EXECUTIVE BOARD MEETING

SM/22/67

March 23, 2022

To: Members of the Executive Board

From: The Secretary

Subject: **April 2022 Global Financial Stability Report—Analytical Chapters 2 and 3**

Board Action:	Executive Directors' **consideration** (Formal)
Tentative Board Date:	**Monday, April 11, 2022**
Publication:	Yes, it is intended that the Global Financial Stability Report documents will be released to the public at the time of the Global Financial Stability Report press conference, tentatively scheduled for **Tuesday, April 19, 2022.** The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.
Questions:	Mr. Deghi, MCM (ext. 34391) Mr. Garcia Pascual, MCM (ext. 34083)
Additional Information:	The paper will be revised for publication in light of the Executive Directors comments. If Executive Directors have comments, they should notify Mr. Deghi and Mr. Garcia Pascual by **5:30 p.m. on Tuesday, April 5, 2022.**

The Sovereign-Bank Nexus in Emerging Markets: A Risky Embrace*

Chapter 2 at a Glance

- Holdings by banks of domestic sovereign debt have surged in emerging markets during the COVID-19 pandemic, on average accounting for about one-fifth of banking sector assets and 200 percent of their regulatory capital.
- The larger holdings of domestic sovereign debt by emerging market banks have deepened the ties between the sovereign and banking sectors—the so-called "sovereign-bank nexus." With public debt at historically high levels and the sovereign credit outlook deteriorating in many emerging markets, a deeper nexus poses risks of an adverse feedback loop that could threaten macro-financial stability.
- This chapter examines the sovereign-bank nexus in emerging markets, especially focusing on the COVID-19 pandemic, and puts forward policy options to minimize its potential risks and enhance resilience.
- The transmission of risks between the sovereign and banking sectors is significant—both directly and indirectly through the nonfinancial corporate sector.
- An increase in sovereign risk can adversely affect banks' balance sheet and lending appetite, especially in countries with less-well-capitalized banking systems and higher fiscal vulnerabilities. It can also constrain funding for the nonfinancial corporate sector and reduce its capital expenditure.
- Amid tightening global financial conditions, heightened geopolitical tensions, and large public financing needs, emerging markets face complex policy trade-offs. Given the multifaceted nature of the sovereign-bank nexus, the policy response to mitigate risks needs to be tailored to country-specific circumstances and should include:
  - Better targeting of spending and strengthening of medium-term fiscal frameworks in countries with limited fiscal space and tight borrowing constraints to build resilience and mitigate the impact of an adverse shock.
  - Preserving bank resources to absorb losses by restricting capital distribution where needed.
  - Conducting stress tests of sovereign exposures by taking into account the multiple channels of the nexus.
  - Examining options to weaken the nexus—such as capital surcharges on banks' holdings of sovereign bonds above certain thresholds—once the economic recovery has taken hold and pandemic-related financial sector support measures have been withdrawn.
  - Continuing efforts to foster a deep and diversified investor base to strengthen market resilience in countries with underdeveloped local-currency bond markets.
- Given that risks from the sovereign-bank nexus are not limited to emerging markets but have also manifested in advanced economies in the past, the Basel Committee on Banking Supervision should continue its efforts to develop international standards that reflect a more risk-sensitive regulatory and supervisory treatment. To begin with, and in order to foster market discipline, banks should be mandated to disclose data on their sovereign exposure.

Introduction

1. The increase in public debt in the wake of the COVID-19 pandemic has reinforced the relationship between sovereigns and banks in emerging market economies. The average public-debt-to-GDP ratio in emerging markets surged to a record 67 percent in 2021 from about 52 percent before the pandemic, as economic activity declined and governments greatly increased fiscal support to nonfinancial firms and households to cushion the impact of the crisis (Figure 2.1, panel 1).[1] Although public debt levels have also risen in advanced economies, the domestic sovereign debt exposure of banks has increased relatively more in emerging markets (Figure 2.1, panel 2)—reaching 17 percent of total banking sector assets in 2021—as the additional government financing needs have been met mostly by domestic banks amid declining foreign participation in local-currency bond markets and a generally limited domestic investor base (Figure 2.1, panel 3). Consequently, the linkages between the financial health of the sovereign and banking sectors—the so-called "sovereign-bank nexus"—have intensified in these economies.

