 2). On the positive side, the credit cycle started tapering off in 2015, partly due to increased risk aversion by banks, and the increase in equity and house prices has been moderate. While available data indicate that foreign exchange exposures of the financial sector are limited (5–6 percent of the commercial banks and Specialized Financial Institutions (SFIs)' aggregate assets and liabilities), uneven distribution of Foreign Currency (FX) assets and liabilities across sectors, if any, could be a potential source of risk. The main financial vulnerabilities are:

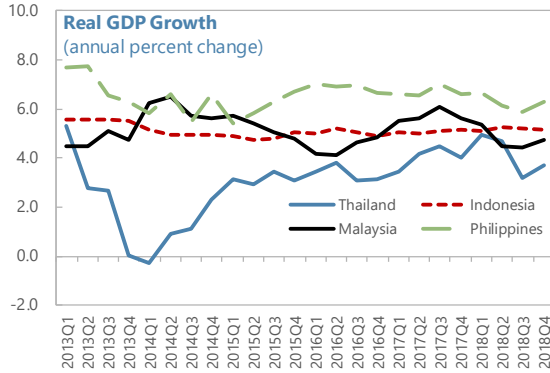
- **Household vulnerabilities** (Figure 3). Credit to households expanded rapidly until 2015, largely due to reconstruction efforts after the 2011 floods and the first-time car buyer program (October 2011–December 2012). As a result, household debt reached 80.8 percent of GDP in 2015 (up from 59.3 percent in 2010). Its growth started to pick up in 2018, driven mainly by hire purchase (auto loans). Moreover, since 2015 households have become increasingly exposed to capital markets through mutual funds.
- **Corporate vulnerabilities** (Figure 4). Corporate debt has been relatively stable and stood at 70.5 percent of GDP in 2017 (similar to the 2009 level). While leverage is relatively low compared to regional peers, debt-at-risk and the rollover risk are somewhat higher. There are signs of weaknesses in the SME sector, with nonperforming loans (NPLs) and special mention loans (SMLs) inching up. NPLs of SMEs related to the construction and real estate sectors appear to be relatively high, exposing banks to an adverse shock in the real estate market.

3. Risks to the macrofinancial outlook have shifted to the downside. Near-term risks have shifted to the downside, reflecting external and domestic headwinds. If trade tensions intensify, export growth could decline and spill over to domestic demand. A sharp rise in risk premia could precipitate capital outflows, adding to FX volatility and higher borrowing costs. Domestically, a difficult transition to a new government could lead to policy paralysis, derailing the Eastern

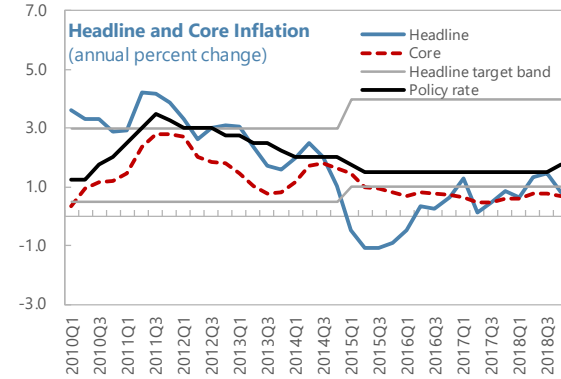
Figure 1. Thailand: Main Macroeconomic Developments

Growth continues its moderate recovery amid low inflation. External buffers have been built up supported by strong exports and a flexible exchange rate.

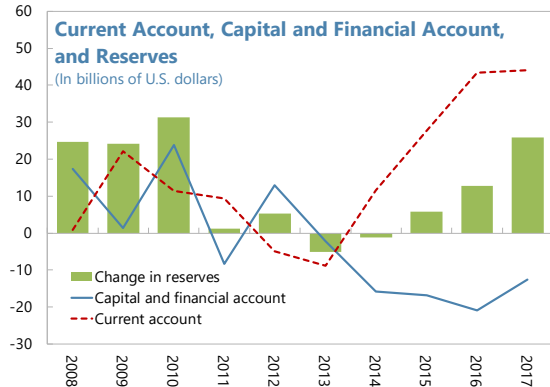
Growth momentum appears to be faltering...



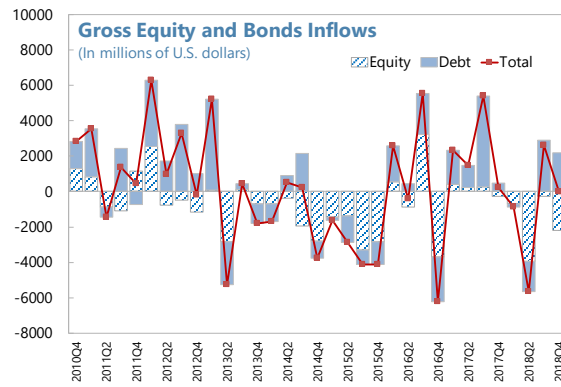
...and inflation remains subdued.



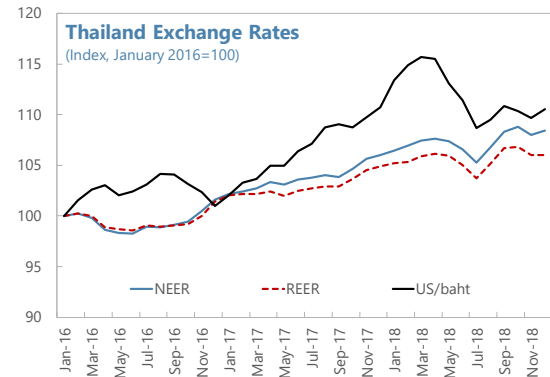
A large current account surplus led to a rapid accumulation of international reserves.



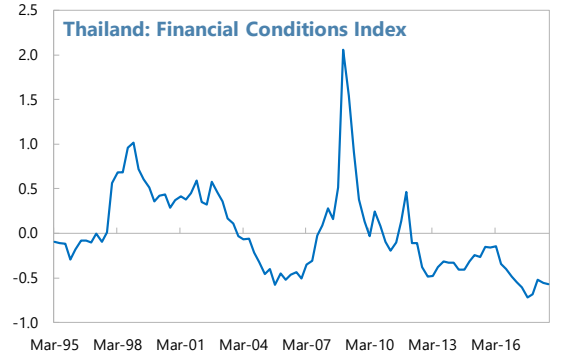
Portfolio flows turned positive in the third quarter of 2018, partly due to a flight to safety within emerging economies.



The appreciation of the exchange rate in 2017 (reflecting a large current account surplus and portfolio inflows) was reversed in the first semester of 2018 due to outflows.



Financial conditions have been accommodative during the last decade.

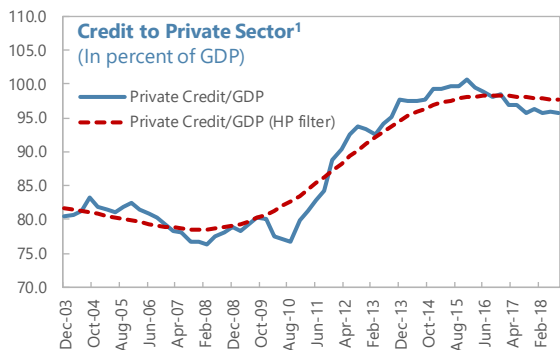


Sources: Bank of Thailand, Bloomberg, CEIC Data Co. Ltd, Datastream, Haver Data Analytics, IMF Global Data Source and World Economic Outlook databases, and IMF staff estimates and calculations.

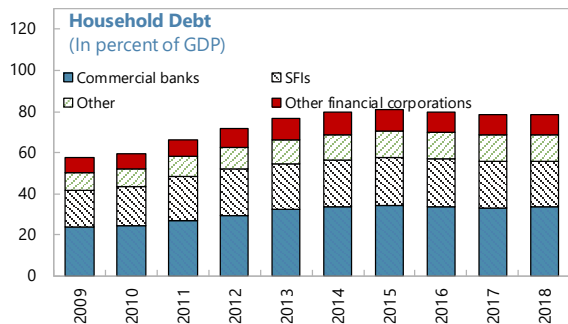
Figure 2. Thailand: Financial Vulnerabilities

While household indebtedness is relatively high and deleveraging is progressing slowly, corporate debt has been broadly stable and the increase in asset prices has been moderate.

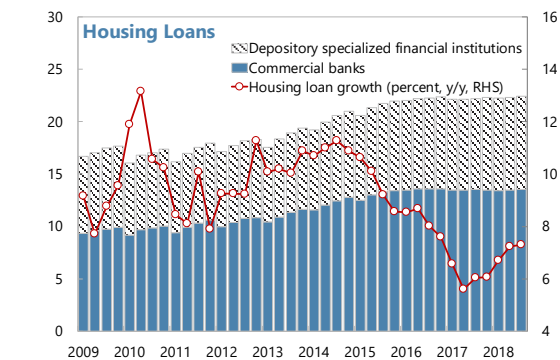
The credit gap turned negative in mid-2016, reflecting a slow-down in credit growth between 2015 and 2016.



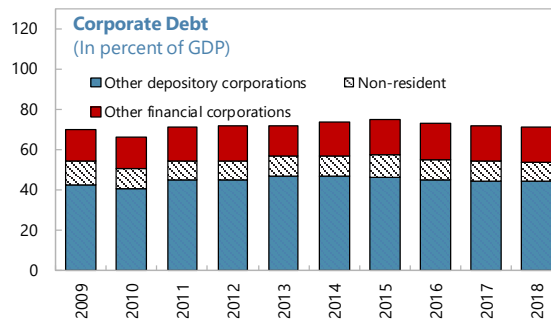
...total household indebtedness has decreased somewhat since its peak in 2015...



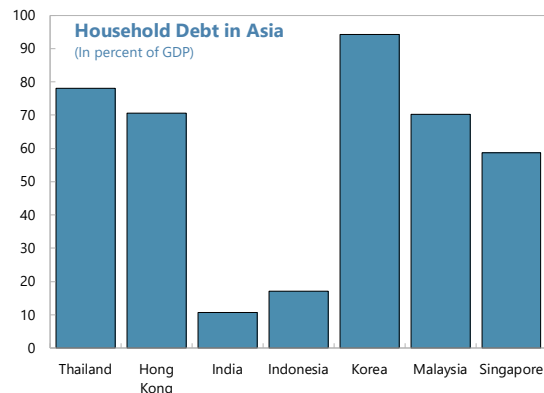
The growth in housing loans is picking-up in recent months, after a significant slowdown in the previous few years...



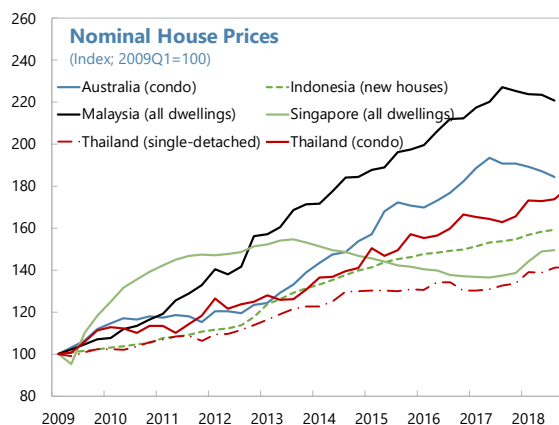
While corporate debt-to-GDP has been broadly stable...



...but remains high compared to regional peers.



...while the condominium prices have been increasing steadily.



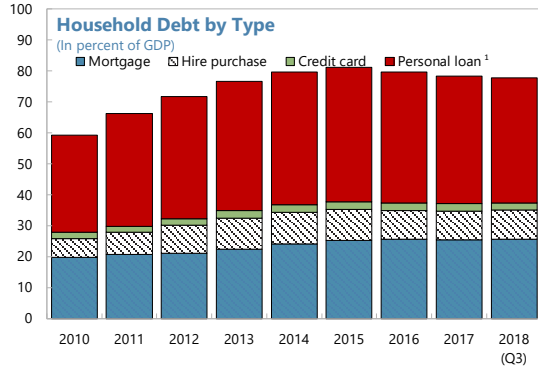
¹ Credit to corporate and household sectors extended by commercial banks and SFIs.

Sources: Bank of Thailand, CEIC Data Co. Ltd, Datastream, Haver Data Analytics, and IMF staff calculations.

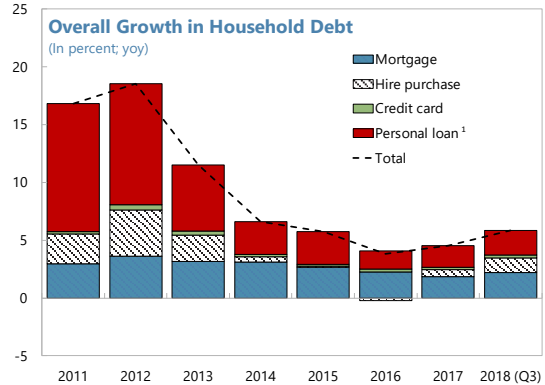
Figure 3. Thailand: Selected Facts of the Household Sector

While the recent pick up in household loans is partly attributed to favorable labor market dynamics, the increase in mortgages may be putting pressure in some segments of the housing market.

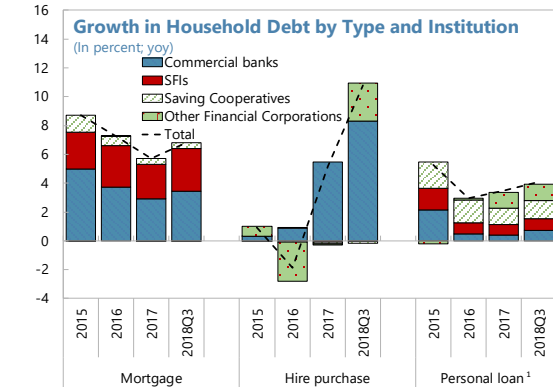
While total household debt as a share of GDP has stabilized since 2015...



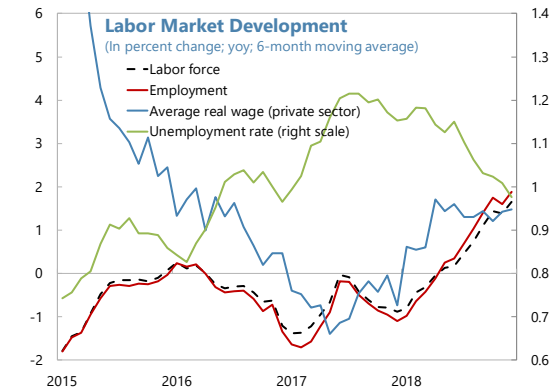
...in nominal terms, household debt continued to grow driven by hire purchase, mostly associated with auto loans.



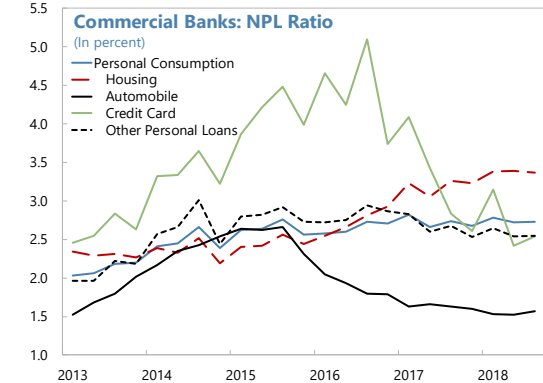
Growth in hire purchase (auto loans) accelerated in recent months; the contribution to the growth in personal loans is shifting towards non-bank institutions.



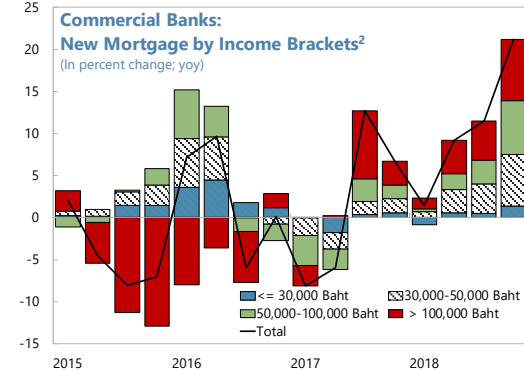
The recent pick-up in credit demand is supported by favorable labor market developments.



The NPL ratio of mortgages has been gradually edging up...



...with mortgages largely extended to high income individuals who earn more than THB50,000 per month.



¹ Includes loan for business purpose and other categories.

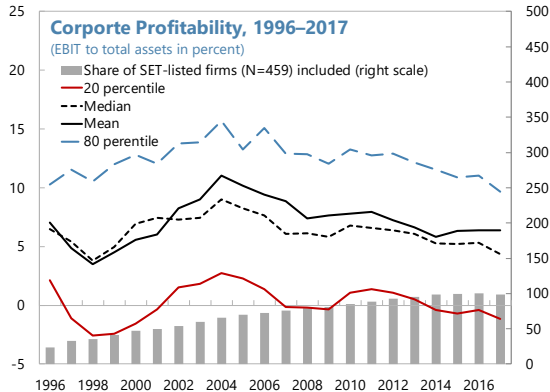
² Based on monthly income.

Sources: Bank of Thailand; and IMF staff calculations.

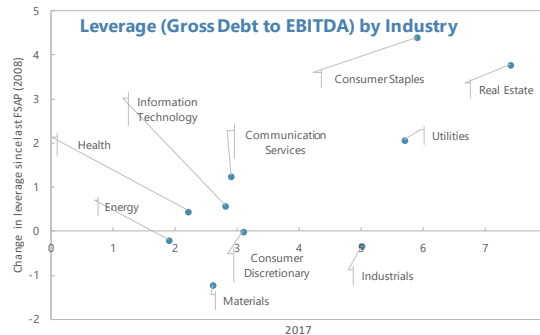
Figure 4. Thailand: Selected Facts of the Corporate Sector

With declining corporate profitability and increasing leverage in some sectors, debt-at risk is relatively high for regional standards and there are signs of vulnerabilities in SMEs.

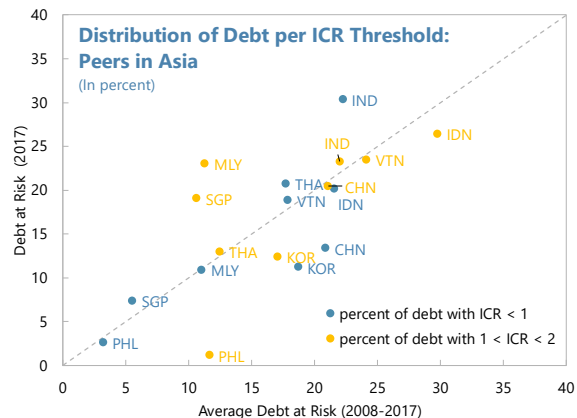
Corporate profitability has been on the decline since the fallout of the Global Financial Crisis in 2008–2009...



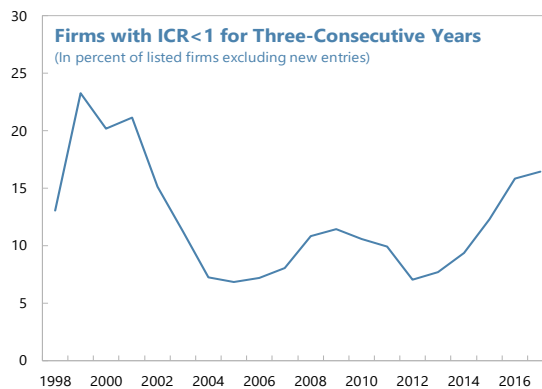
...and the leverage has increased substantially in sectors such as real estate, utilities, and some manufacturing ...



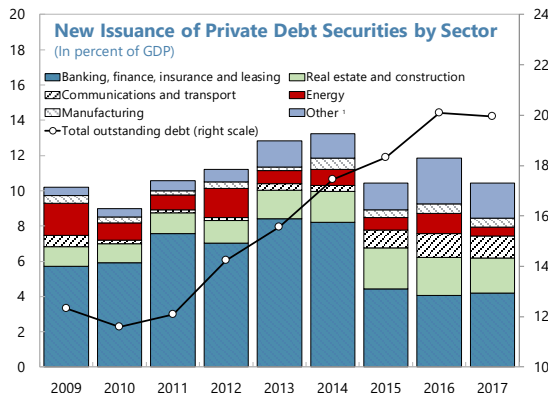
Debt held by Thai corporates with ICR less than 1 has increased somewhat and remains relatively high...



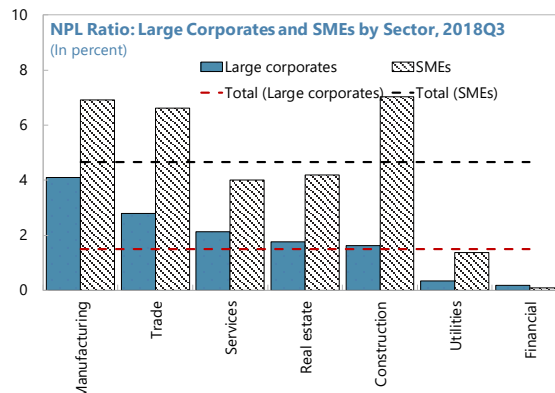
...and the number of firms with ICR less than 1 for three consecutive years has increased.



The corporate bond market has been growing rapidly, and securities are being issued more broadly across sectors.



NPLs are larger in SMEs than in large companies.



¹ Others include Agriculture, recreation and hotel, electronic and computer, and others.

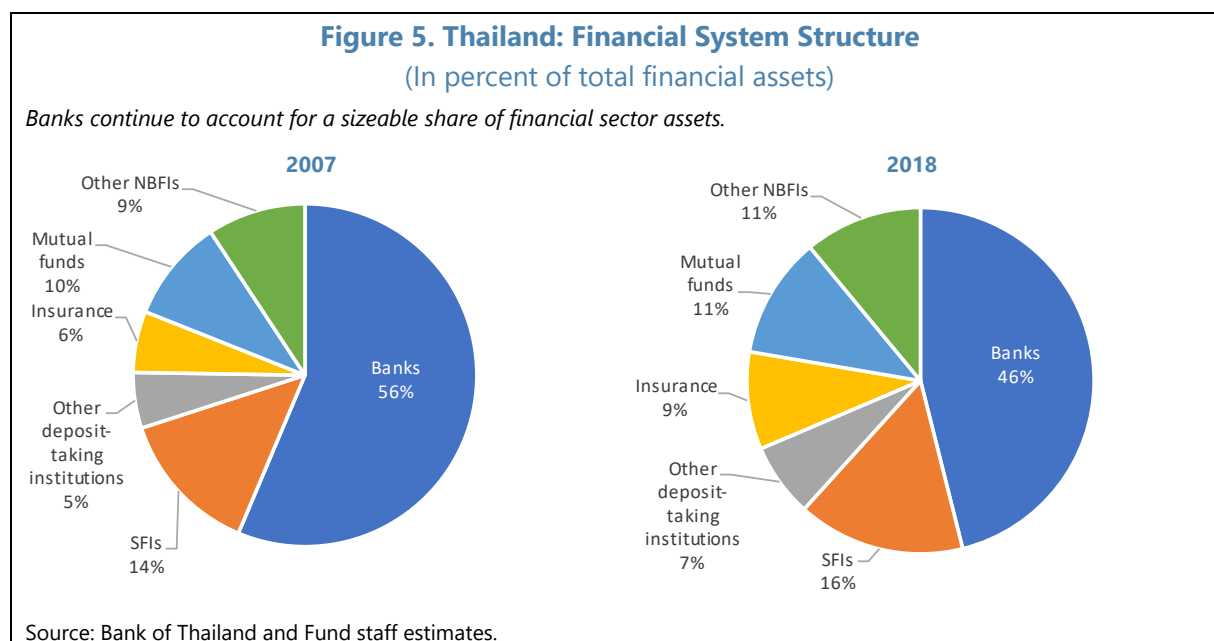
Note: Based on the sample of 459 listed companies with asset size larger than US\$25 million.

Sources: Bank of Thailand, Capital IQ (covers more than 10,000 firms across major Asian countries with total assets of US\$ 25 trillion), and IMF staff calculations.

Economic Corridor infrastructure push. Nevertheless, the country's ample buffers and strong fundamentals should be sufficient to help smooth these shocks. The medium-term growth outlook could be dampened by the high level of household debt, weaker-than-expected fiscal stimulus, and anemic productivity growth.

FINANCIAL SYSTEM STRUCTURE

4. While banks continue to account for a sizable share of the financial sector, the role of SFIs, other deposit-taking institutions, and nonbank financial institutions (NBFIs) has grown (Figure 5 and Table 2). Financial sector assets reached 266 percent of GDP at end-2018 (up from 183 percent in 2007). Assets of banks represented 46 percent of total financial sector assets at end-2018, down from 56 percent in 2007. The assets of SFIs (government-owned financial institutions for promoting economic development and supporting credit to specific sectors) and other deposit-taking institutions (e.g., credit unions (CUs) and thrift and credit cooperatives (TCCs)), as well as those of mutual funds and insurance companies (some of which are subsidiaries of the commercial banks), grew faster than banks' assets.

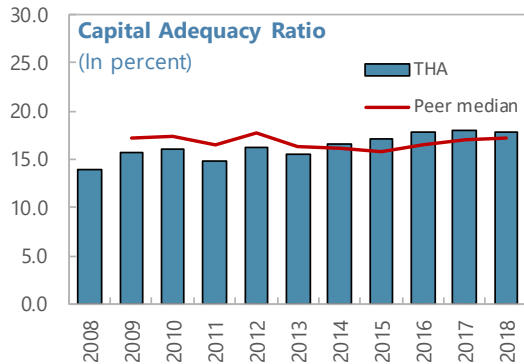


5. Commercial banks appear to be sound, though profitability is weak (Figures 6 and 7, and Table 3). The sector is supervised by the BoT, and consists of 30 institutions, with five domestic systemically important banks (D-SIBs) accounting for 70 percent of assets. The aggregate capital adequacy ratio (CAR) stood at 18.0 percent in the second quarter of 2018, well above the minimum of 10.375 percent in 2018 and 11 percent from 2019 (including the conservation buffer). While the ratio of NPLs to total loans is relatively low at 3.1 percent, the quality of credit to SMEs has deteriorated. Current weaknesses in loan management practices may be understating the level of NPLs, though this is being mitigated by high levels of provisioning and targeted in-depth

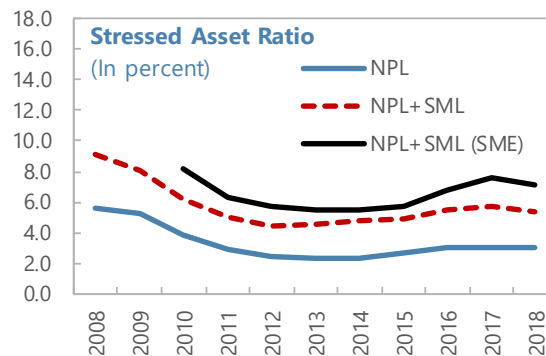
Figure 6. Thailand: Financial System Soundness Indicators

Banks appear to be sound, though liquidity indicators and profitability are somewhat below peer countries.

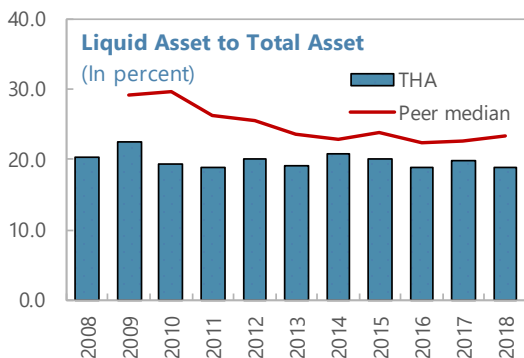
The capital adequacy ratio remains well above the regulatory minimum and increasing...



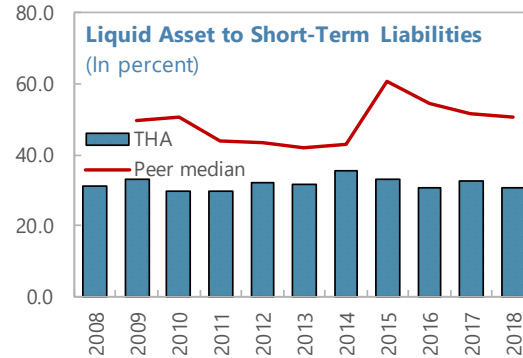
...and the NPL ratio is low, albeit the quality of credit to SMEs is showing signs of deterioration.



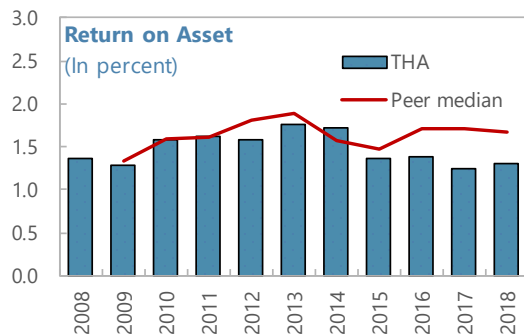
The share of liquid asset to total asset is moderately below the median of peer countries...



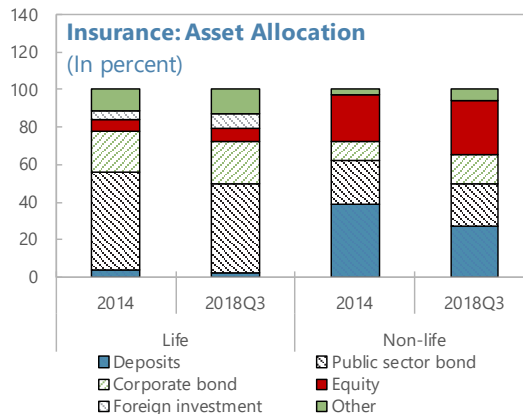
...and Thai banks appear to rely more on short-term liabilities.



Profitability is somewhat below peer countries.



The insurance sector has a diversified asset allocation, but the share of equities is high for non-life companies.



Note: SML stands for special mention loans. Peer countries include ASEAN 5 (Indonesia, Malaysia, Philippines, Singapore), Colombia, South Africa, and Turkey.

Sources: Bank of Thailand and IMF Financial Soundness Indicators database.

Figure 7. Thailand: Balance Sheet Structure of Banks and SFIs

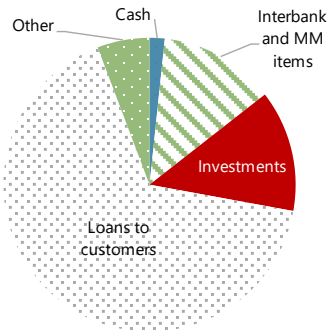
(As of end-2018)

The corporate and household sectors account for the majority of banks' loans and deposits, and SFIs' loans and deposits are predominantly to households.

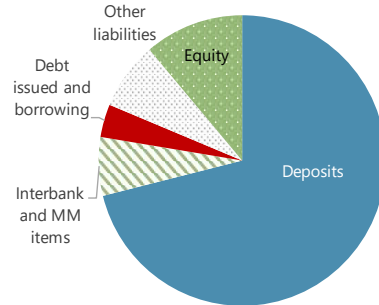
Loans account for around two-thirds of banks' assets...

...and 70 percent of the liabilities are in deposits, with a loan-to-deposit ratio slightly below 100 percent.

Structure of Bank Assets



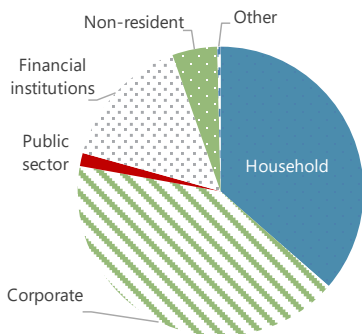
Structure of Bank Liabilities and Equity



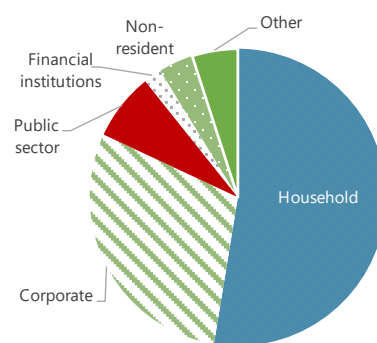
Corporates and households account for roughly one-third of banks' portfolio each, with small exposure to the public sector.

Banks rely mostly on retail deposits for funding.

Structure of Bank Loans



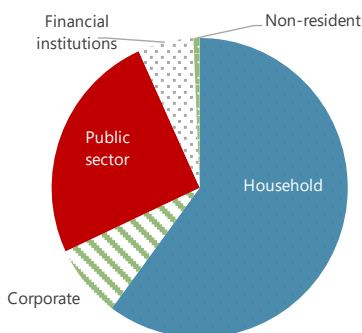
Structure of Bank Deposits



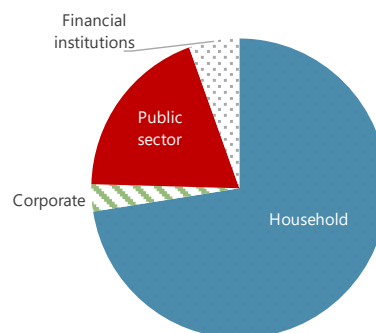
Households account for 60 percent of SFIs' loan portfolio...

...and close to three-quarters of funding.

Structure of SFI Loans



Structure of SFI Deposits



Sources: Bank of Thailand.

supervision. Commercial banks rely mostly on retail deposits and have been improving liquidity risk management. While the liquidity coverage ratio (LCR) was almost 170 percent in the third quarter of 2017, higher than in other regions,³ the liquidity metrics of the financial soundness indicators (FSIs) indicate that Thailand is below the median for peer countries. The profitability of the sector remains below peer countries.

6. SFIs, TCCs, and CUs play a key role in providing credit to households. The supervisory responsibility for the SFIs was shifted to the BoT in April 2015, as recommended by the IMF TA (2015) and the World Bank FSAP Development module (2011), and a structured framework for prudential supervision is being developed; the oversight of financial cooperatives (FCs, including TCCs and CUs) is under the Ministry of Agriculture Cooperatives. There are eight SFIs (four take retail deposits), 566 CUs, and over 1,400 TCCs. SFIs' loans and deposits are equivalent to about 40 percent of those of commercial banks, and SFIs, CUs, and TCCs account for about 45 percent of loans to households. SFIs' asset quality is somewhat weaker than that of commercial banks, with an average NPL ratio at 4.5 percent as of Sep 2017.

7. The assets of the main NBFIs reached 61 percent of GDP in 2018 (up from 33 percent in 2007). Insurance and mutual fund assets doubled as a share of GDP, while private pension funds experienced a moderate increase (text table).

- **Insurance.** The insurance sector is supervised by the OIC, created in line with the recommendations of the 2008 FSAP and accountable to the MoF. With gross premiums written growing well above nominal GDP in the last 10 years, the insurance penetration ratio (the ratio of premiums written to GDP) has increased from 3.6 percent in

Assets of Main NBFIs (In percent of GDP)						
<i>Insurance and mutual fund sectors have doubled as a share of GDP in the last decade, while private pension funds remain small.</i>						
	Insurance		Mutual fund		Pension ¹	
	2007	2016*	2007	2016*	2007	2016*
Colombia	3.8	6.8	0.2	0.1	13.5	22.1
Indonesia	3.3	4.4	2.2	1.8
Malaysia	18.4	20.3	25.3	29.1	47.8	59.9
Philippines	6.5	8.5	1.4	1.6	3.6	3.5
Singapore	43.8	42.8	...	641.2	...	29.9
South Africa	68.9	65.8	31.8	49.3	57.2	...
Thailand	11.2	24.2	17.8	30.98	5.2	6.9
Turkey	1.5	4.5	3.1	1.4	0.4	2.3

Sources: FinStats, The BoT, and Fund staff estimates.
¹ Excludes government pension fund for Thailand.
* End-2018 for Thailand.

2008 to 5.6 percent in 2017 (somewhat below the 8.8 percent observed in Singapore, but higher than most other countries in the region including Malaysia, Indonesia, and Vietnam). Of the 23 life (re)insurers operating in Thailand, the top 5 represent 72 percent of total assets in the sector and include a branch of a foreign insurance group (the largest) and 2 insurers owned by domestic banks. The non-life sector is less concentrated. Of the 53 non-life (re)insurers operating in Thailand, the top 5 represent 42 percent of direct premium in the sector (all data end-2017). At the same time, interest of foreign participants in the market is increasing, and the Thai authorities are actively working to increase foreign investment, most immediately, by

³ For example, the LCR was 130 percent in Europe, 126 percent in the Americas, and 128 percent for the rest of the world (these aggregated LCR ratios are for systemically important banks); Basel III Monitoring Report, March 2018.

adopting incentives to encourage foreign reinsurers to make Thailand a business center for their Southeast Asian operations. The industry is well-capitalized, with a diversified asset allocation, and has adjusted to the low interest rate environment by shifting away from endowment products. However, profitability has been weakening, reflecting rising costs, and competition. Asset allocation to equity is relatively high for non-life at around 30 percent, and investments in riskier assets have increased.

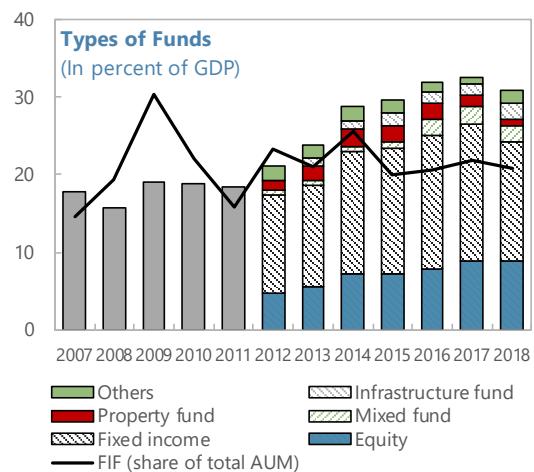
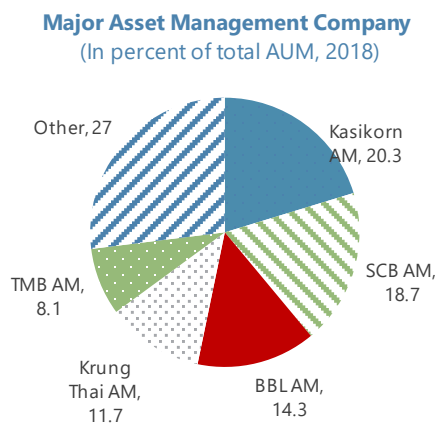
- The pension system.** The pension system is fragmented, and coverage is low. The incentive structure of the private pension system is not aligned with the long-term objective of contributors of ensuring an adequate lifetime pension. Instead, the system includes incentives for overly conservative, low-growth investments, and for pay lump-sum payments upon retirement (or occasionally installment payments for a limited number of years) rather than lifetime pensions. This structure of the pension system increases the risk of retirement poverty for Thailand’s fast-aging population.
- Mutual funds.** The Securities and Exchange Commission (SEC) oversees capital markets and investment intermediaries. The top five AMC (all part of conglomerates) accounted for over 70 percent of assets under management (AUM) at end-2017 (Figure 8). Roughly half of the funds are fixed income, while the shares of equity and infrastructure funds have increased in the last few years. Foreign investment funds account for about one fifth of total AUM. Retail clients dominate the investor base for mutual funds, which account for 83 percent of the total, potentially exacerbating liquidity risks.

Figure 8. Thailand: Asset Management Industry

Mutual funds’ AUM are equivalent to close to 37 percent of bank deposits, with foreign investment funds (FIFs) representing about 20 percent of AUM.

The largest five AMCs, accounting for 70 percent of AUM, are all part of bank conglomerates.

Roughly half of the AUM are in fixed income, but equity and infrastructure funds have been growing.



Source: Association of Investment Management Companies.

KEY RISK FACTORS AND STRESS TESTING APPROACH

A. Stress Testing under FSAP program

8. The FSAP, established in 1999, is a comprehensive, in-depth assessment of a country's financial sector. The stability assessment under the FSAP is the main responsibility of the Fund in countries where FSAPs are done jointly with the World Bank (developing and emerging market countries). It is meant to cover, inter alia, the source, probability, and potential impact of the main risks to macrofinancial stability in the near-term.

9. In the context of FSAPs, a stress test is a financial stability tool to assess bank resilience to extreme but possible scenarios. The goal is to provide recommendations to help preserve financial stability, i.e. minimize the probability of financial disruptions and crisis. This is also consistent with the FSAP institutional focus on supervisory ability to monitor and regulate bank risks, crisis management and resolution frameworks.

10. Stress tests in FSAPs aim at assessing the resilience of the banking sector at large, rather than the capital adequacy or financial soundness of individual institutions. They embrace a macrofinancial perspective, as opposed to the microprudential angle adopted by supervisors.

B. Key Risk Factors

11. The Thai financial sector is exposed to several macrofinancial risks stemming from external and domestic factors (Risk Assessment Matrix (RAM), Table 4).

- **External risks.** The negative impact on growth from rising protectionism, exacerbated by adverse changes in market sentiment and investment, could lead to weak (even negative) growth in key advanced economies and in China, ultimately depressing Thailand's exports. This would cause lower GDP growth and higher unemployment, which, coupled with an increase in corporate vulnerabilities and a deterioration in households' repayment capacity, could lead to a weakening of banks' asset quality. Sharp rise in risk premia could lead to a reversal of capital flows and a depreciation of the baht that could raise financial sector funding costs and weaken balance sheet of corporates with unhedged foreign currency exposures and currency mismatches.
- **Domestic risks.** An increase in real interest rates and the real debt burden could pose balance sheet risks in the private sector. In addition, the outcome of the general elections may lead to a political gridlock which may disrupt public investment projects and lead to higher risk premia for sovereign and corporate yields. In the unlikely event that such uncertainty was to become a crisis of confidence, it could lead to a collapse in equity prices, sharp exchange rate depreciation, and translate into funding pressures if banks experience a sudden withdrawal of retail and wholesale deposits.

12. An adverse scenario has been designed, which is in line with the RAM. The adverse scenario would be triggered by: (i) a weaker-than-expected growth in the U.S. (due to waning confidence and weaker investment); (ii) a prolonged period of anemic growth and low inflation in the euro area (due to weak foreign demand, Brexit, concerns about some high-debt countries, and faltering confidence); and (iii) lower growth in China due to weaker external demand, the potential reversal of globalization, and the increasing role of the state. This is modeled through a shock to demand in the United States, Euro Area, and China. The global demand shock would lead to a sell-off in emerging markets, which would affect Thailand through weaker exports and imports and through investor uncertainty. This would lead to a rise in corporate and household risk premia, which in turn would lead to a strong decline in investment, consumption, and asset prices. This, in turn, would trigger portfolio outflows and a depreciation of the exchange rate. However, the exchange rate depreciation is limited (to 12 percent in the first year of the shock) due to Thailand's substantial reserve buffers and the expectation that authorities will step in to support the exchange rate. It is also assumed that, in response to the decline in GDP and inflation, the central bank would lower the policy rate to the zero lower bound. Moreover, since households and corporates are debt constrained, it is assumed that they would sell-off their assets to meet interest payments and other debt obligations leading to further declines in stock prices.

C. Stress Testing Approach for the Thailand FSAP

13. The resilience of the Thailand banking system was assessed under a battery of stress tests:⁴

- **Solvency stress test and sensitivity tests.** The solvency stress test estimated the evolution of banks' profitability and capitalization under a baseline scenario and one adverse scenario. The sensitivity tests focused on banks' exposure to risks from shifts in other risk factors, such as interest rates and corporates spreads, and concentration risk.
- **Liquidity stress tests.** The tests were based on two frameworks: (i) the Basel III LCR under a severe scenario, combining shocks from the outflow of the retail, wholesale and mutual funds deposits due to a confidence crisis and resulting in a sharp exchange depreciation, and (ii) an implied cash-flow-based analysis by maturity bucket.
- **Test on investment funds' redemption risk.** The test assessed the investment funds' capacity to withstand a severe redemption shock, their impact on the banking sector, and the bond market.
- **Intereconnectedness and contagion.** Systemic and contagion risks stemming from interlinkages were explored using market based and balance sheet approaches. The team used four approaches: (i) Espinoza and Sole (2009) to simulate credit and funding shocks across the domestic interbank network as well as the potential cross border spillovers; (ii) Diebold and Yilmaz (2012), based on market data, to measure the network interconnectedness between listed

⁴ Further details on methodologies and coverage are presented in the Stress Testing Matrix (STeM) in Appendix I.

banks and nonbanks (with a possible extension to major Thai corporates); (iii) Financial Stability Measures to quantify the impact of systemic risk amplification mechanisms due to interconnectedness across banks, insurance companies, IFs, and other financial intermediaries; and (iv) a balance sheet analysis based on flow of funds data.

SOLVENCY STRESS TEST

14. A solvency stress test was conducted combining a scenario-based assessment with sensitivity analyses on single risks. The scenario-based assessment was based on full-fledged macroeconomic scenarios comprising a baseline and one severe but plausible adverse scenario. Sensitivity analyses were performed for aspects not covered under the scenarios and/or for further investigation into specific sources of risk.

A. Macroeconomic Scenarios

15. The scenarios span a three-year period from June 2018 to June 2021. The baseline scenario was based on the October 2018 World Economic Outlook (WEO) projections. The projections for the adverse scenario were based on the IMF's Flexible System of Global Models (FSGM) for the external environment, on previous crisis observations (such as the Global Financial Crisis (GFC)) and on expert judgement (Table 5).⁵

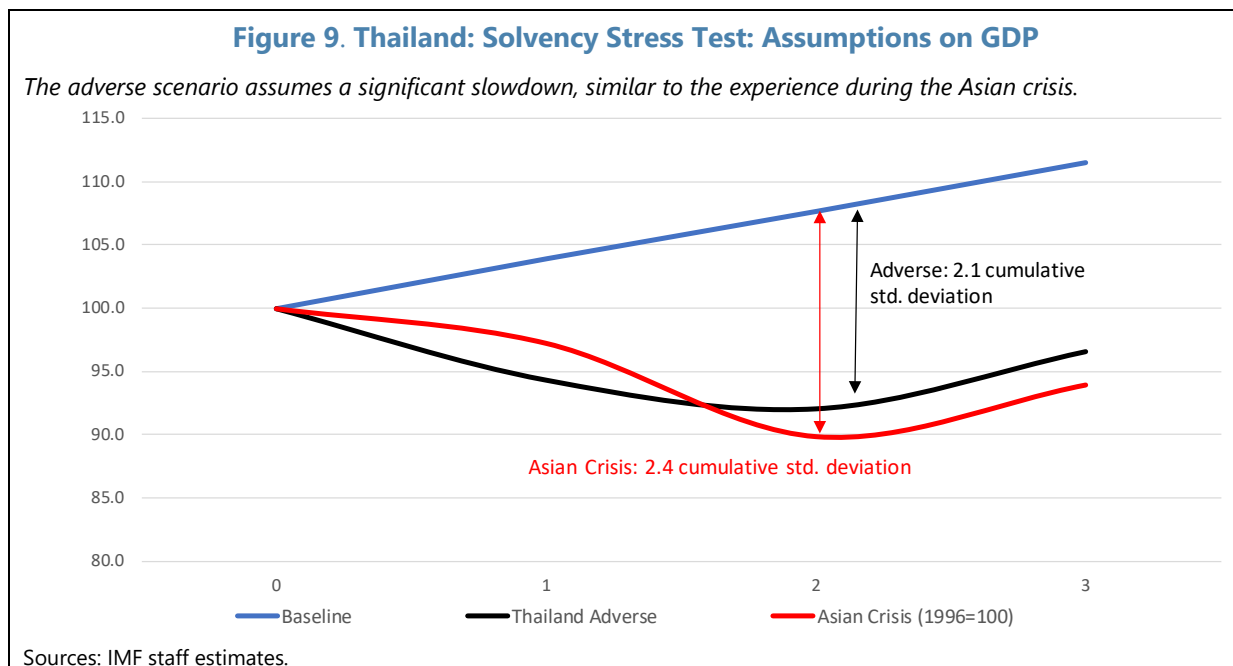
16. The adverse scenario features a U-shaped GDP profile, resulting in a prolonged decline in GDP, with a path similar to the experienced by Thailand during the Asian Financial Crisis (Figures 9 and 10). A fundamental assumption under the adverse scenario is a deviation of GDP from baseline of -15.6 ppt over the first two years (2019 and 2020). This represents approximately 2.1 standard deviations of GDP growth (as calculated over the 1980–2017 period) and it is broadly in line with recent FSAPs in similar countries and with Thailand's experience during the Asian crisis.⁶ The GDP assumption is also consistent with a calibration based on the Growth-At-Risk methodology at low percentiles.⁷ Based on current financial conditions, the assumed decline in the growth rate of 5.6 percent in the first year has a likelihood of about 7 percent, which lies between the 5 percent GaR threshold of -6.75 percent and the 10 percent GaR threshold of -3.3 percent. The estimate for

⁵ The FSGM follows a modular approach in order to model the various member countries of the IMF. It contains several modules (which can be run separately) and among the modules is an Asia-Pacific module, which comprises 18 Asia-Pacific countries as well as the U.S. and 6 regions. FSGM modules are semi-structural, with some key elements, like private consumption and investment, having microfoundations, with others, such as trade, labor supply, and inflation having reduced-form representations. See also IMF working paper by Andrieu et al. (2015).