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[1] Henceforth, the chapter uses the shorthand "firms" for nonfinancial firms: that is, small, medium, and large enterprises other than banks and other financial institutions.

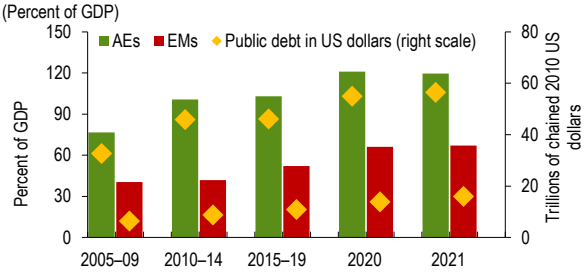
2. The relationship between sovereigns and banks has also become more complex during the pandemic as interdependencies with the real sector have deepened. Countries across the world have supported liquidity and solvency of firms through unprecedented policy measures, including accommodative monetary policy and fiscal measures such as cash transfers, equity injections, loans, and guarantee schemes. In emerging markets, the discretionary fiscal response to the pandemic averaged about 10 percent of GDP in 2020–21—of which 6 percent consisted of additional spending and forgone revenues and 4 percent consisted of equity, loans, and guarantees. In turn, the corporate sector has become highly dependent on the continuation of policy support in cases where the economic recovery is yet to firmly take hold and corporate vulnerabilities are high (Figure 2.1, panel 4). This has significantly deepened the interconnectedness between sovereigns and banks through firms, so that stress in the sovereign sector could spill over quickly to firms and hurt banks' balance sheets.[2]

Figure 2.1. Developments in Emerging Market Public Debt and Banks' Sovereign Exposures

Public debt has surged in emerging markets…

1. Public Debt, 2005–21

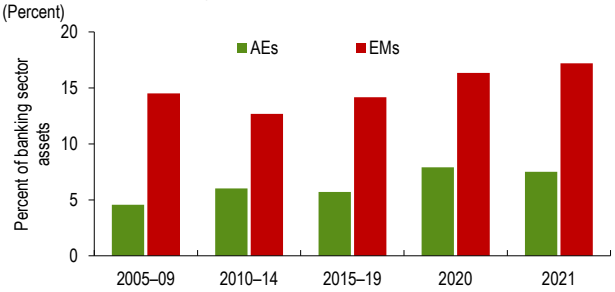
(Percent of GDP)



… and banks' domestic sovereign debt exposure has reached historic highs…

2. Banks' Domestic Sovereign Debt Exposure, 2005–21

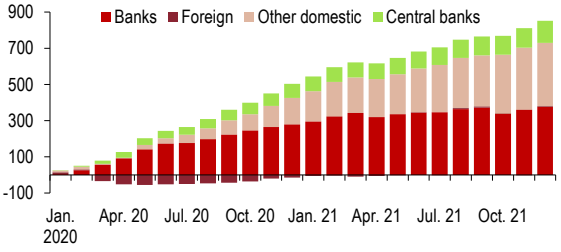
(Percent)



…as banks have been the main buyers of domestic debt.

3. Change in Local-Currency Sovereign Bond Holdings

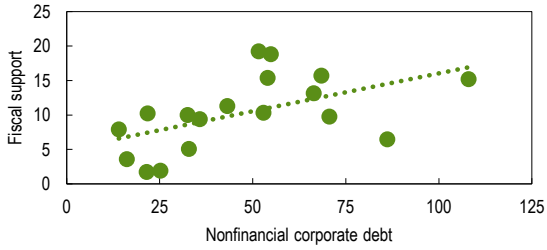
(Billions of US dollars, cumulative change since end-2019)



Fiscal policy has supported firms during the pandemic.