⁶ For example, this is the description of the adverse scenario used for the FSAP in Indonesia in 2017: “[in] the most severe scenario [...] real GDP deviates by 17 percentage points from the baseline by 2018 [2nd year] (equal to 2.4 standard deviations),” (p.16).

⁷ Growth at Risk (GaR) is a concept to quantify macrofinancial risks to future GDP growth. It entails the estimation of the entire probability distribution of GDP growth at different horizons, conditional on the current state of financial and macroeconomic conditions. See “Is Growth at Risk?” in IMF, Global Financial Stability Report, October 2017.

the 10 percent GaR for the second year is equal to -2.5 percent, close to the assumed decline in GDP growth of 2.4 percent in the second year.



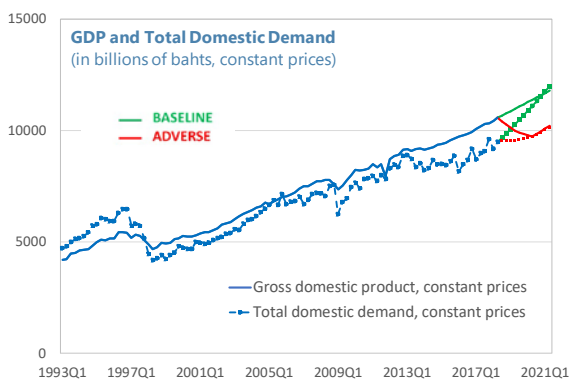
17. The exercise involved eight commercial banks, representing 75 percent of banking sector assets. The sample includes the 5 D-SIBs, all of them using the standardized approach for credit risk and 3 banks authorized to use their IRB models for the calculation of their regulatory capital requirements for credit risk.

B. Methodological Approach to Balance Sheet and Income Projections

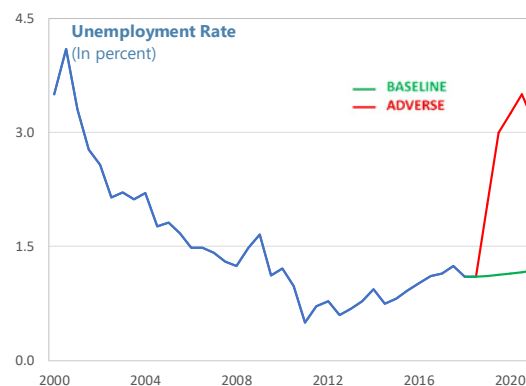
18. The exercise was based on a quasi-static allocation balance sheet assumption. This means that: (i) interest earning assets and exposures at default grow at a rate consistent with the macro scenario (based on the estimated relationship between total bank credit and domestic demand and unemployment, with a judgmental floor to prevent excessive deleveraging), adjusted by losses suffered in the previous period and by exchange rate changes (for assets denominated in foreign currency); (ii) non-interest earning assets grow at a rate aligned with historical experience; (iii) the evolution of the bank's equity over the risk horizon depends on the results of the stress tests—in particular on the profits realized, net of the losses incurred; and (iv) interest earning liabilities grow at the rate necessary to equate assets to total liabilities. The asset allocation and the composition of funding sources remain the same throughout the risk horizon.

Figure 10. Thailand: Main Macroeconomic Variables under the Adverse Scenario

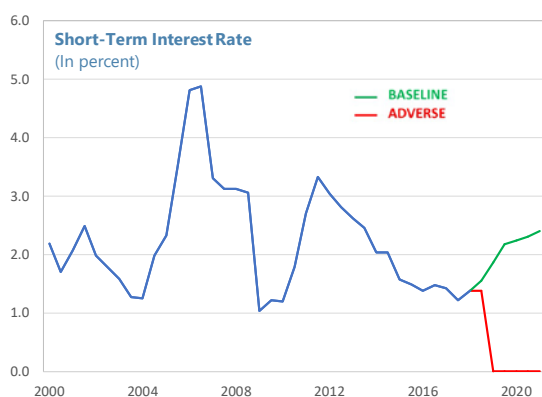
The external environment would cause GDP and domestic demand to deviate substantially from their baseline path...



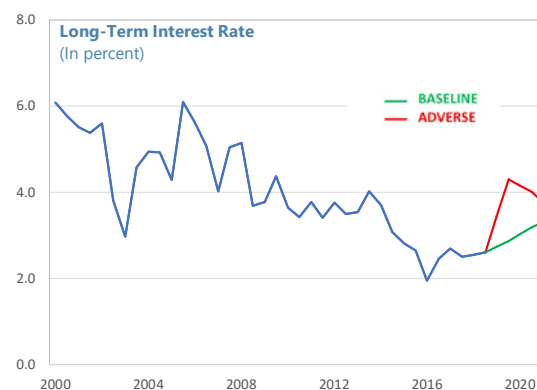
...and unemployment to raise to levels not seen since the Asian financial crisis.



In response to the decline in GDP and inflation, the central bank would lower the policy rate to zero, determining a similar drop in short-term interest rates...



...while long-term rates on sovereign and corporate bonds would rise as a result of investors' increased risk aversion.



Sources: WEO, IMF staff estimates.

19. Interest income was derived from the evolution of interest-bearing assets and liabilities and of interest rates applied by banks (Figure 11). To capture the impact of the general level of interest rates on banks' interest margin, the effective interest rate on deposits was projected based on a panel data model with an autoregressive component and the short-term rate as an exogenous explanatory variable. The effective interest rates on loans were estimated bank by bank, using a system of seemingly unrelated regressions (SUR). The impact of idiosyncratic increases in funding costs was estimated via a nonlinear feedback effect mechanism based on the interaction between solvency (total capital ratio) and liquidity (spread paid by the banks on their wholesale borrowings, i.e., interbank funding and issued debt).

Figure 11. Thailand: Solvency Stress Test: Methodological Approach

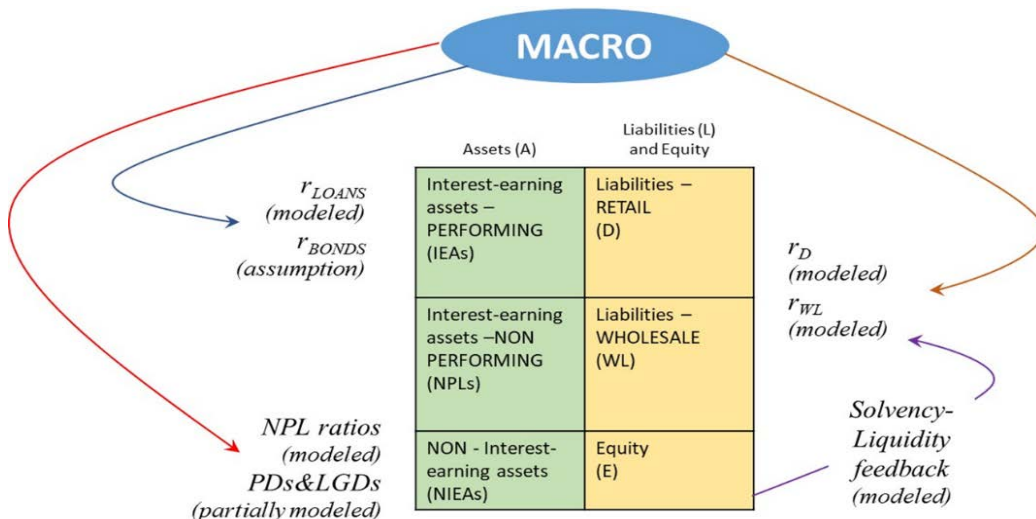
The approach is based on a combination of modeling/assumptions on quantities...

Assets (A)	Liabilities (L) and Equity
Interest-earning assets – PERFORMING (IEAs)	Liabilities – RETAIL (D)
Interest-earning assets –NON PERFORMING (NPLs)	Liabilities – WHOLESALE (WL)
NON - Interest-earning assets (NIEAs)	Equity (E)

• Growth rates

- $g_{IEAs} = f(DD, unemp)$
- $g_{NPLs} \rightarrow$ determined by in/outflows of NPLs
- $g_{NIEAs} \equiv g_{IEAs}$
- $g_E \rightarrow$ determined by P&L
- $g_D, g_{WL} \rightarrow$ residual ($L=A-E$)

...and 'prices' (in a broad sense, including the cost of risk).¹



Source: IMF staff.

¹ In particular: (i) r_{LOANS} are estimated through separate bank-by-bank equations in a Seemingly Unrelated Regression with the current short-term rate and lagged interest rate on loan as explanatory variables; (ii) r_{BONDS} change according to the initial composition of each bank's bond portfolio (i.e., assuming constant roll-over of maturing bonds over the risk horizon) and the changes in domestic sovereign, domestic corporate, and foreign sovereign spreads assumed in the scenario; (iii) r_D are estimated as dynamic panel data with the short-term interest rate as exogenous variable and floored at 0 percent plus the fee paid to the Financial Institutions Development Fund (47 bp); (iv) r_{WL} is set equal to the short-term rate plus a spread based on a function that links the average spread for wholesale funding across banks to its lagged value plus the (lagged) average capital ratio and the reciprocal of the current average capital ratio (to capture the nonlinear impact of solvency on liquidity); (v) NPL ratios are estimated as explained in ¶22; (vi) PDs and LGDs are estimated as explained in ¶21.

20. The bulk of fees and commissions was assumed to evolve in line with the growth of assets, adjusted for certain categories to take into account impact from competition. For example, some e-banking fees have already been slashed down by the largest banks, while the

remuneration of other digital services has been exposed to competition from FinTech companies. Given their current sensitivity to competitive pressures from within and outside the banking sector, the income from certain digital (or ‘digitizable’) services was assumed to be impacted by the compounded effect of the crisis scenario and the materialization of increasing competitive pressures. Operating expenses and other non-interest expenses were assumed to grow in line with the growth of interest-bearing assets. Taxes were conservatively set at the marginal tax rate (30 percent) in case of positive net income and zero otherwise.⁸ Dividends were also assumed to be paid out only in case of positive income, at a flat 30 percent payout ratio, consistent with historical experience in Thailand, and subject to restrictions in case of erosion of the CCB.⁹

21. The calculation of risk-weighted assets (RWAs) took into account the Basel regulatory framework under which banks operate. For banks adopting the standardized approach for credit risk, RWAs under stress were adjusted for asset growth in the current year, including impairments accrued in the past year, and by changes in the exchange rate for those exposures denominated in foreign currency. For IRB banks, RWAs were recalculated according to the projections of probability of default (PDs), LGDs,¹⁰ and exposure at default (EADs) in the adverse scenario. For banks under the IRB approach, satellite models were used to estimate (bank by bank and portfolio by portfolio) the link between PDs and LGDs and macro variables; then, the forecasts of PDs and LGDs under the adverse scenario were used to estimate RWAs and expected losses.

22. For banks under the standardized approach (and for exposures of IRB banks treated as standardized), credit loss estimates were based on a satellite model linking NPLs to macro variables. NPL ‘inflows’ (i.e., the transition of performing loans to nonperforming status, quarter by quarter) were modeled separately, as a SUR system, for each of the 11 sectors for which public data are available.¹¹ NPL ‘outflows’ (i.e., the exit from nonperforming status for different reasons) were calibrated bank by bank based on their recent experience and under the assumption of a reduced outflow under stress. Based on the estimated coefficients, NPL inflow ratios were forecasted over the risk horizon—year by year and sector by sector—and applied to the stock of performing assets existing at the beginning of each year. The resulting new NPLs (net of the share of old NPLs leaving the non-performing status) determined the amount of additional provisions to be expensed against the profit and loss account. The net flow of NPLs (for exposures under the standardized approach) and expected losses (under the IRB approach) were assumed to be fully provisioned. This means that the full amount of new NPLs and expected losses enter the income statement and that losses cannot be distributed over time. Also, existing ‘excess’ provisions are not allowed to be used to absorb the

⁸ The effective tax ratio (share of net profit) for the banks within scope of the exercise ranged approximately between 20 and 25 percent in 2018.

⁹ In 2018 the dividend payout ratios of the eight banks ranged from 0 to 40 percent.

¹⁰ The PD and LGD estimates were point-in-time.

¹¹ The sectors are: agriculture forestry and fishing, mining and quarrying, manufacturing, wholesale and retail trade, financial and insurance activities, construction, real estate activities, public utilities and transportation, services, households, and other (residual). The main explanatory variables in the SUR system are the unemployment rate and the long-term interest rate, while GDP growth and the (nominal and real) exchange rates were not significant.

emerging losses, implicitly assuming that they cover existing losses and are hence not available to cover new ones.¹²

23. The evolution of financial variables under the adverse scenario determines the impact on market risk exposures in the trading book and—for FX risk—in the whole balance sheet.

The impact of shocks to (risk-free) interest rates and credit spreads was captured via a duration gap analysis. Shocks to the major foreign currencies (USD, CNY, JPY, and EUR) directly affect the banks' net open positions. Similarly, the assumed shock to the stock exchange index was applied to all equity holdings.

24. The outcome of the exercise is measured in terms of capital ratios, against the current and future requirements and buffers.

In particular, three distinct hurdle rates were used: Common Equity Tier 1 (CET1) ratio, Tier 1 (T1) ratio, and Total Capital ratio (CAR). Each of these is considered with and without buffers. The BoT Regulation on Supervision of Capital for Commercial Banks introduced a CCB and the possibility of introducing also a CounterCyclical Buffer (CCyB). The CCyB is currently set at 0 percent, while the CCB was subject to a phase-in and has now reached its final level of 2.5 percent of RWAs. The buffers are meant to amortize the impact of negative (idiosyncratic or systemic) developments, granting a bank (and its supervisor) time to react and prevent a breach of the minimum requirements. A reduction of the CCB below 2.5 percent triggers specific limitations to earning distribution. Finally, D-SIBs are subject to a capital surcharge of 0.5 percent of RWAs in 2019 and 1 percent from 2020 onwards (Box 1).

Box 1. Hurdle Rates
(in percent)

	Minimum Requirement	Minimum + D-SIB surcharge	Minimum + CCB	Minimum + CCB + D-SIB surcharge
CET1	4.5	5.5 (5 in 2019)	7	8 (7.5 in 2019)
Tier 1	6	7 (6.5 in 2019)	8.5	9.5 (9 in 2019)
Total Capital	8.5	9.5 (9 in 2019)	11	12 (11 in 2019)

Source: Bank of Thailand and IMF staff estimates

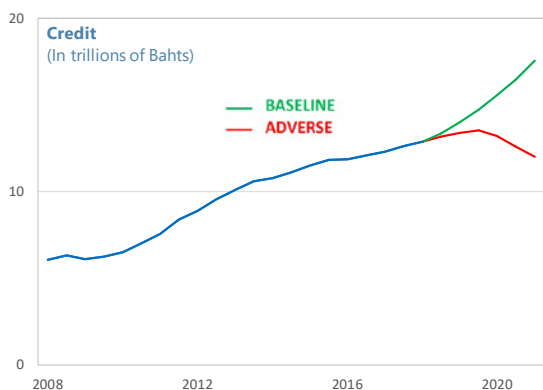
C. Results of the Solvency Stress Test

25. Under the adverse scenario, credit growth would slow down and then turn negative while NPLs accumulate rapidly (Figure 12). While under the baseline banks' loans to customers would grow and accelerate (from +8.5 to +12.8 percent between 2019 and 2021), credit growth

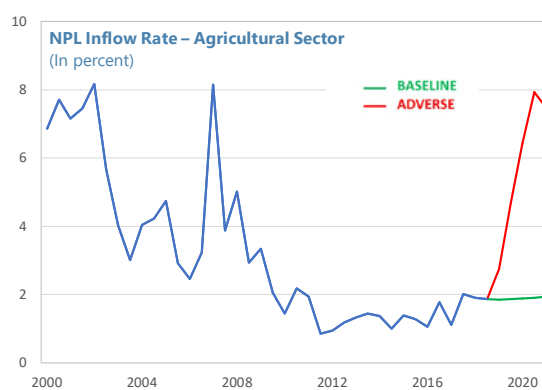
¹² This contrasts with the approach followed by the BoT (which compensates losses with excess provisions) and might be particularly conservative for banks with very high provision coverage ratios.

Figure 12. Thailand: Credit growth and Evolution of NPLs Under the Adverse Scenario

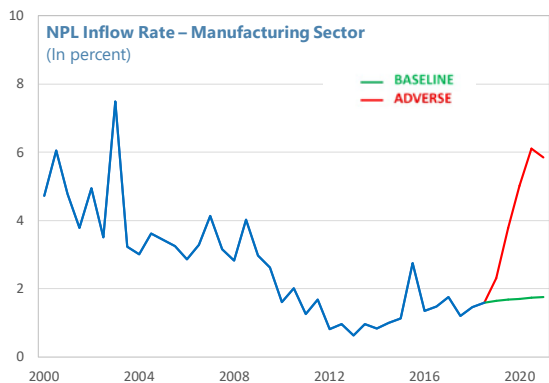
Credit would slow down in the first year and decrease in the following two years...



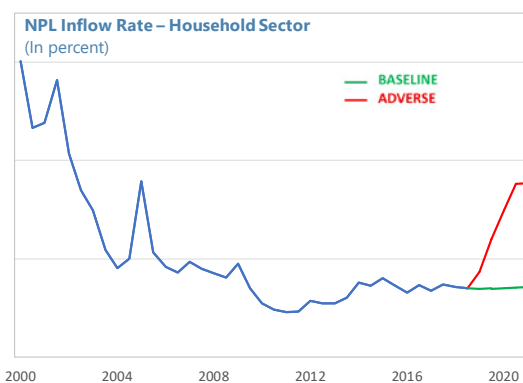
...while NPL inflow rates would increase substantially in most business segments, from the agricultural sector....



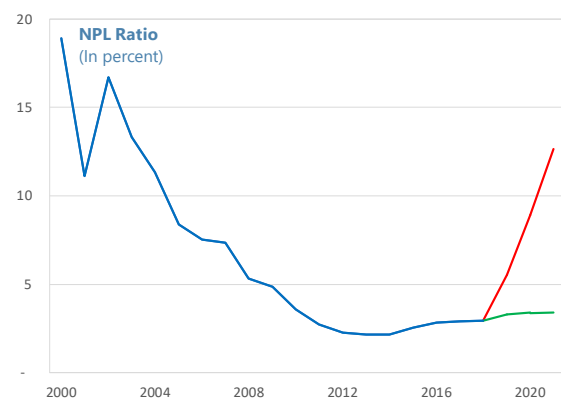
...to the industrial ones..



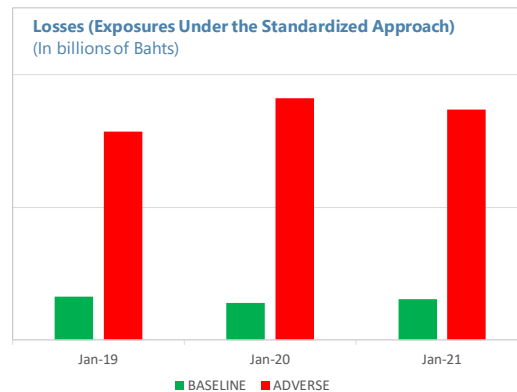
...and in the business segment of credit to households.



NPL ratios would spike...



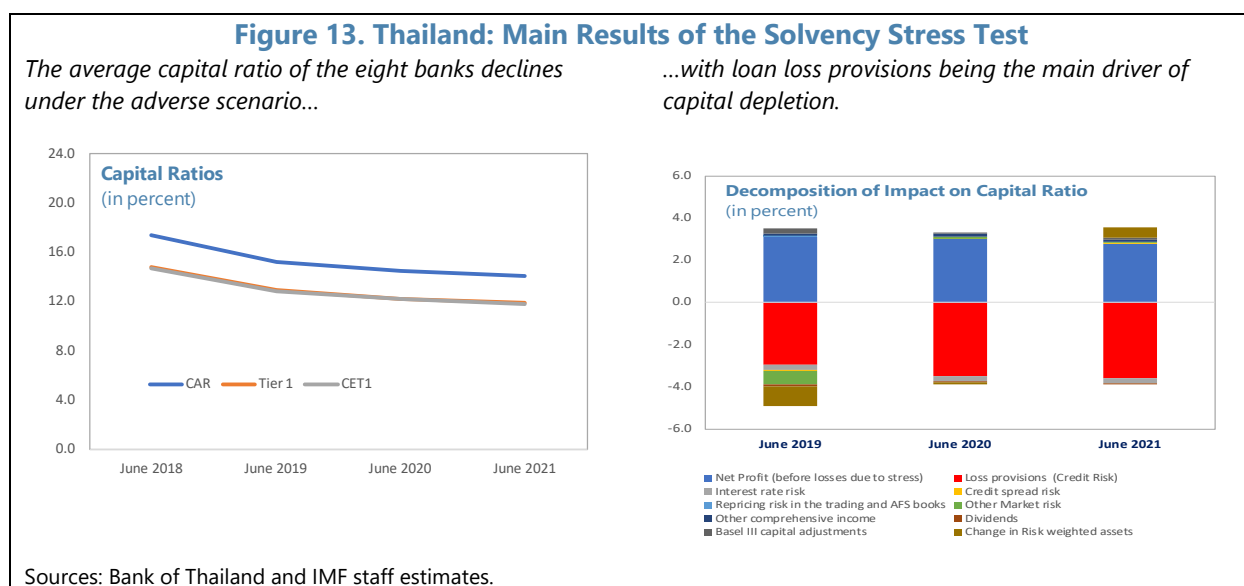
...leading to losses far larger than under the baseline scenario.



Sources: Bank of Thailand; and IMF staff estimates.

under the adverse scenario would slow down in the first year (+3.9 percent) and decrease in the following two (-1.4 and -5 percent in 2020 and 2021, respectively). There would be a widespread increase of NPLs across the financial system as a result of the very high unemployment rate, the consequent impact on domestic demand, and the increase in the weight of debt (via higher interest rates) against dwindling incomes in the corporate and household segments. The picture is similar for IRB banks, though the estimation of the relationship between PDs (and LGDs) and the relevant macroeconomic variables is more challenging due to either short time-series or poor data quality.¹³ The estimation was satisfactory only for a limited number of bank-portfolio pairs, and the results of the estimation were extrapolated, when possible, to the remaining bank-portfolio pairs as a fallback option. The increase in NPLs and PDs (and, hence, losses) would likely be larger if FX depreciation were included; however, the portion of FX loans is small and the negative effect is already captured to a large extent by the decline in GDP. Losses would be larger also if the policy rate were to increase instead of decrease. Nonetheless, it is assumed that the central bank would privilege restoring growth—by cutting the policy rate—over defending the currency, given the high level of international reserves and current account surplus in the current situation and likely fall of imports under the adverse scenario.

26. Banks show substantial resilience to the adverse scenario even though significant losses are accumulated and capital ratios decline sharply, and the recapitalization needs would be minimal (Figure 13). Most banks would incur negative net income throughout the horizon of the exercise. Three banks would experience a depletion of their CCB, but of modest quantity and the shortfall would occur in the last year (2021). The resources needed by the three banks to restore their capital buffers would be approximately THB 5 billion, equivalent to about 0.03 percent of Thailand’s GDP and easily covered by one quarter of ‘normal’ profits for the three banks (measured with respect to their average profits earned in the previous 5 years).



¹³ The erratic path of some of these series raises the doubt, inter alia, of whether IR banks estimate through-the-cycle PDs and LGDs, as required by the Basel framework.

27. Credit losses are the main factor behind the decline in capital ratios, with an additional impact from the following factors:

- **The compression of the net interest margin.** The adverse scenario assumes significant monetary accommodation as a reaction to the pronounced slump in economic activity, with the policy rate dropping to zero and remaining at that level through the horizon of the exercise (i.e., no negative rates). As the rates on deposits would approach the lower bound rapidly following the benchmark rate and stop declining while lending rates would continue to decline, the net interest margin would shrink from 3.3 to less than 2.6 percent, on average, for the eight banks.
- **A solvency-liquidity feedback.** Spreads paid by the banks on their market funding (interbank funds and bonds issued, in particular) would increase in the three-year horizon for almost all the banks, as a result of their perceived weakness—proxied by the falling capital ratios. This solvency-liquidity feedback includes a nonlinear component that amplifies the effect as capitalization declines.
- **Equity investments.** Banks with important equity investments are significantly penalized under the adverse scenario, reflecting the sizable drop in the Thai stock exchange index (SET) assumed in the first year (55 percent) and a partial recovery in the following year (20 and 10 percent in 2020 and 2021, respectively).
- **The increase in the RWAs.** For IRB banks, the deterioration in borrowers' financial conditions and in the recovery rates on defaulted loans determine an increase in PDs and LGDs that translates into larger RWAs.¹⁴

D. The BoT Stress Tests Results

28. The BoT has conducted a top-down macro (solvency) stress test in parallel with the FSAP team, based on the same scenarios and cut-off date.¹⁵ The impact of the macroeconomic environment on bank-level variables (via satellite models) has been estimated independently by the BoT and IMF staff. While at a broad level the fundamental approach is very similar, differences arise in the more granular methodological decisions and in the numerous assumptions needed—beyond the statistical evidence—to operationalize the stress test exercise. In particular, in the BoT approach, banks, on average, would not experience a compression of their net interest margin. This can be ascribed at differences in the way effective rates on loans and deposits are estimated, and is an area where the BoT could increase the severity of its assumptions. Protracted periods with the policy rate at or next to the zero lower bound can seriously jeopardize banks' net interest margin, as

¹⁴ Under the standardized approach for credit risk, RWAs could also be adjusted upwards, mainly as a result of rating migrations (for externally rated obligors) and of a potential increase in risk weights on defaulted exposures, if not adequately provisioned against. However, the share of externally rated borrowers in the banks' loan portfolio is negligible (and, hence, neglected) and all NPLs are assumed to be fully provisioned.

¹⁵ Commercial banks have been instructed to perform a (bottom-up) stress test exercise based on the same scenarios, though with a different cut-off date (December 2018) from those of the IMF and the BoT macro stress tests (June 2018).

experienced by banks in several advanced economies in the post-GFC period and also relevant for Thailand given its experience in the last decade (weak growth and persistently low inflation).

29. Notwithstanding the methodological differences, the IMF and the BoT results are very similar. As in the IMF-run stress test, no bank would experience, over the risk horizon and under the adverse scenario, breaches of their capital requirements; two banks would see their capital buffers partially eroded (marginally in one case, slightly more substantially in the other one).

E. Sensitivity Tests

Concentration Risk in the Loan Portfolio

30. Sensitivity tests incorporating capital surcharges for single-name and sectoral concentration affect only one bank that has enough capital buffers to comfortably absorb the shock. The surcharges have been estimated by calculating the Herfindahl–Hirschman Index (HHI)¹⁶ on the top 20 exposures—for single name concentration—and total exposures by sector—for sectoral concentration. The HHIs have been translated into capital surcharges by applying the multipliers developed and adopted by the U.K. Prudential Regulation Authority as part of their methodologies for setting Pillar 2 capital.¹⁷ The concentration risk adjustment materially impacts the RWAs of only one bank, which however has enough excess capital to comfortably absorb it. A reverse stress test on the top 20 exposures, assuming the default (and 100 percent loss) of the largest borrower, followed by the next largest and so on, indicates that the default of the five largest borrowers would cause two banks to breach their Tier-1 capital requirements, and one bank would breach the required threshold with the default of the top three borrowers, indicating a significant concentration risk.

31. There is room for improvement in the BoT’s analytical approach to concentration risk. While the BoT already adopts the fundamental elements of concentration risk from a supervisory angle (e.g., large exposures regime and limits on investments), it could further develop its analytical tools for the assessment of this type of risk, including its implications on systemic risk: asset concentration typically impacts the tail of the distribution of losses, manifesting itself more acutely in times of stress and potentially acting as a shock amplifier. It is then important to estimate as accurately as possible the weight that concentration has on the risk inherent in banks’ loan portfolios—as well as other forms of credit concentration, such as the bond portfolio and interbank market. This could also help, on the supervisory side, to estimate the capital surcharge for IRB banks

¹⁶ Sum of the squares of the percentage shares of each exposure (or group of exposures, for sectoral concentration) with respect to the whole loan portfolio. Theoretically bounded between 0 (infinitely granular portfolio) and 1 (portfolio comprised of a single exposure).

¹⁷ Prudential Regulation Authority, “Statement of Policy—The PRA’s methodologies for setting Pillar 2 capital,” April 2018. The results have then been compared with the add-ons calculated according to the ‘Partial Portfolio Approach’ from Grippa and Gornicka (2016) on the same data and have shown very close alignment between the two approaches.

(whose Pillar 1 requirements are based on the unrealistic hypothesis of infinitely granular portfolios) and to calibrate an add-on to be applied to all the other banks.

Interest Rate Risk in the Banking Book

32. A sensitivity test was run to gauge the exposure of the structure of banks' assets and liabilities to changes in interest rates (Interest Rate Risk in the Banking Book (IRRBB)). These tests are meant to complement the moderate policy rate assumption in the macro scenario. The Basel Committee defines IRRBB as the “current or prospective risk to the bank’s capital and earnings arising from adverse movements in interest rates that affect the bank’s banking book positions.” While IRRBB does not attract a Pillar 1 requirement in the Basel framework, it needs to be adequately addressed, measured, and managed by banks, as specified in a Basel standard.¹⁸ IRRBB can be analyzed from two different perspectives: (i) Economic Value of Equity (EVE), i.e., the change in the net present value of a bank’s assets and liabilities under a stressed interest rate scenario, representing a ‘stock’ perspective; and (ii) NII, i.e., the difference between total interest income and total interest expense within a one-year horizon, given a certain scenario, representing a ‘flow’ perspective.

33. The EVE and NII measures depend on the assumptions about the evolution of the term structure of interest rates. The sensitivity test is based on the derivation of six interest rate shock scenarios for the Thai economy according to the methodology proposed in the Basel standard.¹⁹ The scenarios are the following: (i) parallel shock up; (ii) parallel shock down; (iii) steeper shock (short rates down and long rates up); (iv) flattener shock (short rates up and long rates down); (v) short rates shock up; and (vi) short rates shock down. The calibration of the shocks is based on daily zero-coupon sovereign rates and money market rates over a 16 year-time span, as suggested in the Basel methodology.²⁰ The shocks have been applied to the aggregate assets and liabilities of the banks as of end-June 2018, broken down by maturity band. The impact is approximated via modified duration and convexity for the median tenor in each time band.

34. The results point to a relatively contained exposure of the banks to IRRBB (Figure 14). The parallel shocks give rise to larger impacts on EVE than the non-parallel shocks and all banks are exposed to upward shocks to interest rates, as expected.²¹ All banks would experience an implicit

¹⁸ Basel Committee on Banking Supervision (BCBS), “Interest rate risk in the banking book,” April 2016.

¹⁹ Ibid., Annex 2.

²⁰ This leads to ‘revised interest rate shocks’ of 199, 282, and 133 basis points for the ‘Parallel’, ‘Short,’ and ‘Long,’ respectively; values that are closer to those of many advanced economies than to those of most emergency market ones (ibid., Annex 2, Table 4).

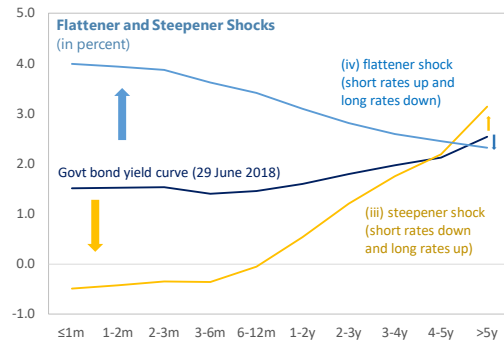
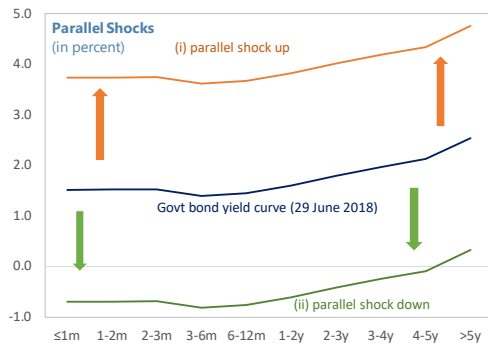
²¹ Non-parallel shocks are more apt to single out more sophisticated investment strategies (i.e., betting on specific shapes of the yield curve), while Thai banks—especially the domestically owned ones—appear to adopt a more standard role, centered on traditional maturity transformation.

Figure 14. Thailand: Interest Rate Risk in the Banking Book—Impact on EVE and NII

Sensitivity analyses indicate the impact of interest rate shocks is relatively contained.

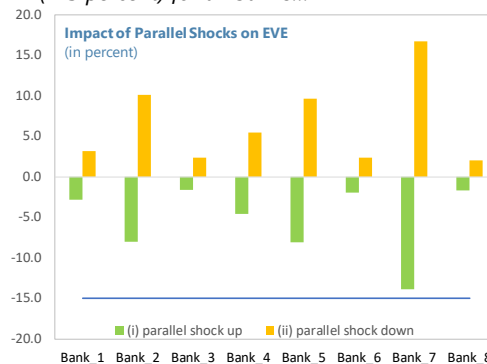
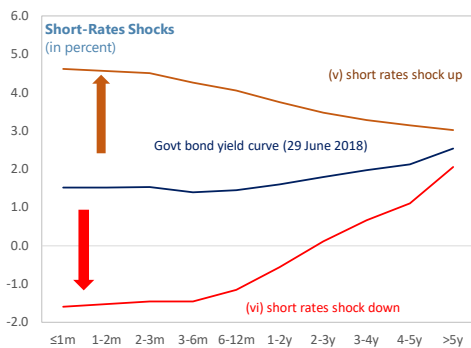
Six standard scenarios envisaged in the Basel standard are used, including parallel shocks...

...to different types of yield curve inversion...



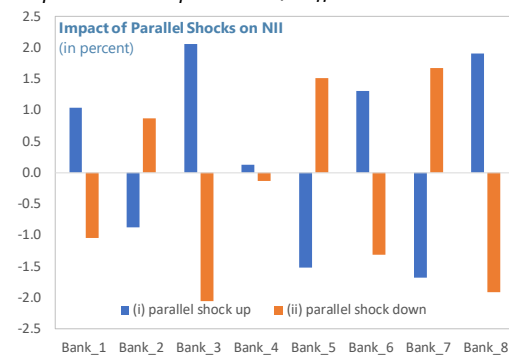
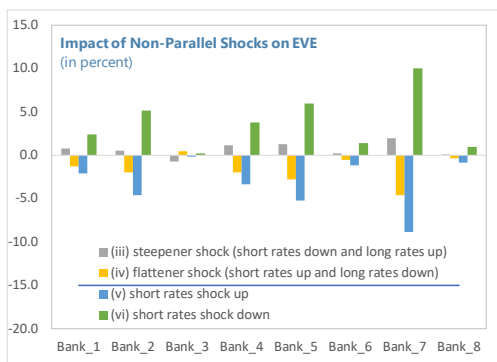
...and shocks concentrated in the short end of the curve.

While the EVE impact, in terms of T1 Capital, of parallel shocks is within the suggested threshold (-15 percent) for all banks...



... non-parallel shocks generate an even smaller impact.

For NII, parallel shocks cause impacts of different sign across banks, but all within the size of existing capital surplus above requirements/buffers.



Sources: Bank of Thailand and IMF staff estimates.

drop in EVE, as a percent of Tier 1 capital, lower than the -15 percent level identified by Basel as the threshold for the identification of “outlier banks.”²²

35. An alternative analysis, based on a historical simulation Value-at-Risk (VaR) run on the same data, broadly confirms the previous results, but also highlights the importance of using alternative tools in the assessment of IRRBB. The historical simulation was conducted by revaluing the current portfolio of assets and liabilities according to the year-on-year changes in the yield curve for each day over the same period used for the Basel calibration (2002–2018). The comparison of the 99th percentile obtained from the simulation with the results of the previous exercise indicates a broad alignment between the methodologies, but also, in some cases, slightly more extreme results: for example, at the 99 percent confidence level the largest negative impact of a parallel shock would be -13.8 percent, instead of the -12.6 percent in the Basel methodology. In general, the results of the Basel methodology correspond to percentiles of the historical simulation lower than the 99th and as low as the 96th, underlining the opportunity to use a wide range of tools in monitoring banks’ interest rate risk.²³

36. The analysis in terms of NII points to a limited impact across banks. While the direction of the impact is not the same across banks, implying differentiated asset and liability structures at the shorter tenors, the negative impacts are overall quite small, and would not, per se, dent the banks’ profitability in such a way as to compromise their capitalization.

Trading Book

37. The fixed income instruments categorized as Held For Trading (HFT) and Available For Sale (AFS) determine an immediate impact on capital—unlike those held to maturity. HFT instruments impact capital via profit and loss, while AFS hit capital via other comprehensive income. The sensitivity test focused specifically on two asset classes: own sovereign and corporate bonds. In both cases, a historical simulation was run to estimate the VaR of the portfolio at the 99th confidence level. However, the assumed liquidity horizon differs:²⁴

- **Government bonds.** The data source for the term structure of interest rates is the same as per the IRRBB test, i.e., 16 years of daily zero-coupon sovereign rates and money market rates; the liquidity horizon is 20 business days, i.e., double the minimum liquidity horizon available in Basel’s market risk framework.

²² “Banks identified by supervisors under their criteria as outliers must be considered as potentially having undue IRRBB and subject to review.” *ibid.*

²³ From a systemic risk analysis perspective, these tools are useful in exploring the presence of pockets of vulnerabilities in the system; from a supervisory perspective, they represent a first step in understanding the actual exposure of supervised entities and must be followed by an active engagement with the entities to further investigating the structure of the balance sheet, the presence of financial or behavioral optionality, the use of hedging instruments, etc.

²⁴ Liquidity horizon is defined as “The time required to exit or hedge a risk position without materially affecting market prices in stressed market conditions.”

- **Corporate bonds.** The test is based on 10 years of monthly yields on THB-denominated BBB-rated corporate bonds; the liquidity horizon is 60 business days, in consideration of the significantly lower liquidity of corporate vs. sovereign instruments, especially under stress.

38. The results indicate a small impact both for government bonds and corporate bonds, with a single exception. For government bonds, the 99th percentile VaR represents around 1 percent of Tier 1 capital or less for all banks except for one bank, for which it represents more than 5 percent of Tier 1 capital and a potential reduction of its Tier 1 capital ratio by up to two percentage points, suggesting a non-negligible exposure to sovereign risk.²⁵ For corporate bonds, the 99th percentile VaR represents less than 0.4 percent of Tier 1 capital for all banks.

Other Risks

39. The exposure of Thai banks to foreign exchange risk is moderate. Commercial banks in Thailand are subject to a net open position rule that limits their exposure to foreign currencies in either direction (long or short) to no more than 15 percent of total capital (or US\$5 million, if greater) per single currency and 20 percent (or US\$10 million, if greater) for the aggregate exposure to all currencies. A historical simulation of FX losses based on 10 years of daily changes shows that over a 2-week horizon the current (as of cut-off date) banks' exposure in foreign currency would generate losses that represent less than 0.3 percent of Tier 1 capital, at a 99 percent confidence level.

40. Risks from the residential property market are difficult to assess due to the lack of data.²⁶ House prices have risen almost continuously over the past 10 years, with limited price corrections.²⁷ While not necessarily the sign of an asset bubble, this long and almost uninterrupted growth raises concerns about the possibility of a more pronounced price correction. The share of new mortgage loans with a Loan-To-Value (LTV) ratio above 90 percent has increased from 33 to 46 percent since end-2012. However, no data is available with the needed granularity and updated LTVs to allow an assessment of the impact that a decline in house values could have on the adequacy of banks' collateral. Staff estimate based on flows of mortgage loans by income bracket point to a likely steady increase in the debt-service-to-income (DSTI) ratios in the past 5 years across all income brackets, with the lowest bracket probably recording, on average, a DSTI in excess of the conventional wisdom threshold of one-third (and without considering other possible debt incurred by the same households).

²⁵ This is mitigated, however, by abundant capital in excess of the minimum + buffer. The situation deserves to be further investigated to more accurately estimate the government bond portfolio VaR and verify the possible presence of hedging instruments.

²⁶ In the BoT ST framework these risks are indirectly captured in the PD satellite models of the banks with significant proportion of housing loans on their portfolios by including the change in house prices among the regressors.

²⁷ In the recent past, the largest correction was in the single-detached house prices in mid-2016 to mid-2017 (-3.1 percent). During the Asian crisis the property market experienced larger declines: -8.5 percent YoY, on average, with a spike of -26.9 percent drop in 5 quarters between 1998Q1 and 1999Q2 (caused by a large asset liquidation by the Financial Sector Restructuring Authority and followed by an almost full recovery afterwards).

LIQUIDITY STRESS TESTS FOR THE BANKING SECTOR

41. Liquidity risk in the banking system was assessed using various stress tests. The first test measures bank's capacity to meet its liquidity needs in a 30-day stress scenario by using a stock of unencumbered high-quality liquid assets (HQLA). The second test is a cash-flow-based analysis by maturity buckets. It involves a more granular analysis of bank's liquidity buffers cash flows generated by different assets and liabilities with varying maturities (ranging from seven days to more than one year). For AMCs, their resilience to meet redemption shocks was assessed, as well as its impact on banks (given the asset management company bank nexus) and on government bonds (since a majority of these funds hold sovereign securities).

A. Banks' Current Liquidity Conditions and Liquidity Profiles

42. Liquidity risks appear limited as banks rely mostly on retail deposits. For the eight banks, 50 percent of banks funding comes from retail depositors (Figure 15). Most deposits are placed in demand and savings accounts (66 percent of total deposits for the eight banks), with term deposits accounting for 34 percent. Stable deposits (deposits that are fully insured) are about a quarter of total retail deposits. Retail depositors in Thailand are perceived to be more stable: in fact, deposits rose by 9 percent in 1998, during the Asian Financial Crisis.

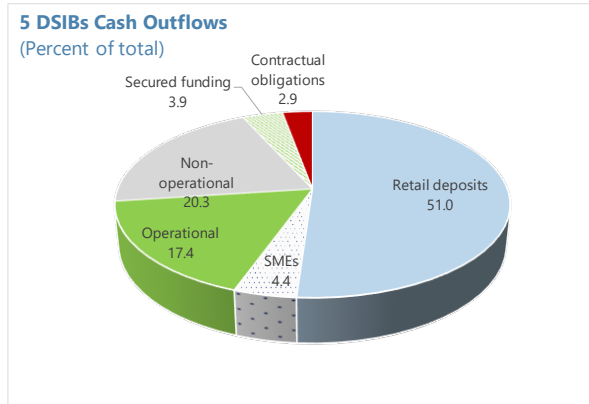
43. HQLA comprise mainly government securities. The eight banks appear highly liquid, with 93 percent of HQLA in level 1 unencumbered assets (consisting mostly of government securities). The HQLA assets of the 5 D-SIBs includes both level 1 and 2 assets, while the 3 IRBs hold mainly level 1 assets. Within Level 1 assets, 5 D-SIBs hold a larger amount of cash, and central bank reserves than the 3 IRB banks. In addition, the holdings of government and central bank securities are largely domestic and those issued in foreign currency represent less than one percent of total HQLA.

44. IRB banks rely mainly on wholesale funding and nonfinancial corporations (NFCs) are the largest source of these funds. Wholesale funding accounts for 57 percent of total funding for the 3 IRBs (which are largely subsidiaries of foreign banks), higher than the share of 47 percent for the 5 D-SIBs. The competitive retail market dominated by the 5 D-SIBs could be the reason contributing to the IRB's reliance on wholesale funding.

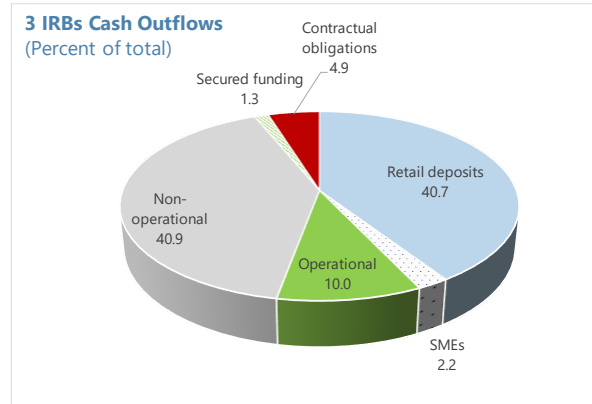
45. Reliance on foreign funding is limited. Foreign exchange exposures represent less than 8 percent of total liabilities of the banking system (mainly in the form of loans and repos), and the net open FX position is less than 2 percent of capital. In the event of a market-wide USD liquidity stress, the BoT can step in to ease the stress by supplying USD liquidity to the market via its FX swap window, which is part of the BoT's regular open market operations.

Figure 15. Thailand: Funding Structure

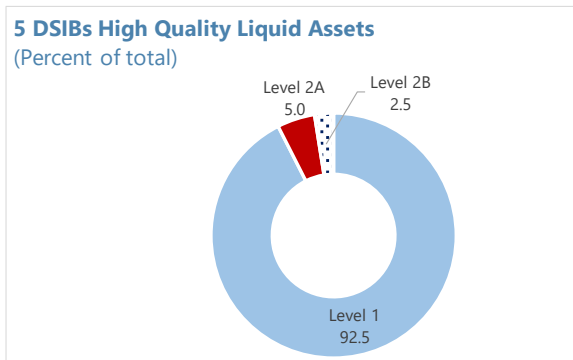
The 5 D-SIBs are primarily funded by retail deposits...



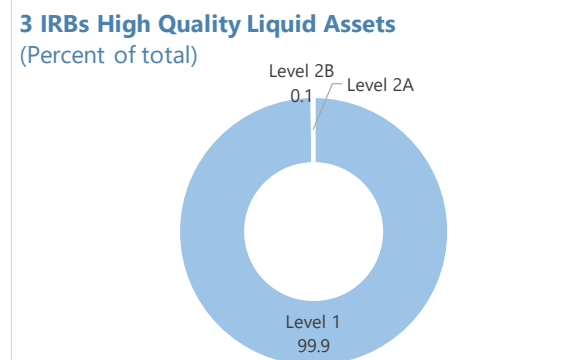
...while the 3 IRBs rely on unsecured wholesale funding...



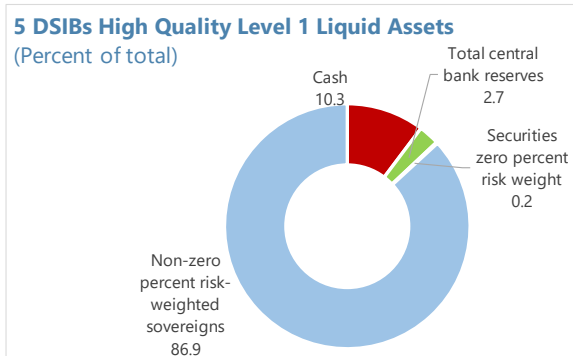
HQLA consists mainly of level 1 assets and level 2 for the 5-DSIBs...



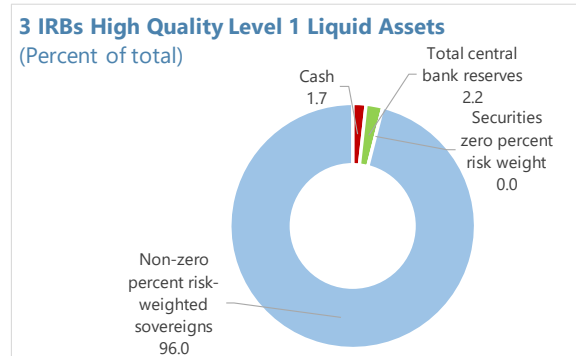
...while level 2 assets are negligible for the 3 IRB banks.



The 5-DSIBs hold mainly government securities...



...as is the case in the 3 IRB banks.



Source: Bank of Thailand; and IMF staff estimates.

46. Thailand’s liquidity metrics are mixed when compared to peer countries or other regions. Thailand’s LCR ratio of 170 percent is well above the regulatory threshold of 80 percent and significantly higher when compared with other regions such as Europe (130 percent), the Americas (126 percent) and rest of the world (128 percent). For the eight banks covered in this exercise, the aggregate LCR was 188 percent as of end-June 2018. While liquid assets to total assets of all Thai banks have remained relatively stable at around 19.5 percent in September 2018, this ratio

is moderately below the median of peer countries. Thai banks tend to rely more on short-term liabilities, with liquid assets to short-term liabilities accounting for 32 percent. This may be due to the different definition between financial soundness indicator metrics and the LCR methodology where the latter only looks at a one-month horizon.