4. Corporate Debt and Fiscal Support during the COVID-19 crisis, 2021

(Percent of GDP)



Sources: Fitch Connect; IMF, Monetary and Financial Statistics, World Economic Outlook, and Fiscal Monitor databases; and IMF staff calculations.
Note: In panels 1 and 2, indicators are country averages weighted by purchasing power parity GDP. Public debt is in real terms: that is, in trillions of chained 2010 US dollars. In panel 2, banks' sovereign exposure corresponds to claims on central government debt divided by total banking sector assets. Advanced economies include economies classified as advanced in the IMF's World Economic Outlook database. In panel 4, fiscal support corresponds to the discretionary fiscal announced or taken during the COVID-19 crisis expressed as a percent of GDP. For 2021, fiscal support and the corporate-debt-to-GDP ratio shown in the panel correspond to September data. AEs = advanced economies; EMs = emerging markets; PPP = purchasing power parity. See Online Annex 2.1 for countries in the emerging market sample.

3. Emerging markets are particularly vulnerable to the macro-financial stability risks associated with a strong sovereign-bank nexus in the face of an adverse shock as global financial conditions tighten. Growth prospects are generally weaker relative to the pre-pandemic trend in emerging markets compared to advanced economies (see the April 2022 *World Economic Outlook*), while governments' ability to support the economic recovery through increased spending or reduced revenues (fiscal space) is more limited with a higher debt-servicing burden (Figure 2.2, panel 1). The public-debt-to-GDP ratio is thus projected to continue to grow in several emerging markets over the medium term, while it is expected to decline in advanced economies (Figure 2.2, panel 2). At the same time, refinancing risks are higher in emerging markets given the shorter average maturity profile of public debt compared to advanced economies (see the October 2021 *Fiscal Monitor*), a higher share of public debt denominated in foreign currency (especially in US dollars) and rising sovereign spreads amid a worsening of the sovereign credit outlook (Figure 2.2, panels 3-5). Local-currency government bond yields have also increased for most

[2] The sovereign-bank nexus has also strengthened in some advanced economies, particularly in Europe. ECB (2020) documents considerable heterogeneity in banks' sovereign debt exposure across European countries, and notes that vulnerability of banks to higher holdings of sovereign debt securities has been contained during the pandemic as valuation changes have been modest.

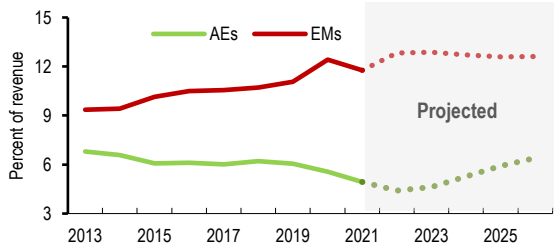
emerging markets in recent months as foreign participation in local-currency bond markets has declined, while central banks have tightened monetary policy on the heels of rising inflationary pressures (Figure 2.2, panel 6; see also Chapter 1).

Figure 2.2. Fiscal Vulnerabilities in Emerging Markets

Emerging markets have much higher debt servicing burdens relative to advanced economies…

1. Interest Payments to Revenues, 2013–26

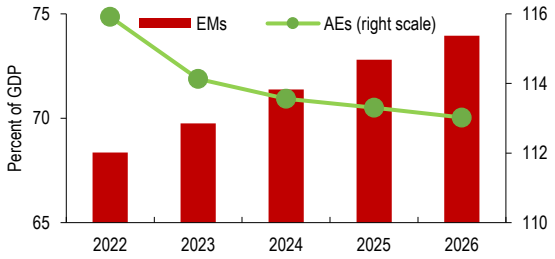
(Percent)



…and rising debt levels in the medium term.

2. Projected Public-Debt-to-GDP Ratio, 2022–26

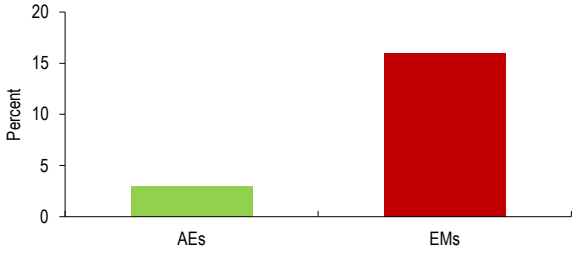
(Percent)



A large share of sovereign debt is denominated in foreign currency.

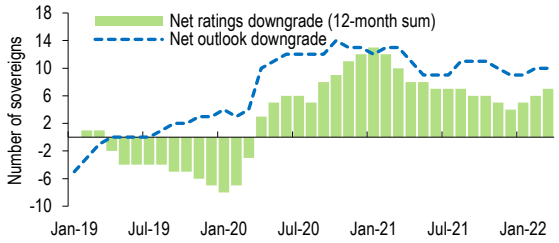
3. Share of Foreign Currency in Total Public Debt, 2021

(Percent)



The sovereign credit outlook has worsened in emerging markets….

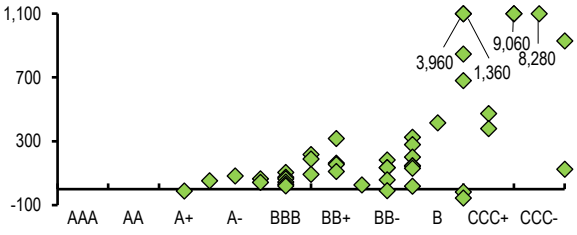
4. Net Emerging Market Sovereign Rating Downgrades and Net Negative Outlook (Number)



…and spreads are above pre-pandemic levels.

5. Change in Emerging Market Sovereign Credit Spread by Sovereign Rating, 2020–22

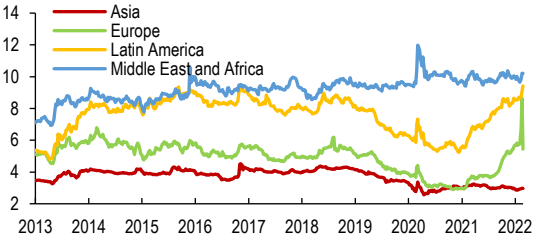
(Basis points)



Local-currency government bond yields have also risen for most emerging markets in recent months.

6. Average Yields of JP Morgan Government Bond Index by Region, 2013–22

(Percent)



Sources: Bloomberg; Capital IQ; Fitch Connect; JP Morgan EMBI Global; Moody's; Standard & Poor; and IMF staff calculations.
Note: In panels 1–3, indicators are country averages weighted by purchasing power parity GDP. In panel 4, changes in sovereign rating and rating outlook are computed using a 12-month rolling sum based on changed reported by S&P. Panel 5 shows the difference in credit spreads between December 31, 2020 and March 11, 2022. Spreads are calculated as the difference between a bond's yield and the linearly interpolated yield of the two base curve bonds that bracket the maturity of this bond. In panel 6, the drop in average yields for Europe in the second week of March 2022 reflects the exclusion of Russia from the JP Morgan index. AEs = advanced economies; EMs = emerging markets.

4. Amid higher fiscal vulnerabilities, a sharp tightening in global financial conditions on the back of monetary policy normalization in advanced economies and intensifying geopolitical tensions caused by the conflict between Russia and Ukraine could push emerging market borrowing costs higher and potentially trigger an adverse feedback loop between the sovereign and banking sectors through multiple channels.[3] For example, with public debt levels already elevated, higher sovereign borrowing rates could fuel debt sustainability concerns and adversely affect banks' funding conditions and balance sheets through their *exposure* to sovereign debt.[4] In this regard, it is worth noting that countries with a higher

[3] Commodity-importing emerging markets may be particularly at risk as they face the prospect of tighter global financial conditions and high commodity prices putting pressure on their external accounts.

[4] These effects could be aggravated if tighter global financial conditions were accompanied by a large reversal in capital flows from emerging markets, inducing sharp currency depreciation, and raising the domestic currency burden of liabilities denominated in foreign currency (Chapter 1; April 2022 *Fiscal Monitor*).