47. Top-down liquidity stress tests were conducted on a consolidated basis, jointly by the FSAP team and the BoT. The LCR-based test and cash-flow based analysis were carried out using June-2018 data, covering the eight largest banks (five domestically owned and systemically important banks and three IRB banks). For the LCR-based test, the BoT adopted a gradual implementation of the LCR on January 1, 2016, with the initial minimum requirement starting at 60 percent (currently 80 percent LCR for banks) and subsequently increasing by 10 percentage points to reach 100 percent by January 1, 2020. For the FSAP, the hurdle rate was set at 100 percent.

B. LCR Based Tests

48. The LCR test considered a severe scenario against a baseline LCR scenario. The severe scenario reflects deposit outflows due to a confidence crisis and results in a sharp exchange depreciation, which incorporates the sensitivity analysis on retail deposits, wholesale, and mutual funds:

- **A baseline LCR scenario.** The analysis applied the same parameters as required by the authorities under the LCR implementation. This was done at the aggregate currency level including local and foreign currencies (Table 6 and 7).
- **A severe scenario.** The authorities and the IMF team calibrated a one-month severe scenario, premised in the unlikely event that extreme external volatility and political uncertainty could become a crisis of confidence, leading to a collapse in equity prices and a sharp exchange rate depreciation that would translate into panic and funding pressures, with banks faced with sudden withdrawal of deposits. Under these circumstances, there would likely be an increase in yields for government and corporate bonds. The changes in the yields underpinned the assumptions for haircut rates.
- **A retail shock.** The shock assumed a run on deposits by assuming higher run-off rates for insured and uninsured demand deposits to 10 and 20 percent, respectively; for savings accounts, the insured and uninsured rates were raised to 15 and 30 percent, respectively. All other rates remained the same as in the baseline.
- **The wholesale shock.** Based on the assumptions of the one-month severe scenario envisaging higher corporate yields and a collapse in equity prices, higher run-off rates were applied to the operational non-operational deposits of NFCs, government, banks and other financial institutions. Specifically, the run-of rates for insured and uninsured non-operational deposits were increased to 30 and 50 percent, respectively.

- **The investment funds shock.** The shocks assumed increased funding pressure on other financial institutions due to a large withdrawal by investment funds (IFs) such as savings and time deposits, resulting from large unexpected redemption shocks. The key assumptions included higher run-off rates of up to 15 and 50 percent for insured and uninsured operational deposits of other financial institutions, respectively, reflecting some feedback loop effect. In addition, a parent bank is assumed to provide liquidity assistance up to 10 percent (5 percent in the baseline) if an affiliated subsidiary is unable to meet redemption demands due to the maturity structure of the fund.

Calibration of Run-off Rates and Data Issues

49. Countries that have not faced a major banking crisis tend to rely more on expert judgement and international benchmarks as inputs in the calibration of run-off and roll-off rates for the LCR analysis. Ideally, the run-off rates should be based on withdrawals of funding experienced during historical stress episodes. However, except for the Asian Financial Crisis, Thai banks have not faced a major liquidity crisis. Given such limitation, BoT employed the 11 years of historical data and calculated the negative outflow rates for different percentiles before choosing the combination of the 90th to 92nd percentile of the outflow rate. This yielded, on average, the 27 percent outflow rate experienced by finance companies during the 1997 Asian Financial Crisis, supplemented by expert judgement. The loan maturing inflow rates were pinned by stressed NPLs from the solvency stress test with an additional layer of expert judgement.

50. The lack of granular data, and the absence of long time series and higher frequency data, is another constraint on the calibration of run-off rates. Indeed, the robustness of the LCR tests depends on the quality of the data, historical availability and granularity. Higher frequency data helps in identifying significant outflows or anomalies in a stressed environment. The BoT provided bank-by-bank deposit data segmented by guaranteed and non-guaranteed accounts on a quarterly basis starting from 2009 and monthly from 2017.

51. Current data reporting requirements are inadequate to assess the impact of unexpected exchange rate shocks. A comprehensive liquidity stress test would require undertaking an LCR analysis on a currency specific basis. Often, in a stressed scenario, domestic currency is subject to significant depreciation, which would undermine the capacity of liquidity surpluses in domestic currency to offset shortfalls in FX. In most instances, FX positions face a liquidity crunch. However, the LCR analysis in Thailand cannot be separated by domestic currency and FX, as banks are not required to report their LCR by currency unless they have a significant outstanding position (banks only provide the sum of inflows and outflows by significant currency), corresponding to a generally-low net FX position due to the legal restriction on the net FX position that Thai banks can hold. Out of the eight banks included in the stress test, only one bank reports LCR in significant currency in detail.

LCR Stress Test Results

52. Results from the LCR stress test show that banks have sufficient liquidity buffers to withstand the severe scenario, which has a much larger impact on the aggregate LCR ratio than the sensitivity analysis (Figure 16).

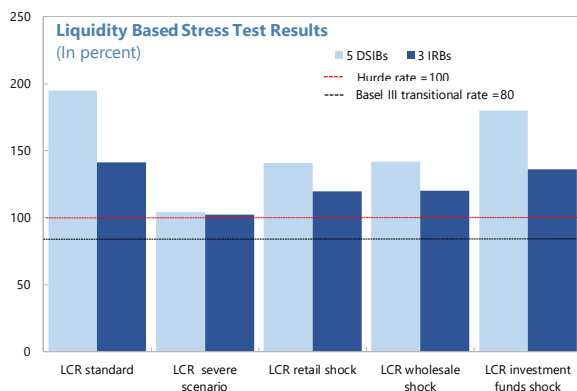
- **Under the current regulatory regime, all banks have sufficient liquidity buffers to withstand a one-month risk horizon.** In the baseline scenario, the 30-day weighted average LCR ratio stood at 188 percent in June 2018. The 5-DSIBs banks have a higher LCR ratio than the IRB banks partly due to their size and higher holdings of liquid assets to total assets (18 percent compared to IRB's 2 percent).
- **In the severe scenario, the aggregate LCR ratio declines to 104 percent but remains above the hurdle rate of 100 percent.** Three banks fall below the 100 percent hurdle rate, of which one falls below the Basel III transitional threshold of 80 percent. The aggregate liquidity shortfall of the three banks amounts to 0.7 percent of total assets (1.5 percent of GDP).
- **The shock on retail deposits indicates that banks can meet the prevailing 80 percent regulatory rate.** The aggregate LCR for the eight banks would fall to 138 percent. Two (one D-SIB and one IRB bank) out of the eight banks fall below the hurdle rate of 100 percent, representing a liquidity shortfall of THB 25 billion or 0.2 percent of total assets of the eight banks, but are able to meet the current regulatory threshold of 80 percent.
- **The wholesale scenario shows a similar impact with the aggregate LCR ratio falling to 140 percent.** The aggregate LCR falls to 139 percent, leaving one D-SIB and one IRB bank below the 100 percent. The total liquidity shortfall would reach THB 54 billion or 0.4 percent of total banks' assets.
- **All banks remain above the 100 percent mark following the shock on investment funds.** It is still however useful to analyze the linkages between banks and IFs given the bank-AMC nexus.

C. Cash-Flow Analysis

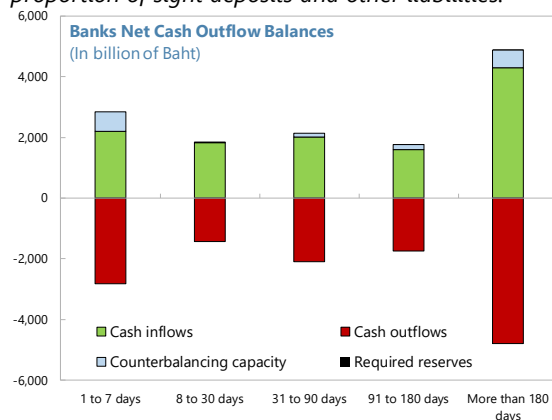
53. The cash-flow analysis captures the comprehensive time structure of banks' cash inflows and outflows. The maturity ladder is composed of five time buckets: one day to one week, one week to one month, 1–3 months, 3–6 months, and over six months. The analysis was conducted for all currencies due to data constraints. The data consists of projected contractual cash flows generated by type of liabilities and distributed across maturity buckets. Banks' resilience to severe funding shocks is characterized by the same severe scenario in the LCR analysis resulting in higher run-off rates on funding sources calibrated by type, lower roll-off rates and liquidation of assets subject to a 3 percent haircut since the counterbalancing capacity only includes HQLA assets.

Figure 16. Thailand: Liquidity Stress Test Results

The aggregate LCR under the severe scenario falls to 104 percent.



The counterbalancing capacity is used in the "1–7 day" window and "more than 180 days," due to the large proportion of sight deposits and other liabilities.



The aggregate LCR under the severe scenario, which combines the shocks to retail, wholesale and investment funds' deposits, remains above the hurdle rate of 100 percent.

	LCR Standard	LCR Severe	LCR Retail	LCR Wholesale	LCR Investment Funds
5DSIBs + 3IRBs LCR ratio (percent)	188	104	138	139	174
Liquidity shortfall ¹					
THB billion	...	248	24.7	53.7	0
Percent of GDP	...	1.5	0.2	0.3	0.0
Percent of banks' assets in sample	...	0.7	0.2	0.4	0.0
Number of banks failing					
to meet the regulatory rate	...	1 out of 8	0 out of 8	0 out of 8	0 out of 8
to meet the hurdle rate	...	3 out of 8	2 out of 8	2 out of 8	0 out of 8

Source: Thailand Securities and Exchange Commission; and IMF staff estimates.

¹ Liquidity shortfall is the amount required so that the liquidity ratio in each bank in the system be equal to or above 100 percent; the ratio effective as of June 2018.

Note: The analysis of the impact of IFs deposit withdrawal partially took into account the feedback effects between commercial banks, investment funds, and the financial market.

54. The cash-flow analysis assesses banks' resilience to liquidity risk based on net cash balance following the funding outflow shock. In a stressed scenario, a portion of the deposits is withdrawn generating a cash outflow in each maturity bucket, while the rest of the deposits is rolled over. Within each maturity bucket, the net outflows are compared with the liquid assets available for sale (AFS) to counterbalance funding gaps. In the analysis, banks would have liquidity shortfalls if they experience a negative net cash balance after fully using their counterbalancing capacity. The net cash balance consists of the existing cash position, the counterbalancing capacity (i.e., the ability to obtain additional liquidity in secondary markets by selling securities or through standard central bank facilities, and the amount of net funding inflows). In such situations, the central bank can provide Emergency Liquidity Assistance (ELA) under stringent conditions. These include that the bank is adequately capitalized (in essence, that it complies with BoT capital requirements or is on path back to compliance) and that it has sufficient collateral to cover any borrowings from the BoT

under the ELA facility. In situations where the standard collateral has already been used, the BoT can consider accepting alternative forms of collateral, such as parts of a bank's loan portfolio. However, despite its ability to be used as collateral, the alternative form of collateral, such as the loan portfolio, was not considered as counter-balancing capacity under the FSAP liquidity stress test, since it was not part of the HQLA under the LCR requirement.

55. The robustness of the analysis is somewhat affected by the lack of granular data, and the results should be interpreted carefully. In the context of Thailand, deposits cannot be differentiated by type of depositor (retail and wholesale) and maturity. As a proxy, the analysis uses the ratio of each banks' share of retail and wholesale deposits and applies a constant ratio across the five maturity buckets. In addition, data is unavailable for deposits by type and maturity (sight, term, stable, unstable) (Table 8). Given these data constraints, the analysis assumes the proportion of retail deposits stable vs unstable to be a weighted average of 60 percent and 40 percent. This is the first time the authorities are conducting the test, and there is room for further refinement and sourcing of datasets for the analysis.

56. The results of cash flow analysis were consistent with the LCR test over a one-month horizon. All banks, except two, have a positive funding over all the time horizons ("1–7 days" and up to "more than 180 days") (Figure 17). The counterbalancing capacity is mostly utilized in the "1–7 days" window and "180 days and beyond" window as most banks experience shortfalls based on their cash inflows and outflows. However, two banks would have a negative cash balance in "180 days and beyond" horizon even after utilizing their existing required reserves. The nominal amount of the cash shortfall for each bank is small, 6 percent and 7 percent respectively, of each banks' total assets during the "180 days and beyond" window.

57. Banks should address the maturity mismatch between assets and liabilities, particularly at the long-end. The maturity structure of the funding is more front loaded compared with cash inflows. In the analysis, sight deposits are treated to have instantaneous maturity. Based on the available data (which lacked a detailed decomposition of assets and liabilities by maturity) the maturity structure of the cash flow of banks seems to point to a possible significant maturity mismatch.

LIQUIDITY STRESS TESTS ON INVESTMENT FUNDS

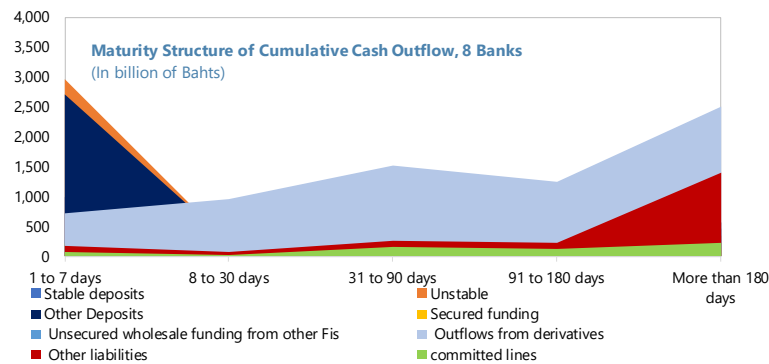
A. Overview of the Industry

58. The investment fund industry has grown during the last 10 years (Figure 18). Total net AUM have increased from 18 percent of GDP in 2007 to slightly over a third of GDP in 2018, with growth averaging 11 percent per annum. As of September 2018, there were 1,411 funds covering bonds, equity, property, infrastructure, money market, and retirement fund. Funds such as property and infrastructure funds are more long-term and most of the investment funds are listed in the

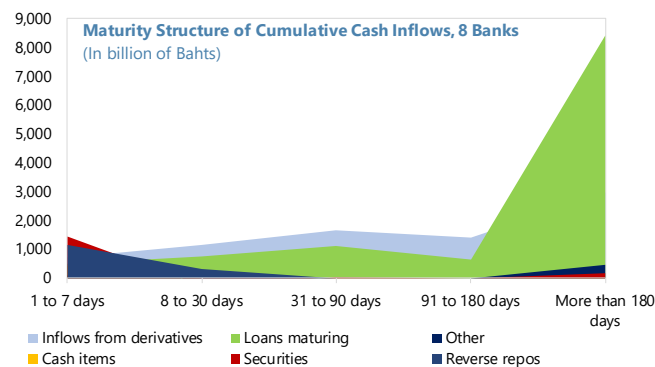
Figure 17. Thailand: Maturity Structure of Cash Flow Analysis
(Billions of baht)

The funding maturity structure is front loaded to sight deposits in the near-term.

Sight deposits average around 60 percent for D-SIBs and 40 percent for the 3 IRBs, other deposits average around 60 percent for the 3 IRBs and 40 percent respectively for the 5 D-SIBs.



Cash inflows are geared more towards the long end of the maturity.



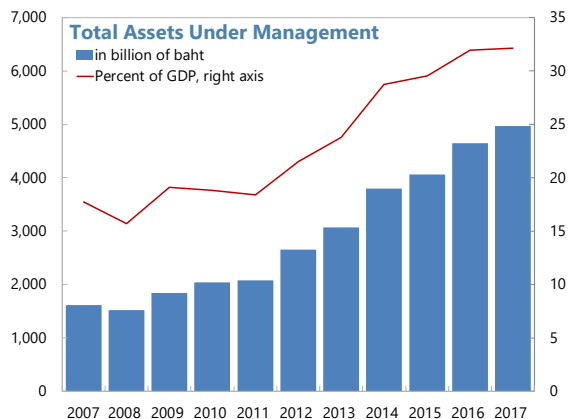
Sources: Bank of Thailand; and IMF staff estimates.

stock exchange. While half of the funds are in fixed income (51 percent of total AUM), the share of equity and infrastructure funds have increased in recent years. Foreign investment funds account for one-fifth of total funds. Most of the investment funds are open ended funds accounting for 90 percent of the total industry.

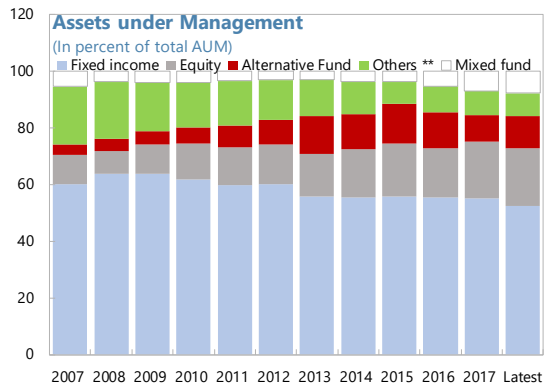
59. Investment Funds (IFs) in Thailand are less sensitive to global financial shocks, while the dominance of the retail segment could elevate liquidity risks. A larger proportion of foreign participation in an investment fund industry has financial stability risk implications. The inflow of funds by foreign investors does not pose a risk during normal times, but these investors could abruptly withdraw their funding when faced with a global financial shock. Such an event is unlikely in Thailand since the investor base is largely domestic with a 98 percent share of total value of investment funds. Retail investors account for 83 percent of the total AUM, followed by corporates

Figure 18. Thailand: Investment Fund Industry, 2007–2018

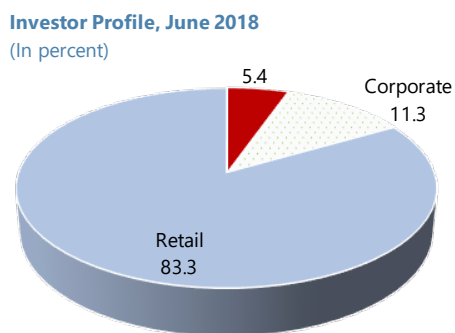
Investment funds have grown significantly...



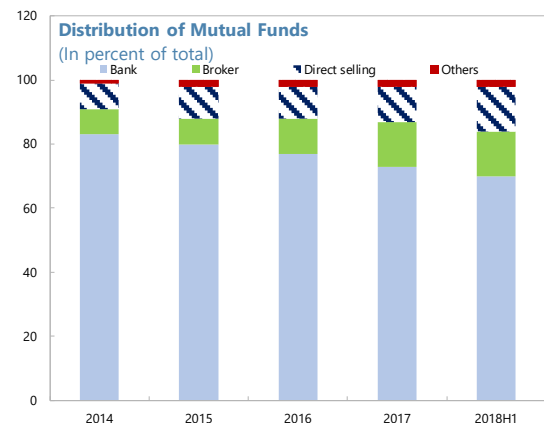
...dominated mainly by fixed income (FI) funds.



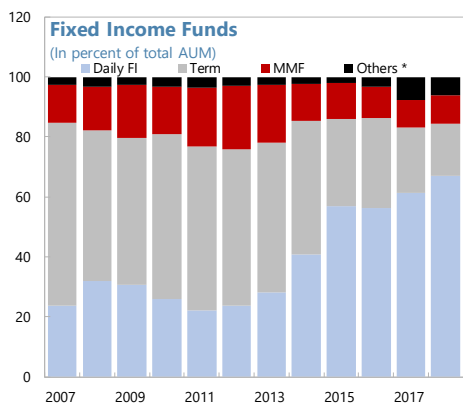
Retail investors are the largest segment.



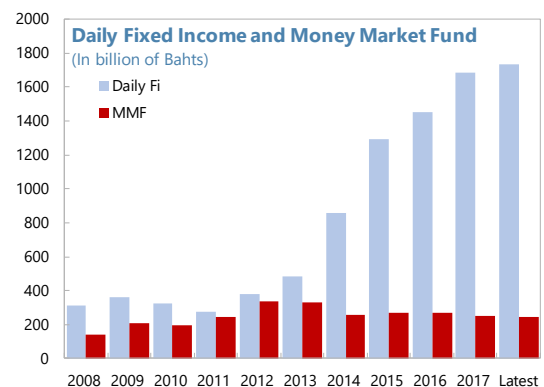
Banks are the main distribution channel of Investment funds.



Shares of daily FIs and MMF have increased rapidly...



...particularly daily FIs.



Source: Thailand Securities and Exchange Commission; and IMF staff estimates.

(11 percent) and institutional (6 percent). Empirical research suggests that retail investors are more inclined towards momentum investing and reactive to global shocks. The behavioral aspect of retail investors is considered in the calibration of the redemption rates which were based on the first and fifth percentile of distribution of flow rates of funds.

60. The close nexus between the banking sector and investment funds exacerbates the risks of transmission of redemption shocks from the fund industry to the banking sector. The top six AMCs, which are part of banking conglomerates, accounted for 80 percent of AUM as of September 2018, and there could potentially be reputational risks from branding in case of a panic redemption. In addition, banks engage in the cross-selling of investment products (accounting for 73 percent of total AUMs), which further elevates reputational risks for the banking sector.

61. Daily fixed income (daily FI) fund and MMF are the largest segments of fixed-income funds. There are 446 funds, totaling US\$81 billion as of September 2018. Daily FI fund and MMF account for 72 percent of the total fixed income funds. Term funds—which are another type of fixed income funds—have seen their share falling in the last two years as some funds experienced a default causing investors to realign their risk preferences.

62. Within the fixed income segment, daily FI funds and MMFs are identified as potential sources of systemic risk. Daily FI funds have increased more than four-fold from US\$12 billion in 2012 to US\$51 billion in September 2018 while MMFs have remained stable. Daily FI funds and MMFs are distributed mainly through the branches of AMCs' parent banks as substitutes for bank deposits. Thai retail investors perceive these funds to be risk free and liquid. Misperceptions of risks by retail investors and unexpected distresses in funds or panic redemptions can amplify liquidity shocks for investment funds.

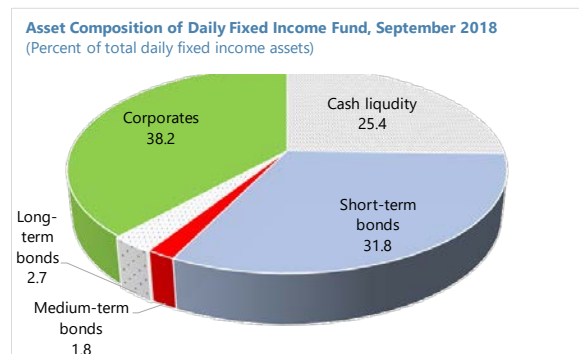
63. Assets of daily FI and MMF are liquid and largely short-term. Daily FI funds consist mainly of cash, holdings of sovereign bonds (mostly short-term government bonds), and corporate bonds. MMFs are more liquid as their asset composition only consists of cash, short-term government and corporate bonds with majority of the maturities less than a year (Figure 19). For the 6 largest AMCs, asset with maturities of less than 6 months accounts for 60 percent of Daily FI and 96 percent of MMFs.

64. The liquidity stress test on IFs assess their capacity to withstand a severe redemption shock, their impact on the banking sector and the bond market. The exercise assumes that: (i) the redemption shock will transmit through a liquidation of assets at fire sale prices to meet redemption demands; and (ii) fire sale of assets by a captive fund, impacting banks through step-in support, and government bonds through higher yields; and (iii) the analysis assumes a static balance sheet (no new inflows are considered).²⁸

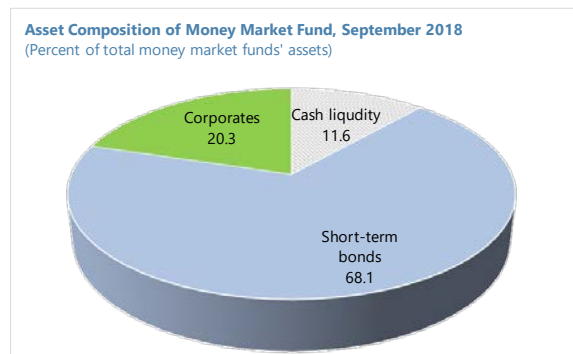
²⁸ According to Basel Committee on Banking Supervision (2017), when faced with reputational risks, banks have incentives beyond contractual obligation or equity ties to “step in” to support unconsolidated entities to which they are connected.

Figure 19. Thailand: Asset Profile of Investment Funds, 2018

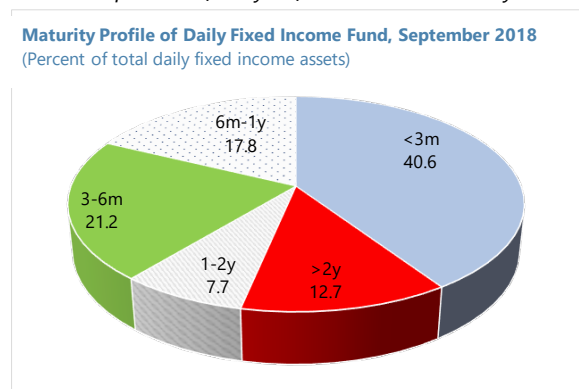
Daily FI funds consist mainly of short-term government bonds...



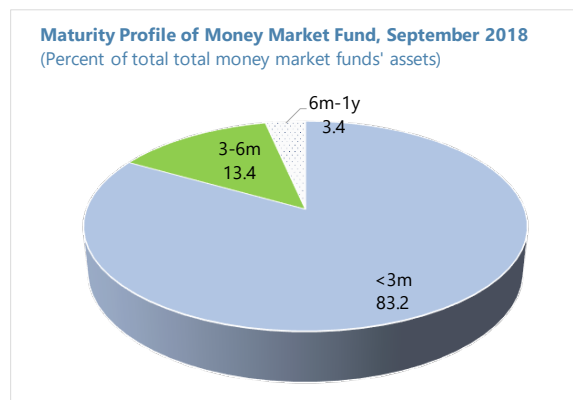
...and likewise for MMFs.



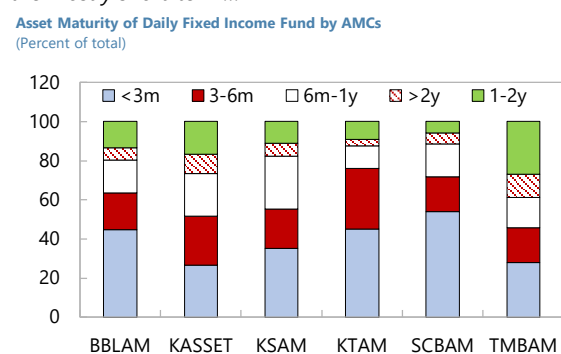
Almost 80 percent of daily FI funds are less than a year...



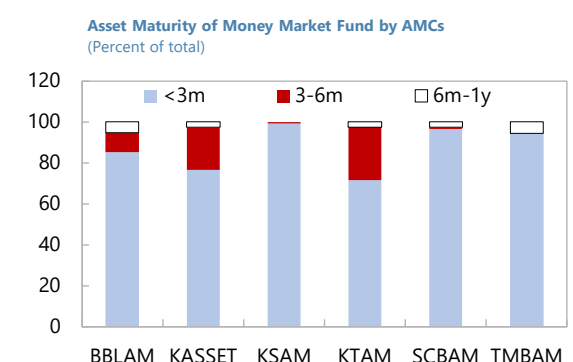
...and MMFs have all short-term maturities.



For the 6 largest AMCs, asset maturities of daily FI funds are mostly short-term...



...and MMFs' s maturities are mostly less than 3 months.



Source: Thailand Securities and Exchange Commission; and IMF staff estimates.

65. The scope of the analysis is limited to open-ended Daily FI and MMF funds and uses monthly data from 2015–2018 to capture historical fund flow patterns. Compared with other funds, Daily FI funds has come to dominate the fixed income market in recent years. This makes it more susceptible to financial stability risks, especially liquidity mismatches and spill-overs to the banking sector. As for MMF, even though the segment's share has fallen, and it focuses largely on the less risky part of the investment universe, it is still vulnerable to redemption risks. Both these

funds account for 33 percent of total AUM and they are open-ended and are representative of types of funds in Thailand. The historical time frame of the analysis represents a stable macrofinancial environment without substantial shocks, and this could affect the results of the liquidity stress test on IFs.

B. Methodology and Results

Methodology: Calibration of Redemption Shocks

66. A redemption shock is defined as net outflows in percent of total net asset value of a fund:²⁹

- The redemption shock was calibrated by looking at the first percentile of the distribution of flow rates of all fund monthly observations in each fund family. Depending on data availability, the redemption shock was calibrated in three ways.³⁰
- The first calibration approach was premised on fund-homogeneity. For each fund, a common size redemption shock was applied regardless of their differences.
- The second calibration approach was premised on fund heterogeneity. This implies that each individual fund experiences an outflow equivalent to the first percentile of its own historical flow rate. In this case, the size of each redemption shock impacting each fund is different.
- The third calibration approach was based on the type of fund using the first percentile distribution of combined outflows by type of fund-daily FI and MMF.

67. Funds' redemption patterns also seem to depend on fund-specific factors such as size and returns. A regression model was estimated to determine the sensitivity of redemptions to returns and size of the fund, suggesting that smaller funds and funds that have higher returns in the previous month experience lower outflows (Box 2). However, additional results indicate that there are possibly nonlinearities with respect to size, suggesting that up to a certain level, larger flows attract more inflows. Furthermore, size and returns also seem to interact significantly, as for a given size, funds with better returns seem to be associated with higher inflows (and vice versa, for a given return, larger funds seem to be associated with higher inflows). In addition, momentum seems to be an important factor in fund redemption, given the significance of the lagged dependent variable. These findings seem to support calibration approaches that take into account fund heterogeneity.

²⁹ The flow rate is defined = Number of shares t_m / Number of shares t_{m-1} .

³⁰ The report would like to acknowledge that some aspects of the methodology were based on the analysis of investment funds in the Brazil FSAP and guidance provided by Majid Bazarbash from MCM.

Box 2. Regression Analysis on Sensitivity of Investors to Returns and Size of Fund

Simple model, with interaction		Model with nonlinearity		Model with nonlinearity in size, interaction returns and size		Focusing only on outflows (flow/nav<0; and excluding outliers)	
Coefficients:				Dependent Variable: FLOW/NAV(-1)			
	Prob.		Prob.		Prob.		Prob.
C	0.509 *** 0.000	C	-0.063 0.741 C	-0.059 0.746 C	0.083 0.116		
FLOW(-1)/NAV(-2)	0.133 *** 0.000	FLOW(-1)/NAV(-2)	0.128 *** 0.000	FLOW(-1)/NAV(-2)	0.127 *** 0.000	FLOW(-1)/NAV(-2)	0.049 *** 0.015
RETURN(-1)	-0.105 *** 0.000	RETURN(-1)	0.003 0.548	RETURN(-1)	-0.105 *** 0.000	RETURN(-1)	-0.032 0.036
LOG(NAV(-1))	-0.054 *** 0.000	LOG(NAV(-1))	0.085 ** 0.050	LOG(NAV(-1))	0.082 ** 0.048	LOG(NAV(-1))	-0.014 ** 0.011
RETURN(-1)*LOG(NAV(-1))	0.020 *** 0.000	LOG(NAV(-1))^2	-0.008 *** 0.001	LOG(NAV(-1))^2	-0.008 *** 0.001	RETURN(-1)*LOG(NAV(-1))	0.006 0.036
Adjusted R2	0.313	Adjusted R-squared	0.305	Adjusted R-squared	0.320	Adjusted R-squared	0.194
Fixed effects							
Number of observations =1637							
Number of Funds =43							

Sources: Thailand Securities and Exchange Commission; and IMF staff estimates.

68. The results of the stress test depend on the type of calibration. The redemption rate for daily FI funds and MMFs was 22 percent under the fund homogeneity calibration. Under this approach, the distribution of net outflows was calculated for the fund sector as a whole, and the redemption shock was based on the first percentile of the outflows (Box 3, Figure 20). The data showed that the net flows follow a normal distribution with a large number of net flows of zero percent.³¹ This approach was used in other FSAP assessments for liquidity stress tests on IFs such as United States, Sweden Luxembourg, and Brazil with average redemption rates ranging between 11.5 percent and 25 percent.

Box 3. Redemption Rates by Type of Calibration Approach

	First Percentile		Fifth Percentile	
	Daily FI	MMF	Daily FI	MMF
Fund Homogeneity	21.9		11	
Fund Heterogeneity	36-0.1	60-7	23-0.6	20-5
Fund Type	19.9	22.7	11	12.1

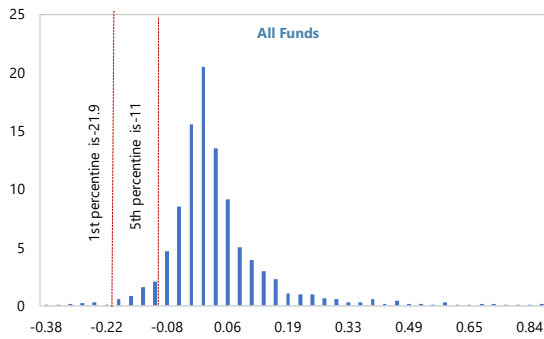
Sources: Thailand Securities and Exchange Commission; and IMF staff estimates.

69. Under the fund heterogeneity calibration, the redemption rate was 14 percent for daily FI funds and 19 percent for MMFs on average. However, the redemption rate varied substantially across funds and fund types. This approach takes differences in individual funds' characteristics into account, evidenced by the large standard deviations of their individual redemption rates (amounting to 8 for Daily FI funds and 15 for MMFs) and the broad dispersion of redemption rates across funds. MMFs generally have higher outflow rates, ranging between 7 and 60 percent for MMFs and between 0.1 and 36 percent for Daily FI funds, since the Daily FI funds are more liquid.

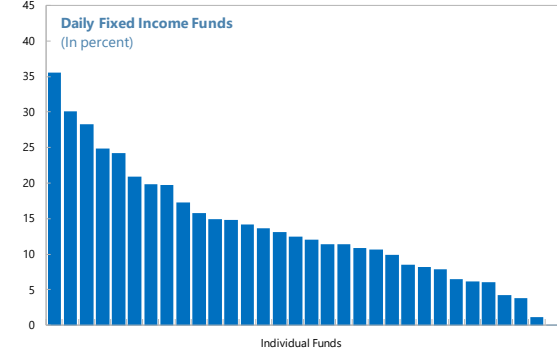
³¹ There were 1,791 observations.

Figure 20. Thailand: Historical Distribution of Flow Rates, 2015–2018
(In percent of net outflows)

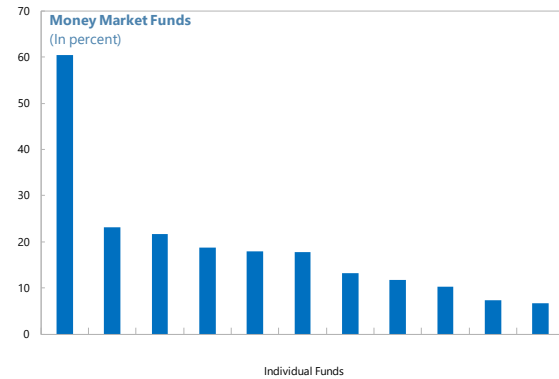
Homogeneity-Fund Approach



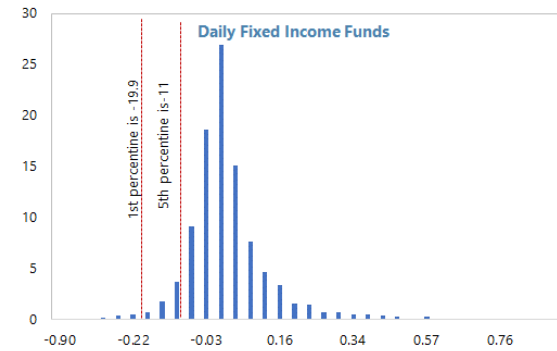
Heterogeneity-Fund Approach



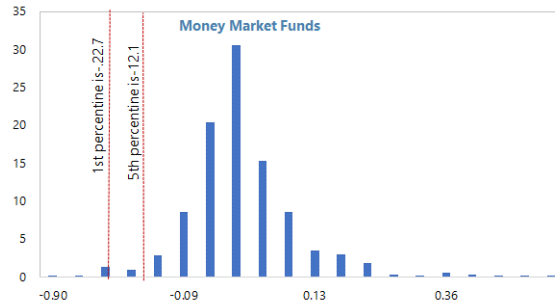
Heterogeneity-Fund Approach



Fund Type Approach



Fund Type Approach



Source: Thailand Securities and Exchange Commission; and IMF staff estimates.

70. The calibration by fund-type shows a slightly high outflow rate for MMFs when compared to the fund-homogeneity calibration, and a slightly lower outflow rate for daily FIs. The redemption rate for the first percentile for daily FI fund was 19.9 percent and 22.7 percent for MMFs compared to an overall rate of 21.9 percent and at the one percent extreme.

Methodology: Asset Sales

71. In the event of a redemption shock, an investment fund is assumed to sell its assets to meet the redemption demand using either of two possible strategies. The analysis looks at the composition of asset holdings of investment funds and estimated the expected total value of assets that must be sold.³² Two different strategies can be followed in the estimation of redemption-induced assets sales since these assets have to be sold at fire-sale prices, haircuts are also applied.³³

- **Strategy 1: Waterfall approach.** In this sales strategy, a fund is assumed to cover redemptions by liquidating its most liquid asset in an orderly manner. The assets are assumed to be sold in the following order: (i) cash; (ii) reverse repo; (iii) bank deposits; (iv) short-term government bonds; (v) medium-term government bonds; (vi) long-term government bonds; and (vii) corporate debt.³⁴
- **Strategy 2: Pro rata approach.** In pro rata selling of assets, assets are sold to meet the redemptions by making sure that the structure of assets is intact. As a result, redemptions are met by liquidating a common fraction of all assets held by each fund.

72. Under the waterfall strategy, the liquidation of governments bonds is relatively small as cash is able to meet most of the redemption demand. IFs have to sell THB 26.7 billion and THB 11 billion of government bonds under the fund-heterogeneity and fund-type calibration approaches, respectively, while under the fund-homogeneity approach, cash alone is sufficient to meet the redemption value (Table 9).³⁵ The cash liquidity position of funds would be sufficient to meet 100 percent, 85 percent, and 96 percent of total value of redemptions, respectively, under the fund-homogeneity, fund-heterogeneity, and fund-family calibration approaches.

73. The pro rata sales strategy requires a larger sale of government bonds to meet redemption demands. By definition, the pro rata sales strategy results in the forced selling of all assets and does not rely on the most liquid asset first. IFs can only liquidate cash holdings of 37 percent, 36 percent, and 38 percent, respectively, to meet total redemptions under fund-homogeneity, fund-heterogeneity, and fund-family calibration approaches. IFs will have to sell

³² Since the analysis focuses on the impact on government bonds, both liquidation approaches exclude the assets holdings of corporate bonds.

³³ For government bonds, the authorities provided us with the haircuts (2–3 percent), while for corporate bonds the team estimated the haircut rates (3–22 percent).

³⁴ The waterfall approach, in which the most liquid assets are liquidated, would expedite the time to liquidation but it can also materially change the composition of the portfolio. This could undermine liquidity managements tools that are currently in place and changing the asset location may place remaining investors at a disadvantage.

³⁵ One main caveat to the analysis is the liquidation approach is based on historical rather than forward looking data, hence the ability of the market to continue offering liquidity in times of stress may have an additional impact even though the analysis applies haircuts.

THB 214 billion, THB 97 billion, and THB 193 billion of government bonds under the fund-homogeneity, fund-heterogeneity and fund-family calibration approaches respectively.

Results: Assessing the Resilience of Investment Funds

74. Using the calibrated redemption shocks and estimated liquidity buffers, the resilience of an investment fund to a liquidity shock can be assessed by the Redemption Coverage Ratio (RCR).

$$\text{RCR} = \frac{\text{Liquid Assets}}{\text{Net outflows}}$$

If $\text{RCR} > 1$, it implies that the fund has sufficient liquidity assets to cope with the shock, and if $\text{RCR} < 1$, the fund will be pressured to sell less liquid assets at a discount. In the event, that the market does not absorb the sales of the asset, investors will have to bear the losses. If the selling pressures persist under tight liquidity conditions, this could trigger contagion effects across other funds/investors.

75. The results suggest that even in case of a first percentile tail risk event, the IFs (at an aggregate level) are able to meet the total value of redemptions. The redemption coverage ratio for the fund homogeneity and fund type calibration approach is 1.9 and 2.2 (daily FI funds) and 3.2 (MMFs). The aggregate liquidity position of IFs, excluding corporate assets, is THB 1 trillion and exceeds the total redemption value of THB 335 billion, THB 149 billion, and THB 304 billion under the calibration approaches of fund-homogeneity, fund-heterogeneity and fund-family, respectively. However, under the fund-heterogeneity approach, there are eight funds that have an RCR below 1, but the impact on the investment fund industry is limited as they account for 9.7 percent of total NAV of daily FI funds and MMFs. Especially, if we take the assets of corporate bonds as part of the 8 IFs' liquidity buffer, except for one fund, the rest were able to meet the redemption demands. Finally, the credit lines of the 6 parent banks would serve as an additional layer of protection in the event of a reputation risk requiring the parent bank to step in to support its subsidiary.

Results: Assessing the Impact on Government Bond Market

76. The asset sales under the pro rata approach are much higher when compared with the historical turnover of government bonds in Thailand. Asset sales under the pro rata strategy are at the upper most end of the distribution, and thus, do not fall within the historical monthly turnovers (Box 4). Assets sales in the waterfall strategy are at the lowest end of the distribution. This implies that the selection of a liquidation strategy is important in ensuring that the government bond market can cope with a rapid liquidation, or fire sale, of government bonds.

Box 4. Comparison of the Scale of Government Bonds by Investment Funds Relative to Monthly Turnover
(In billions of baht)

Asset sales						
Maturity Bucket	Waterfall Strategy			Pro rata Strategy		
	1	2	3	1	2	3
Short-term	24.2 (8th)	11.2 (1st)	191.8 (> Max)	77.8 (91st)	171.5 (> Max)	
Medium-term	0.05 (0th)		8.2 (13th)	5.5 (5th)	7.7 (12th)	
Long-term	2.4 (0th)		14.8 (0th)	13.5 (0th)	13.9 (0th)	

Sources: Thailand Securities and Exchange Commission; IMF staff estimates.

Note: 1, 2 and 3 stand for calibrations under fund-homogeneity, fund-heterogeneity, and fund-family approaches respectively. The numbers in parenthesis represent the percentile of asset sale in the distribution of monthly turnover of the assets in 1, 2, and 3.

77. The Amihud measure is used to estimate how bonds would react to selling pressures from investment funds. The measure uses historical turnover and price changes of government securities. The Amihud illiquidity measure assesses each government security type and maturity as the equally weighted average of the weekly ratio of absolute return on the security to its monthly market turnover over the period of a year and, as such, measures the price impact of government bond sales.

78. Price effects on government bond prices are much lower in the waterfall strategy. The Amihud measure shows the elasticity between asset sales and bond prices (Box 5). Under the waterfall strategy, short-term and long-term government bond prices would fall by 77 and 19 basis points respectively, under the fund-heterogeneity calibration; short-term government bonds would fall 35 basis points under the fund-type family calibration.

Box 5. Comparison of the Impact of Asset Sales on Bond Prices Relative to the Historical Monthly Changes of Bond Prices (Basis Points)¹

	Amihud	Waterfall Strategy			Pro rata Strategy		
		1	2	3	1	2	3
Short-term	0.31642	-	77 (>max)	35 (98th)	607 (> max)	246 (>max)	543 (>max)
Medium-term	0.62346	-	-		51 (>max)	34 (96th)	48 (>max)
Long-term	0.79526	-	19 (3rd)		118 (61st)	107 (57th)	111 (59th)

Sources: Thailand Securities and Exchange Commission; IMF staff estimates.

¹ 1, 2, and 3 stand for calibrations under fund-homogeneity, fund-heterogeneity, and fund-family approaches respectively. The numbers in parenthesis are in historical distribution of monthly trading volume relative to historical price changes

INTERCONNECTEDNESS ANALYSIS AND CONTAGION RISKS

79. Systemic and contagion risks stemming from interlinkages were explored using market based and balance sheet approaches. The IMF team used four approaches: (i) Espinoza and Sole (2009) to simulate credit and funding shocks across the domestic interbank network as well as the potential cross border spillovers; (ii) Diebold and Yilmaz (2012), based on market data, to measure the network interconnectedness between listed banks and nonbanks (including major Thai corporates); (iii) Financial Stability Measures to quantify the impact of systemic risk amplification mechanisms due to interconnectedness across banks, insurance companies, IFs, and other financial intermediaries; and (iv) a balance sheet analysis based on flow of funds data.

80. Contagion risks stemming from domestic interbank exposures are limited (Figure 21). The exercise based on Espinosa-Vega and Solé (2009) showed that no failure of a single domestic bank would trigger another bank to fail, indicating the absence of a “cascade effect.” The largest four of the 19 banks covered by this exercise have a relatively large impact on the rest of the banks (the failure of bank 2 would erode the aggregate capital buffer of other banks by over 8 percent), but these four banks are resilient to shocks from other banks. Some banks lose over half of their capital buffers, but they do not transmit too much shock themselves. A visual representation of interbank network also illustrated the low level of domestic interconnectedness between banks in Thailand. Banks’ cross border exposures are also small, except for one bank due to its relationship with the parent bank. Inter-sectoral exposures under the balance sheet analysis also point to limited cross-border exposures except in the case of corporate sector (primarily through FDIs).

81. The low degree of interconnectedness was confirmed by financial stability measures (Figure 22).³⁶ Contagion among the five largest banks, at its highest at the height of the GFC, has subsequently decreased to the lowest levels in the past 11 years.

82. The market data-based measures suggest a low degree of interconnectedness between banks and non-banks (insurance and IFs) (Figure 23). The pairwise interconnected measures based on the Diebold-Yilmaz approach covering 32 institutions (banks, insurance companies, investment funds and corporates) indicate banks to generally have net outward spillover effect.³⁷ While insurance companies appear to have no strong pairwise interconnectedness with Thai banks, two insurers show a relatively high degree of outward spillovers to the rest of the nonbank sector.

³⁶ Extension to the whole financial sector of the Banking Stability Measures developed by M. Segoviano and C. Goodhart (2009).

³⁷ Diebold, Francis X., and Kamil Yilmaz (2014), “On the network topology of variance decompositions: Measuring the connectedness of financial firms,” *Journal of Econometrics* 182, No. 1: 119–134.

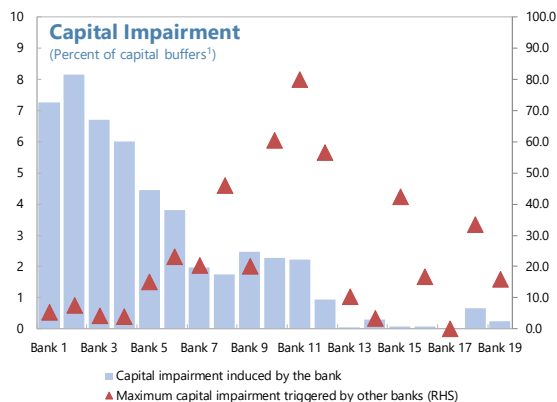
Figure 21. Thailand: Balance Sheet-Based Measures of Interconnectedness Among Banks

Among the largest eight banks, only Bank 11 has strong linkages with other banks (Bank 3 and 4).

Interbank Exposure Network

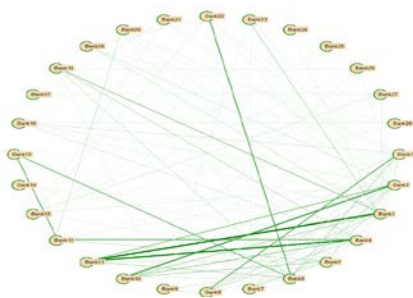


Impact on capital buffers from extreme shocks is manageable.



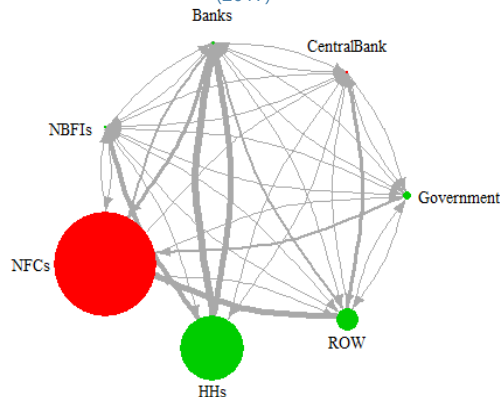
Cross-border exposures are limited, except for Bank 11, which has a strong relationship with its parent bank.

Interbank and Cross-Country Exposure Network



Balance sheet-based sectoral exposure analysis confirms limited cross-border exposures except for nonfinancial corporate sector.³

Inter-Sectoral Exposure Network (2017)



Sources: Bank of Thailand; and IMF staff estimates.

Note. For the network figures, the sample consists of banks and countries. Banks are denoted as bank1 to 19 and countries are from bank 20 to 28.

¹ Aggregate capital buffer of other banks when the bank is the trigger; capital buffer of individual bank otherwise.

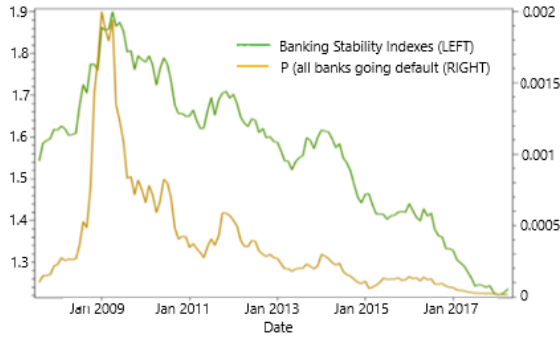
² The types of transaction covered in the network analysis include loans, repos, and debt instruments.

³ Negative cross-border net exposure of NFCs reflects in large part FDIs and portfolio flows.

Figure 22. Thailand: Market Data-Based Joint Default Probability and Spillover Coefficient Among Banks and Insurance Companies

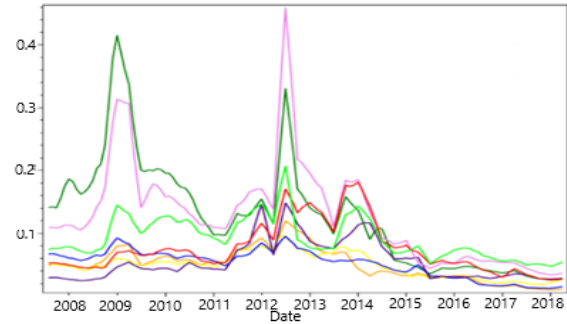
Contagion among the largest banks has steadily decreased in the past 10 years...

Joint Default Probability for the Five Largest Banks and Banking Stability Index



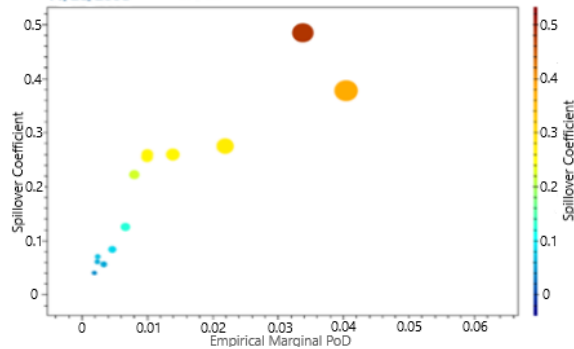
...while the spillover coefficients of the largest insurance companies show at least two separate peaks of increased systemic risk.

Spillover Coefficient for Eight Largest Insurance Companies



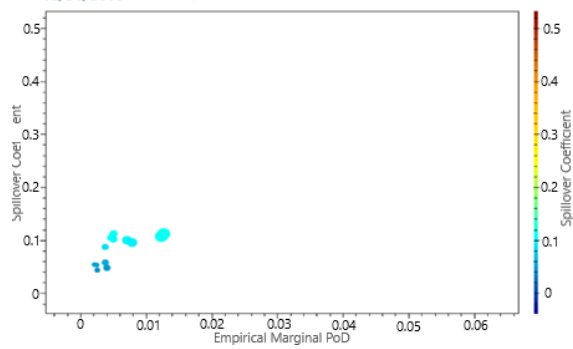
Marginal probabilities of distress and spillover coefficients reached their maximum during the GFC for banks. ...

Marginal Individual Default Probability and Spillover Coefficient 11/28/2008



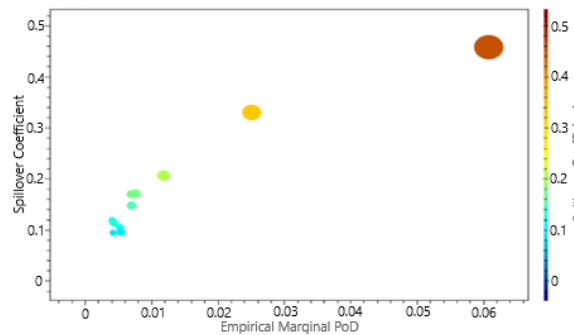
...and after a period of relative tranquility...

Marginal Individual Default Probability and Spillover Coefficient 12/31/2010



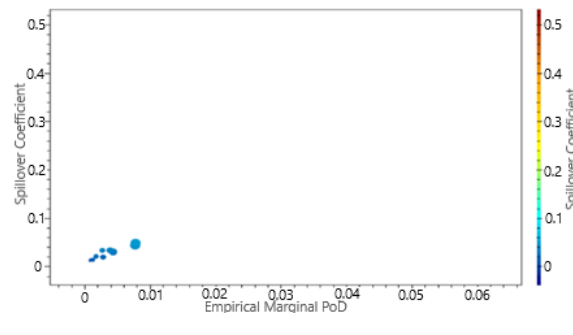
...tensions reemerged in 2012, triggered in the insurance sector...

Marginal Individual Default Probability and Spillover Coefficient 7/31/2012



...followed by a period of decreasing systemic risk.

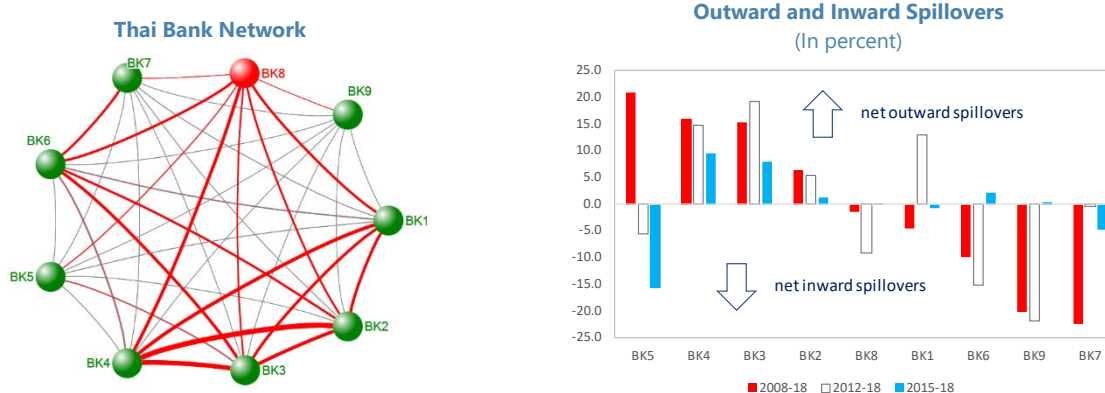
Marginal Individual Default Probability and Spillover Coefficient 5/31/2017



Sources: Moody's CreditEdge and IMF staff estimates.

Figure 23. Thailand: Market Data-Based Measures of Interconnectedness in the Financial System

The spillover analysis reveals a fairly balanced network, with no entity strongly dominating. Spillovers are now less pronounced than in the past.



Source: IMF staff calculations based on the Diebold and Yilmaz (2014) using daily equity returns from Bloomberg (September 2008 to September 2018).

83. The relatively limited contagion within the banking sector and between banks and other sectors should not lead to complacency. Interconnectedness and contagion are inherently difficult to measure: when analytical measures are obtained, it is not immediately evident how these can be operationalized. In particular, it is challenging to incorporate the potential channels of contagion identified by the analysis into the scenario-based exercises to test the resilience of the system when shocks travel through those channels and get amplified in the process. The FSU of BoT has a research program in place aimed at capturing the interconnections between the main financial entities and economic sectors in the economy (including the households sector) and between these and the rest of the world in a granular way and from a structural/analytical perspective (as opposed to the reduced-form/synthetic point of view of market-based measures). This approach seems like a promising way forward and could put the BoT at the frontier of the analytical efforts on the measurement of systemic risk and its operationalization. Once the results of this type of analysis consolidate, it will be worth exploring how the results compare with those obtained using market-based analysis and the possibility of inference from one approach to the other: while structural metrics of interconnectedness are very powerful—but also data-hungry, obtainable with relatively long lags, and difficult to update frequently—market-based metrics, might provide a less clearer signal, but are inherently quicker and easier to estimate and update. Establishing a link between the two could substantially reinforce the framework for systemic risk analysis and provide precious inputs to policy making for financial stability.

CONCLUSIONS AND RECOMMENDATIONS

84. The battery of stress tests performed by the FSAP team on a select and representative sample of Thai commercial banks suggest a substantial resilience of the banking system to severe shocks. Results of stress tests and sensitivity analysis indicate that the solvency and liquidity of the largest banks can withstand an adverse scenario broadly as severe as the Asian financial crisis. While three banks would deplete their CCB, recapitalization needs would be minimal. Banks would be also resilient to sizable withdrawals of liquidity, though some banks would face increased funding pressures.

85. The solvency stress test exercise conducted by the BoT in parallel with—and independently from—the FSAP team produced very similar results. The BoT ran the stress test on the same banks, at the same cut-off date, and under the same baseline and adverse scenarios used by IMF staff. In spite of some fundamental differences of approach—e.g., in the modeling and assumptions adopted on the evolution of net interest margin under stress—the results are remarkably convergent, providing a mutual check on the overall robustness of the two approaches.

86. That said, particular caution must be used in the interpretation of the results. Stress test scenarios are typically based on one or a limited number of adverse scenarios, replicating historical events or expressing judgmental views on what could represent extreme “tail events” in a particular economy. The way the link between the macro variables and the banks’ balance sheets are modeled typically leverages the statistical information contained in historical loss distributions, even though it is well known that the nature of crises is to have unanticipated shocks and unexpected interrelationships where the past offers limited guidance.

87. The BoT staff involved in stress testing and systemic risk analysis is aware of such limitations and of the need to constantly maintain and upgrade the underpinning data feed and analytical framework. The FSU is investing, in particular, on a research program aimed at capturing the interconnections between the main financial entities and economic sectors in the economy (including the households sector) and between these and the rest of the world in a granular way and from a structural/analytical perspective. This looks as an interesting and promising path towards the ultimate goal of convincingly incorporate interconnectedness and contagion channels into scenario-based analysis. The results could also contribute to shed more light on the relationship between structural and market-based metrics of interconnectedness. While structural metrics of interconnectedness are very powerful—but also data-hungry, obtainable with relatively long lags, and difficult to update frequently—market-based metrics might provide a less clearer signal, but are inherently quicker and easier to estimate and update. Linking the two type of metrics and combining their strengths could eventually boost the use (and usefulness) of interconnectedness and contagion analysis for financial stability.

88. The BoT is working on ensuring the adequacy of the severity of its scenarios, partly based on past IMF advice.³⁸ The exercise undertaken by the FSAP team explored an additional way to increase the severity of the scenarios by modeling net interest margin under stress. The FSAP team noted that it was not conservative to assume that banks would maintain their margins constant in a stressed environment with the policy rate hitting the zero lower bound—and that the assumption was also at odds with the experience of banking systems where such a scenario has materialized. The authorities were also encouraged to strengthen their assessment of concentration risk in banks, including from the perspective of potential systemic risk amplification.

89. The authorities should continue strengthening their capacity to monitor liquidity risk and stress testing. Technical capacity has increased significantly, partly supported by IMF's technical assistance in 2018. Several recommendations have been implemented, including: (i) the calibration and integration of LCR run-off and roll-off and haircut assumptions with solvency stress testing framework, (ii) running LCR based stress test on a consolidated basis, (iii) adopting a cash flow based analysis by maturity, (iv) expanding staff resources in the financial stability unit, and (v) feedback loops from mutual funds have been implemented.

90. There are other areas in which the BoT could invest to further advance its analytical capability, starting from the improvement of certain data feeds. The BoT relies on a wide range of well-structured data, from regular supervisory reporting to ad hoc periodic surveys, and has been extremely collaborative in providing the FSAP mission broad access to such data. That said, working on data, IMF staff spotted several areas of improvement:

- The time series of IRB banks' PDs and LGDs obtained by IMF staff were, on average, short and/or erratic, raising doubts on their quality. While the limited historical length of time series cannot easily be addressed (apart from waiting for more data to accumulate), more attention should be paid to their quality.
- Data management for liquidity risk should be enhanced to ensure the availability of more granular data beyond a one more horizon by differentiating deposits by type (sight and time), by insured and uninsured, by depositor (retail and institution), by foreign currency. Specifically, the time structure of maturities and projected cash flows in banks' reporting templates could be further refined (e.g., with finer time buckets at the short-end of time, and after 90 days), and a more granular differentiation of types of funding sources in the templates is highly desirable. Items generating inflows, such as loans, should also be classified by type of borrower (households, corporations, other financial institutions) to facilitate the application of relevant roll-off rates for the cash flow-based analysis.

91. The stress testing methodology of the SEC encompasses credit risk, market risk, and liquidity risk. In their stress testing exercise the SEC identifies the main risk transmission channels such as concentration risk, credit risk, market risk and spillover effects. The SEC also participates with the BoT in the stress testing of banks by providing estimates on portfolio losses due to the fire sale

³⁸ In particular, the recommendations of "Building Financial Stability Analytical Capacity," MCM, IMF, March 2018.

of bonds resulting from the redemption of mutual funds. The SEC does regular offsite monitoring incorporating microprudential surveillance on a daily basis and macro prudential surveillance on a monthly basis. In addition, the SEC has liquidity management tools in place that focus on pre-emptive and post-event measures. These include, investment restrictions, investor concentration limits, internal risk management units within AMCs, redemption in kind options, suspension of dealings, liquidity sources (cross trade, proprietary trade and temporary borrowing) and deferred payment of redemption.

92. While the SEC's macroprudential policies seems to follow best practices, one recommendation is to encourage a routine stress testing exercise with AMCs. Currently, AMCs conduct their own stress testing and the results are only shown to SEC during their onsite supervision. The frequency of visits by the onsite supervisors depends on the risk profile of AMCs (if an AMC is regarded as less risky, the onsite supervisors may only visit the site over a period of two to three years). However, SEC does send out an annual self-assessment questionnaire to AMCs on a range of topics including risk management. It would be beneficial for the SEC to implement a coordinated stress testing approach where all parties can have a dialogue on the methodology of stress testing, scenario design and share latest approaches and techniques to stress testing. The benefits of stress testing are highlighted in the IOSCO Liquidity Risk Management Principles, which call for a holistic approach that takes into account the entire life cycle of the fund, starting from the design of the product, distribution arrangements and asset composition, performing investment, and liquidity risk management tools on an ongoing basis.³⁹

93. The scope of IFs for stress testing by type and risk could be expanded. Currently, the SEC only conducts stress testing on daily FIs and MMFs and it will be useful to expand the scope beyond these two fund types to equity fund and mixed funds. In a deteriorating equity market with persistent selling pressures, the ability to liquidate funds to meet panic redemption demands funds will be a challenge, even if there are measures in place such as suspension on dealings.

³⁹ See OICU-IOSCO, 2018 "Recommendations For Liquidity Risk Management for Collective Investment Schemes."

Table 2. Thailand: Financial System Structure

(In billions of Bahts, unless otherwise stated)

	2007		Number of institutions	2018	
	Assets (bn bahts)	% total financial assets		Assets (bn bahts)	% total financial assets
Financial Sector Assets	16,608	100	7,585	43,389	100
in percent of GDP	183	266	...
Deposit-taking financial institutions	12,499	75	1,454	29,758	69
Banks	9,356	56	30	19,997	46
Private Banks	6,857	41	14	15,274	35
3 largest private banks	3,755	23	3	8,949	21
Other privately owned	3,102	19	11	6,325	15
State-owned	1,261	8	1	2,852	7
Foreign-majority owned	1,238	7	15	1,871	4
Subsidiaries	12	0	4	185	0
Branches of foreign banks	1,226	7	11	1,685	4
Specialized Financial Institutions	2,270	14	6	6,773	16
Finance companies	51	0	2	28	0
Credit Fonciers	1	0	3	4	0
Thrift and credit cooperatives	822	5	1,413	2,956	7
Nonbank Financial Institutions	4,109	25	6,131	13,630	31
Insurance companies	960	6	83	3,951	9
Mutual Funds (incl. MMF)	1,611	10	1,476	4,914	11
Securities companies	0	0	47	366	1
Pension Funds	817	5	382	2,010	5
Leasing companies	0	...	22	1,100	3
Credit card, personal loan and nano finance companies	0	...	28	544	1
AMCs	709	4	36	316	1
Agricultural cooperatives and others	0	...	3,394	265	1
Others ¹	10	6	663	165	0

Sources: Bank of Thailand and Fund staff estimates.

¹ Composed of Secondary Mortgage Corporation and Thai Credit Guarantee Corporation for 2007, and also include pawn shops for 2018.

Table 3. Thailand: Financial Soundness Indicators (2013–2018)

	2013	2014	2015	2016	2017	2018
Regulatory capital to risk-weighted assets	15.5	16.5	17.1	17.8	18.0	17.9
Regulatory tier 1 capital to risk-weighted assets	11.9	13.0	13.9	14.5	15.1	15.0
NPLs net of provisions to capital	7.7	7.8	8.0	8.4	9.1	9.1
NPLs to total gross loans	2.3	2.3	2.7	3.0	3.1	3.1
Sectoral distribution of total loans: Residents	95.0	94.2	93.7	94.3	94.6	94.5
Deposit-takers	5.3	3.9	3.6	3.9	3.6	3.2
Other financial corporations	4.4	3.8	4.0	4.1	4.0	3.7
General government	1.4	1.8	1.4	0.8	0.9	1.1
Nonfinancial corporations	41.3	39.9	40.1	40.4	38.7	39.6
Other domestic sectors	36.7	37.3	37.9	38.4	36.8	38.1
Sectoral distribution of total loans: Nonresidents	5.0	5.8	6.3	5.7	5.4	5.5
Return on assets (ROA)	1.8	1.7	1.4	1.4	1.2	1.3
Return on equity (ROE)	15.9	14.7	11.1	10.7	9.1	9.4
Interest margin to gross income	60.3	62.1	60.4	62.3	61.9	61.5
Non-interest expenses to gross income	45.9	47.5	47.3	47.6	47.7	49.3
Liquid assets to total assets (Liquid asset ratio)	19.2	20.9	20.0	18.8	19.9	18.9
Liquid assets to short term liabilities	31.8	35.6	33.1	30.7	32.6	30.7

Source: IMF, FSI database.

Table 4. Thailand: Risk Assessment Matrix¹

Sources of Risks	Relative Likelihood	Impact and Transmission Channels
Global Risks		
<ul style="list-style-type: none"> Background 1. Weaker-than expected global growth. Idiosyncratic factors in the U.S., Europe, China, and stressed emerging markets feed off each other to result in a synchronized and prolonged growth slowdown. In the U.S., waning confidence could lead to weaker investment and a more abrupt closure of the output gap. In Europe, delays in business investment and a reduction in private consumption could lead to a prolonged period of anemic growth and low inflation. In China, weaker external demand, the potential reversal of globalization and the increasing role of the state could weigh on growth prospects. 	High/medium	<p>Medium</p> <ul style="list-style-type: none"> Weaker exports, including due to retreat from cross-border integration, and tourism income could lead to lower growth, in spite of abundant current account buffers. Corporate vulnerabilities could rise, and the repayment capacity of households, already relatively highly indebted, may come under pressure. These in turn could lead to higher NPLs and provisioning needs for banks.
<ul style="list-style-type: none"> Background 2. Sharp rise in risk premia. An abrupt deterioration in market sentiment (e.g., prompted by policy surprises, renewed stresses in emerging markets, or a disorderly Brexit) could trigger risk-off events such as recognition of underpriced risk. Higher risk premia cause higher debt service and refinancing risks; stress on leveraged firms, households, and vulnerable sovereigns; disruptive corrections to stretched asset valuations; and capital account pressures—all depressing growth. 	High	<p>High</p> <ul style="list-style-type: none"> An increase in global interest rates could lead to a reversal of capital inflows and a depreciation of the baht. Tightening of domestic monetary conditions could result in higher funding costs, pressuring banks' profitability or weighing on corporates' and households' debt servicing capacity (with a consequent impact on banks' impaired assets), depending on the degree of pass-through FX depreciation would increase the stress on unhedged FX borrowers.
Domestic Risks		
<ul style="list-style-type: none"> Background 3. Entrenched low inflation. Inflationary pressures have been subdued and inflation expectations are showing signs of de-anchoring from the BoT's target range. There is a risk of domestic low interest rate environment becoming entrenched. 	Medium	<p>High</p> <ul style="list-style-type: none"> Entrenched low inflation would worsen the macroeconomic environment, increasing real interest rates and the real debt burden, and posing risks to corporates, household, and financial sector balance sheets. Search for yield could result in excessive risk taking by investors, leading to accumulation of vulnerabilities in the financial sector.
<ul style="list-style-type: none"> Background 4. Debt overhang. Household indebtedness remains elevated, after having increased rapidly in the early 2010s. 	Medium	<p>Medium</p> <ul style="list-style-type: none"> Highly leveraged households may hold back spending or banks may tighten credit supply, which would dampen consumption. Furthermore, if these households do not have sufficient buffers to cope with shocks (e.g., a decline in house prices or an increase in unemployment), their debt-service capacity would be constrained, possibly leading to bank losses and a contraction in credit.

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.

Table 5. Thailand: Macroeconomic Scenario Projections (2018–2021)

	Baseline				Adverse Scenario			Deviations from the Baseline		
	2018	2019	2020	2021	2019	2020	2021	2019	2020	2021
Real GDP growth	4.6	3.9	3.7	3.5	-5.6	-2.4	4.9	-9.5	-6.1	1.4
Real private consumption (growth)	3.7	4.6	5.0	5.5	-2.0	-1.3	3.5	-6.6	-6.3	-2.0
Real private investment (growth)	5.7	6.5	8.0	8.5	-18.0	-8.0	8.0	-24.5	-16.0	-0.5
Real government absorption (growth)	7.4	7.4	5.6	3.8	8.5	6.5	4.5	1.1	0.9	0.7
Real exports (growth)	5.9	4.6	3.8	3.9	-18.0	-9.0	9.0	-22.6	-12.8	5.1
Real imports (growth)	6.1	7.3	6.6	6.1	-16.5	-7.0	9.0	-23.8	-13.6	2.9
Unemployment rate (percent)	1.1	1.1	1.2	1.2	3.0	3.5	2.8	1.9	2.3	1.6
Headline CPI Inflation (percent)	0.9	0.9	1.1	1.4	-0.5	-0.2	0.9	-1.4	-1.3	-0.5
Core CPI Inflation (percent)	0.8	1.2	1.4	1.6	0.1	0.3	0.7	-1.2	-1.1	-0.9
One-year nominal corporate interest rate (percent)	2.6	2.9	3.2	3.4	4.3	4.0	3.5	1.4	0.9	0.1
Ten-year nominal corporate interest rate (percent)	3.7	4.0	4.1	4.2	10.1	9.9	8.4	6.1	5.8	4.2
One-year sovereign yield (percent)	1.9	2.2	2.5	2.8	0.3	0.3	0.3	-1.9	-2.3	-2.5
Ten-year sovereign yield (percent)	2.9	3.1	3.3	3.5	2.8	2.1	1.8	-0.3	-1.2	-1.7
Nominal USD exchange rate (growth) neg=apprec	2.2	-1.5	-1.0	-0.6	12.0	5.0	-6.1	13.5	6.0	-5.5
Asset Prices (SET index, growth)	-10.8	7.6	9.3	5.3	-55.0	20.0	10.0	-62.6	10.7	4.7

Sources: IMF, World Economic Outlook database; and IMF staff estimates.

Table 6. Thailand: LCR—Based Stress Test Assumptions on Run-off Rates
(In percent)

	Baseline	Severe Scenario	Retail Shock	Wholesale Shock	Investment fund Shock
Retail					
Demand Deposits					
Insured	5	10	10	5	5
Uninsured	10	20	20	10	10
Savings account					
Insured	10	15	15	10	10
Uninsured	10	30	30	10	10
Term Deposits					
Right of premature withdrawal but subject to significant penalty that affects interest receivable	5	10	10	5	5
With no-premature deposits condition	5	15	15	5	5
With the right of premature withdrawal but subject to significant penalty that affects the principal of customers	0	5	5	0	0
Unsecured wholesale funding					
Non-financial corporates					
Operational deposits					
Insured	5	15	5	15	5
Uninsured	25	40	25	40	25
Non operational deposits					
Insured	20	30	20	30	20
Uninsured	40	50	40	50	40
Sovereigns, central banks, PSEs and MDBs					
Operational deposits					
Insured	5	15	5	15	5
Uninsured	25	35	25	35	25
Non operational deposits					
Insured	20	30	20	30	20
Uninsured	40	50	40	50	40
Banks					
Operational deposits					
Insured	5	15	5	15	5
Uninsured	25	35	25	35	25
Non operational deposits					
Insured	100	100	100	100	100
Uninsured	100	100	100	100	100
Financial institutions and other legal entities					
Operational deposits					
Insured	5	15	5	15	15
Uninsured	25	50	25	50	50
Non operational deposits					
Insured	100	100	100	100	100
Uninsured	100	100	100	100	100
Term deposits/ borrowings with maturity > 30 days					
With no-premature deposits condition: NFC	20	30	20	30	20
With no-premature deposits condition:Gov	20	20	20	20	20
With no-premature deposits condition: Bank	50	60	50	60	50
With no-premature deposits condition: other FI and other legal	50	60	50	60	60
Secured Funding					
Transactions with central bank					
Involving HQLA Level 1	0	3	0	0	0
Involving HQLA Level 2A	0	4	0	0	0
Involving HQLA Level 2B	0	5	0	0	0
Involving non-HQLA	0	40	0	0	0
Transactions with Sovereigns, central banks, PSEs and MDBs					
Involving HQLA Level 1	0	3	0	0	0
Involving HQLA Level 2A	15	19	15	15	15
Involving HQLA Level 2B	25	30	25	25	25
Involving non-HQLA	25	65	25	25	25
Transactions with other counterparties					
Involving HQLA Level 1	0	3	0	0	0
Involving HQLA Level 2A	15	19	15	15	15
Involving HQLA Level 2B	50	55	50	50	50
Involving non-HQLA	100	100	100	100	100
Contractual obligations					
Derivatives cash outflow	100	100	100	100	100
Additional collateral pledged and cash outflow due to credit rating downgrade	100	100	100	100	100
Drawdown on committed credit/liquidity facilities					
Retail customers and SMEs					
Non-financial corporates and MDBs	30	40	30	30	30
Commercial banks	40	40	40	40	40
Non-bank financial institutions and other entities	100	100	100	100	100
For other purposes					
Retail customers and SMEs	5	5	5	5	5
Non-financial corporates and MDBs	10	20	10	10	10
Government and MDBs	10	15	10	10	10
Commercial banks and Non-bank financial institutions	40	40	40	40	40
Other entities	100	100	100	100	100
Off-balance sheet items - Uncommitted obligations					
Banks or entities within the financial group are not the dealer or market maker	5	5	5	5	5
Banks or entities within the financial group are the dealer or market maker	10	10	10	10	10
Liquidity assistance to managed funds which are managed by the entities within the same financial group	5	10	5	5	10
Potential liquidity draws from joint ventures or minority investments in entities	100	100	100	100	100
Customer's short positions covered by another customers' collateral	50	50	50	50	50

Sources: Bank of Thailand; and IMF staff estimates.

Table 7. Thailand: LCR—Based Stress Test Assumptions on Roll-off Rates and Haircuts
(In percent)

	Baseline	Severe Scenario	Retail Shock	Wholesale Shock	Investment fund Shock
Inflow from the paid-back of fully performing loans due within the next 30 days					
Paid back of fully-performing loans due within the next 30 days (both call loans and other types of loans)					
Retail customers	50	45	50	40	50
SME customers	50	40	50	45	50
Non-financial corporates	50	40	50	45	50
Central banks	100	100	100	100	100
Financial institutions	0	0	0	0	0
Operational deposits deposited at other FIs	0	0	0	0	0
Other deposits due within 30 days (both call and other types of loans)	100	100	100	100	100
Other types of customers	50	50	50	45	50
Intra-group transactions	100	100	100	100	100
Other types of paid-back determined by BOT to have 100% inflow rates	100	100	100	100	100
Cash inflow from bonds or securities due within the next 30 days	100	90	100	90	100
Reverse repo and securities borrowing due within 30 days					
Non-rehypothecation or rehypothecation with commitment due within 30 days (both counting toward HQLA and non-HQLA)					
Collaterals are level 1 assets	0	0	0	0	0
Collaterals are level 2A assets	15	15	15	15	15
Collaterals are level 2B assets	50	50	50	50	50
Other types of assets (non-HQLA)	100	100	100	100	100
Inflow from committed obligations					
Derivatives cash inflow	100	100	100	100	100
Inflow from other types of commitment	100	100	100	100	100
Cap on cash inflows	75	75	75	75	75
Haircuts on liquidity buffers					
HQLA level 1- Cash and deposit at central bank	100	100	100	100	100
HQLA level 1	100	97	100	100	100
HQLA level 2A	85	80	85	85	85
HQLA level 2B	50	50	50	50	50

Sources: Bank of Thailand; and IMF staff estimates.

Table 8. Thailand: Cash Flow—Based Stress Test Assumptions on Run-off Roll-off Rates and Haircuts
(In percent)

	1 to 7 days	8 to 30 days	31 to 90 days	91 to 180 days	More than 180 days
Retail funding: sight deposits					
Stable	8	4	4	2	0
Unstable	12	6	6	4	0
Other deposits	40	40	30	30	25
Secured wholesale funding from other financial institutions	100	100	100	100	100
Unsecured wholesale funding from other financial institutions	60	60	55	55	50
Outflows from derivatives	100	100	100	100	100
Other obligations	100	100	100	100	100
Committed lines	20	15	15	10	0
Roll-off rates on cash inflows					
Inflows from derivatives	100	100	100	100	100
Loans maturing	50	50	30	30	10
Other	100	100	100	100	100
Haircuts on liquid assets					
Cash items	0				
Securities (government bond)	3				
Securities (other types of bond)	20				

Sources: Bank of Thailand; and IMF staff estimates.

Table 9. Thailand: Asset Composition and Asset Sales After the Redemption Shock
(In billion of Bahts)

		Daily FI	MMF	Total			
Cash Liquidity		354	24	378			
Short-term bonds		456	125	581			
Medium-term bonds		25		25			
Long-term bonds		45		45			
Total NAV		880	149	1029			
		Waterfall Sales		Prorata Sales			
		All Funds (Daily FI +MMF)		All Funds (Daily FI +MMF)			
Fund homogeneity	Cash Liquidity	43	43	255	255		
	Short-term bonds	569	569	380	380		
	Medium-term bonds	24	24	16	16		
	Long-term bonds	44	44	29	29		
	Total	679	679	679	679		
Fund heterogeneity		Daily FI	MMF	Total	Daily FI	MMF	Total
	Cash Liquidity	242	12	254	302	21	324
	Short-term bonds	433	10	443	389	103	492
	Medium-term bonds	24		24	19		
	Long-term bonds	41		41	30		
Total	740	22	763	740	124	865	
Fund type	Cash Liquidity	84	-	84	245	18.5	264
	Short-term bonds	446	111	558	307	92.9	400
	Medium-term bonds	24		24	16		
	Long-term bonds	44		44	30		
	Total	598	111	710	598	111	663

Sources: Securities Exchange of Thailand; and IMF staff estimates.

Appendix I. Thailand: Stress Test Matrix (STeM) for the Banking Sector: Solvency, Liquidity, and Contagion Risks

Banking Sector: Solvency Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
1. Institutional Perimeter	Institutions included	<ul style="list-style-type: none"> 8 banks (5 D-SIBs and 3 IRB banks) <i>[and 3 specialized financial institutions]</i>. 	<ul style="list-style-type: none"> 8 banks (5 D-SIBs and 3 IRB banks) <i>[and 3 specialized financial institutions]</i>.
	Market share	<ul style="list-style-type: none"> Banks representing 75 percent of banking sector assets. 	<ul style="list-style-type: none"> Banks representing 75 percent of banking sector assets and SFIs 95 percent of SFI sector. Combined accounting for 80 percent of bank+SFI sector.
	Data and baseline date	<ul style="list-style-type: none"> Supervisory reports at June 2018 Data on a 'solo consolidated' (banking group level). PD/LGD/EAD data for IRB banks. 	<ul style="list-style-type: none"> Supervisory reports as of June 2018. Data on a 'solo consolidated' (banking group level). PD/LGD/EAD data for IRB banks.
2. Channels of Risk Propagation	Methodology	<ul style="list-style-type: none"> In-home macro-ST framework (balance-sheet model). 	<ul style="list-style-type: none"> IMF Solvency Stress Test Workbox (balance-sheet model).
	Satellite Models for Macrofinancial linkages	<ul style="list-style-type: none"> In-home satellite models for: <ul style="list-style-type: none"> 'Group 1' variables, dependent on macro factors (effective lending and borrowing rates, effective rate on bonds, loans and liabilities' growth, equity holdings); relationships with macro factors estimated via VAR, OLS, dynamic panel regressions. 'Group 2' variables, dependent on group 1 variables (bond holdings at market price, fees, and commissions, non-interest expenses and non-interest-earning liabilities); relationships with macro factors estimated via OLS. 'Group 3' variables, whose calibration is based on expert judgment (other non-interest income and net open position in FX). 	<ul style="list-style-type: none"> Seemingly unrelated regression of NPL inflow rates, by economic sector, on macro variables. System-wide regression of credit growth as a function of domestic demand and unemployment (with a judgmental floor to prevent excessive deleveraging), growth of capital determined endogenously within the workbox, growth of liabilities obtained residually. Pre-impairment income estimated piecewise: panel data estimation of banks' effective interest rates on loans, bonds, and deposits; loan and deposit growth based on system-wide forecasts; historical evidence for non-interest-income items, coupled with judgmental adjustments to factor in increasing competition on banking services.
Banking Sector: Solvency Risk			
Domain		Assumptions	

		Top-Down by Authorities	Top-down by FSAP Team
	Stress test horizon	<ul style="list-style-type: none"> • 3 years (2019–2021). 	<ul style="list-style-type: none"> • 3 years (2019–2021).
3. Tail shocks	Scenario analysis	<ul style="list-style-type: none"> • Scenario-based tests on the entire portfolio. • One baseline and two adverse scenarios (one of which coincides with the adverse scenario undertaken by the FSAP team). 	<ul style="list-style-type: none"> • Scenario-based test on the entire portfolio. • Variables in the scenarios include global variables (U.S., China, Japan, and Euro area GDP, USD, and JPY interest rates, and oil prices) and domestic macrofinancial variables (e.g., GDP, inflation, exchange rate, interest rates, unemployment rate, equity prices) • Baseline scenario based on the June 2018 WEO projections. • One Adverse Scenario simulated using IMF's Flexible System of Global Models for the external context and calibrated judgmentally with the country team for the domestic impact. • The Adverse Scenario is driven by a combination of external shocks amplified by domestic characteristics (see RAM). The major drivers of the Adverse Scenario are: <ul style="list-style-type: none"> ○ External shocks: weaker-than-expected growth in China and in advanced economies, coupled with sharp rise in risk premia leading to a reversal of capital flows and a depreciation of the Baht. ○ Domestic amplifiers: excessive risk taking by investors and highly indebted households.

Banking Sector: Solvency Risk

Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
			<ul style="list-style-type: none"> Under the Adverse Scenario, the Thai economy experiences a U-shaped growth path, with annual GDP growth shocks of -5.6 percent, -2.4 percent, and +4.9 percent. This represents a cumulative two-year deviation of 15.6 percentage points with respect to the baseline scenario, which is equivalent to a 2.1 standard deviation shock; compared with a GaR calibration, based on current financial conditions, the GDP decline in the first year is close to the fifth percentile of GaR (-5.9 percent) for the first year; the growth rate over the second year is also close to the two years ahead GaR threshold at the tenth percentile (-2.45 percent). This economic slowdown will be accompanied by unemployment rising to 3.0 percent, 3.5 percent, and 2.8 percent over the 3-year horizon. The cumulative decline of the stock price index is 40 percent over the three years, with a negative peak of -55 percent in the first year. The Baht will depreciate by 12 percent in the first year and will still be 10 percent below the June 2018 level at the end of the horizon.
	Sensitivity analysis	<ul style="list-style-type: none"> Sensitivity of listed companies' debt at risk to changes in sales (-10 to -50 percent). Households' resilience to a drop-in income (-20 percent). 	<ul style="list-style-type: none"> Sensitivity analysis of interest rate and sovereign/corporate spread risk in the banking book based on Basel methodology and Value-at-Risk approach. Sensitivity tests on sovereign risk and corporate spread risk (historical simulation at 99 percent confidence level), stock market shocks, concentration risk.
4.Risks and Buffers	Risks/factors assessed (How each element is derived, assumptions.)	<ul style="list-style-type: none"> Credit losses: determined by the increase in NPLs, estimated via panel data regression with a range of macro factors as exogenous variables. 	<ul style="list-style-type: none"> Credit losses: determined by the increase in NPLs for non-IRB exposures and changes in PD/LGD for IRB exposures.

Banking Sector: Solvency Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
		<ul style="list-style-type: none"> Market losses determined by changes in interest rates (including spreads) and exchange rate. Interest income evolution based on projected assets and liabilities' growth and effective lending and borrowing rates. Non-interest income forecast based on growth of net fee and commission and growth of other non-interest income; growth of non-interest expenses based on model (fees and commissions) and expert judgment (other expenses). 	<ul style="list-style-type: none"> Funding costs and interest on loans and bonds estimated as a function of short-term interest rates; interest on loans and bonds also incorporate a spread which reflects the increased credit risk in the economy. Income forecast based on evolution of prices (interest rates), quantities (growth of assets and liabilities), and impairments (for credit risk). Market risk: impact of financial variables' evolution on fixed income holdings of sovereign/corporate bonds, FX and equity positions.
	Behavioral adjustments	<ul style="list-style-type: none"> Growth rate of loans and interest-bearing liabilities (deposits and other borrowings) estimated via VAR with macro factors. Growth of equity holdings assumed to be either zero (for banks showing no significant variation in the size of holdings across time) or via OLS with the return on stock index as explanatory variable (other banks). Share of bond holdings (over total assets) estimated as an inverse relationship with the loans/assets share. Non-interest-bearing liabilities modeled as a function of total liabilities. Net open position in FX (NOP) projected as historical long-term average of year-on-year NOP. Dividend payout based on historical experience. 	<ul style="list-style-type: none"> Credit growth for the whole banking system estimated as a function of domestic demand and unemployment; portfolio allocation constant over the horizon. Dividend payout judgmental, based on historical experience, with limits on distribution in case of breach of capital buffers.

Banking Sector: Solvency Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
5. Regulatory and Market-Based Standards and Parameters	Calibration of risk parameters	<ul style="list-style-type: none"> • PDs and LGDs: point in time for credit losses. RWA estimates via regression models. 	<ul style="list-style-type: none"> • PDs and LGDs: point in time for both credit losses and stressed RWA calculations.
	Regulatory/Accounting and Market-Based Standards	<ul style="list-style-type: none"> • Hurdle rates: capital (CET1, T1, CAR) • RWAs for credit risk are modeled at aggregate level, separately for performing and non-performing loans: via a regression of credit risk weights on macro factors; via a regression of credit risk weights over specific provision over NPL and the share of retail NPL over total NPLs, respectively. 	<ul style="list-style-type: none"> • Hurdle rates: capital (CET1, T1, CAR) requirements (inclusive of CCB) and leverage ratio requirements as per local regulation (largely implementing Basel III); D-SIB capital surcharge included for domestic systemically important banks. • RWAs evolving according to assumed credit growth, net of increase in provisions; the latter is modeled via changes in PD/LGD for IRB exposures and the increase in NPLs for non-IRB exposures.
6. Reporting Format for Results	Output presentation	<ul style="list-style-type: none"> • Macroeconomic scenarios for the macro ST. • Results of the sensitivity tests on listed corporates and households. 	<ul style="list-style-type: none"> • Capital ratios pre and post-shock and capital shortfall, by bank (anonymized) and system wide. • Distribution of capital ratios: minimum, average, maximum.
Banking Sector: Liquidity Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
1. Institutional Perimeter	<ul style="list-style-type: none"> • Institutions included 	<ul style="list-style-type: none"> • 5 D-SIBs and 3 IRB banks for the LCR and cash-flow analysis. 	<ul style="list-style-type: none"> • 5 D-SIBs and 3 IRB banks for the LCR and cash-flow analysis. Simplified liquidity stress test for 3 largest SFIs.
	<ul style="list-style-type: none"> • Market share 	<ul style="list-style-type: none"> • 75 percent banking sector assets. 	<ul style="list-style-type: none"> • 75 percent of banking sector assets and 95 percent of SFI sector assets. Combined accounting for 80 percent of bank+SFI sector].
	<ul style="list-style-type: none"> • Data and baseline date 	<ul style="list-style-type: none"> • June 2018 LCR analysis and liquidity gap analysis. • Supervisory data. 	<ul style="list-style-type: none"> • June 2018 for LCR and cashflow analysis • Supervisory data.
	Scope of consolidation	<ul style="list-style-type: none"> • Consolidated basis 	<ul style="list-style-type: none"> • Consolidated basis
2. Channels of Risk Propagation	Methodology	<ul style="list-style-type: none"> • Basel III-LCR. • LCR scenario with variants (baseline and severe) based on the RAM. 	<ul style="list-style-type: none"> • Basel III-LCR and NFSR.

Banking Sector: Liquidity Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
			<ul style="list-style-type: none"> • LCR and cash-flow test scenario with variants (severe, retail, wholesale funding, and mutual funds). • Cash-flow based liquidity stress testing using maturity buckets by banks.
3.Risks and Buffers	Risks	<ul style="list-style-type: none"> • Funding liquidity shock (short-term liquidity outflows) • Market liquidity shock (asset price shocks and fire-sales). 	<ul style="list-style-type: none"> • Funding liquidity shock (short-term liquidity outflows). • Market liquidity shock (asset price shocks and fire-sales).
	Buffers	<ul style="list-style-type: none"> • Counterbalancing capacity • Central bank facilities • HQLA-equivalent assets (for cash flow analysis only). 	<ul style="list-style-type: none"> • Counterbalancing capacity. • Central bank facilities.
4. Tail shocks	Size of the shock	<ul style="list-style-type: none"> • Run-off rates calculated following historical data, BoT expert judgement, as well as internal forecasts derived from RAM. • Bank run and dry up of wholesale funding markets, taking into account haircuts to liquid assets. 	<ul style="list-style-type: none"> • Run-off rates calculated following historical events, IMF expert judgement, Thai authorities and LCR rates. • Bank run and dry up of wholesale funding markets, taking into account haircuts to liquid assets.
5. Regulatory standards and Parameters		<ul style="list-style-type: none"> • Regulatory: haircuts and run-off rates based on regulatory parameters. For LCR, see BCBS (2013), The Liquidity Coverage ratio and Liquidity Risk Monitoring Tools Basel, January 2013. Stressed: RAM severe scenario (one-month horizon for LCR Severe scenario). Inflow rates derived from projected NPL of solvency stress test. Haircuts are based on historical data of bond price movement as well as haircuts applied by BoT under the ELA framework. Run off rates are calibrated based on the percentile of the distribution of monthly changes in deposits where the percentile chosen mimics the weighted average of outflows during the 1997 Asian Crisis 	<ul style="list-style-type: none"> • Regulatory: haircuts and run-off rates based on regulatory parameters. For LCR, see BCBS (2013), The Liquidity Coverage ratio and Liquidity Risk Monitoring Tools Basel, January 2013. • Stressed: more severe haircuts under a political turmoil scenario and larger run-off rates to reflect more severe episodes of market and funding based on historical events.

Banking Sector: Liquidity Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
		(where FSAP RAM was based upon in terms of degree of severity).	
	Regulatory standards	<ul style="list-style-type: none"> For the LCR phase in, the hurdle is set to 80 percent. 	<ul style="list-style-type: none"> For the LCR , the hurdle is set to 100 percent. For the cash-flow analysis, the hurdle rate is to have a non-negative cash balance.
6. Reporting Format for Results	Output presentation	<ul style="list-style-type: none"> Number of banks that fail to meet the hurdle and their assets share in the banking sector. Bank-level survival period in days, number of banks that still can meet their obligations. 	<ul style="list-style-type: none"> Number of banks that fail to meet the hurdle and their assets share in the banking sector. Bank-level survival period in days, number of banks that still can meet their obligations.
Banking Sector: Contagion Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
1. Institutional Perimeter	Institutions included	<ul style="list-style-type: none"> All commercial banks (for analyses based on balance-sheet data) or listed banks, listed insurance companies, and listed finance and securities companies (for analyses based on market data). 	<ul style="list-style-type: none"> Banks Insurance companies 6 AMCs (Percentage of total sector assets).
	Market share	<ul style="list-style-type: none"> 36 commercial banks. (i) 27 sectors listed in SET, and (ii) 43 companies listed in SET, including 10 banks (98.7 percent of sector market capitalization), 8 insurance companies (83.7 percent) and 25 finance and securities companies (55.5 percent) 	<ul style="list-style-type: none"> Ninety one percent of total banking assets. Sixty five percent of banking and insurance assets.
	Data and baseline date	<ul style="list-style-type: none"> June 2018. Supervisory and market data. 	<ul style="list-style-type: none"> June 2018. Supervisory and market data.
2. Channels of Risk Propagation	Methodology	<ul style="list-style-type: none"> For its systemic risk analysis, the BoT relies on five models and indicators: (i) a bank network analysis model (Espinosa-Vega and Solé, 2010); (ii) an interbank market network 	<ul style="list-style-type: none"> Interbank and cross border network model by Espinosa-Vega and Solé (2010). Diebold-Yilmaz variance decomposition connectedness methodology.

Banking Sector: Contagion Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
		<p>model (based on Bonacich's Eigenvector Centrality measure); (iii) payment system network model (also based on Bonacich's Eigenvector Centrality measure); (iv) CoVaR measures; and (v) Variance Decomposition results from Diebold-Yilmaz methodology. A new methodology is going to be introduced (based on Civilize et al., 2018, forthcoming) to profile and stress test the financial system via the Disaggregated Balance Sheet Network, which is a consistent system of balance sheets with disaggregated balance sheet profiles of non-financial corporations, banks, and mutual funds.</p>	<ul style="list-style-type: none"> • A Comprehensive Mutli-sector Tool for Analysis of Systemic Risk and Interconnectedness (SyRIN approach).
3. Tail shocks	Size of the shock	<ul style="list-style-type: none"> • Balance-sheet data: analysis of the impact of the default of single institutions or group of institutions on the whole network; ranking of institutions according to their degree of contagion (outward spillover) or vulnerability (inward spillover). • Market-based data: conditional probability of distress for single institutions or the whole network in case of one or more institutions defaulting; ranking of institutions according to their degree of "from" connectedness (inward spillover), "to" connectedness (outward spillover), and "net" connectedness (difference between "to" and "from" connectedness measures). 	<ul style="list-style-type: none"> • Balance-sheet data: analysis of the impact of the default of single institutions or group of institutions on the whole network; ranking of institutions according to their degree of contagion (outward spillover) or vulnerability (inward spillover). • Market-based data: conditional probability of distress for single institutions or the whole network in case of one or more institutions defaulting; ranking of institutions according to their degree of "from" connectedness (inward spillover), "to" connectedness (outward spillover), and "net" connectedness (difference between "to" and "from" connectedness measures). • SyRIN: Various metrics, including tail risk, cross-entity interconnectedness and the contribution to systemic risk by different entities and sectors.

Banking Sector: Contagion Risk			
Domain		Assumptions	
		Top-Down by Authorities	Top-down by FSAP Team
4. Reporting Format for Results	Output presentation	<ul style="list-style-type: none"> • Number of undercapitalized, failed or illiquid institutions, and their shares of assets in the system. • Evolution and direction of spillovers within the network. 	<ul style="list-style-type: none"> • Number of undercapitalized, failed or illiquid institutions, and their shares of assets in the system. • Evolution and direction of spillovers within the network.

Investment Funds: Liquidity Risk			
Domain		Assumptions	
		Top-down by FSAP Team	
1. Institutional Perimeter	Institutions Included	<ul style="list-style-type: none"> • 32 daily FI and 11 MMFs. 	
	Market Share	<ul style="list-style-type: none"> • 31 percent of total AUM. 	
	Date and the baseline date	<ul style="list-style-type: none"> • September 2018. 	
2. Channels of Risk Propagation	Methodology	<ul style="list-style-type: none"> • Liquidity measures by (i) cash and short-term debt securities < 1year; and (ii) cash and high-quality liquid assets. 	
3. Risks and Buffers	Risks	<ul style="list-style-type: none"> • Liquidity outflows and inability to liquidate assets to cope with redemptions. 	
	Buffers	<ul style="list-style-type: none"> • Liquidity buffers. 	
4. Tail shocks	Size of the shocks	<ul style="list-style-type: none"> • Monthly redemption shock equal to 1th percentile of historical net flows. 	
5. Regulatory and Market-Based Standards and Parameters	Regulatory Standards	<ul style="list-style-type: none"> • None 	
6. Reporting Format for Results	Output presentation	<ul style="list-style-type: none"> • Redemption coverage ratio by investment fund and liquidity shortfall. • Number of funds and share of funds that cannot meet their obligations. 	