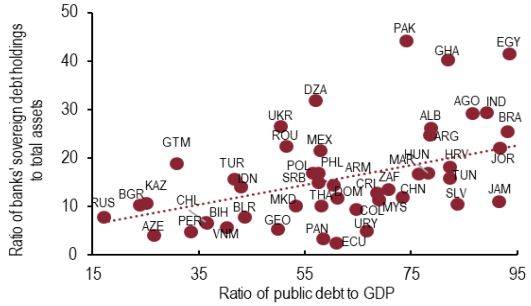
exposure of domestic banks to sovereign debt are also those with a higher public-debt-to-GDP ratio and lower bank capital ratios (Figure 2.3, panels 1 and 2; see also Chapter 1). The occurrence of sovereign stress could thus potentially quickly transmit to the banking sector in these economies.[5] Tighter borrowing constraints could also reduce the ability of governments to support banks through implicit or explicit guarantees (the *safety net*), increasing stress in the banking sector, and in turn, raising the need for actual fiscal support and further weakening the sovereign balance sheet. In addition, a widening of sovereign spreads amid constrained fiscal space could lead to a rapid withdrawal of policy support to the *real economy*, hurting economic growth and intensifying bank losses that could further magnify the sovereign stress.

Figure 2.3. Banks' Exposure to Sovereign Debt in Emerging Markets

Banks' exposure to sovereign debt is greater in economies with higher public debt…

1. Public Debt and Banks' Holdings of Sovereign Debt, 2021

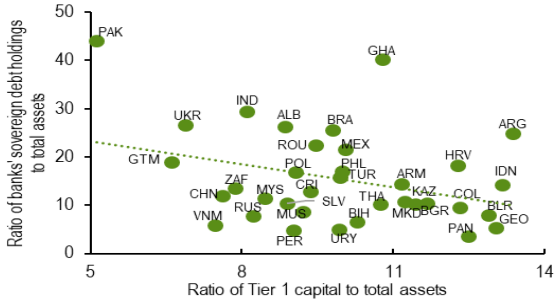
(Percent)



… and lower bank capital.

2. Tier 1 Capital-to-Total Assets Ratio and Banks' Holdings of Sovereign Debt, 2021

(Percent)



Sources: IMF, Financial Soundness Indicators, Monetary and Financial Statistics, and World Economic Outlook databases; Fitch Connect; and IMF staff calculations.
Note: In panel 1, red dots reflect provisional public-debt-to-GDP ratios in 2021 vis-à-vis banks' central government debt holdings in 2021 (third quarter). In panel 2, total assets are used in the denominator of the tier 1 capital ratio (instead of risk-weighted assets) to provide greater comparability across countries. Given limited country-level data availability, banks' sovereign debt exposures for India and Argentina are computed using bank-level Fitch Connect data. Country labels use International Organization for Standardization (ISO) country codes.

5. Domestic shocks such as a weaker-than-anticipated economic recovery in emerging markets amid the spread of new COVID-19 variants could also unleash the pernicious dynamics of the sovereign-bank nexus. For example, a decline in economic activity could put public finances under pressure and worsen the sovereign credit outlook, leading to an increase in sovereign funding costs. A substantial rise in corporate bankruptcies could also undermine banks' capital adequacy and diminish their willingness to lend, further undermining economic activity and straining sovereign balance sheets.[6]

6. Against this backdrop, this chapter examines the relevance of the sovereign-bank nexus in emerging markets for macro-financial stability and puts forward policy options to minimize potential risks and enhance resilience. Building on earlier research on the topic, which has mostly focused on advanced economies,[7] the chapter explores the strength of the nexus in emerging markets, especially during periods of sovereign stress, and the key channels of transmission.[8] Specifically, relying on a comprehensive conceptual framework and drawing on data from the past two decades for a broad sample of emerging markets,[9] the chapter investigates the following key questions:

[5] In some major emerging markets, banks hold floating-rate bonds, inflation-indexed bonds, and "non-defaultable" bills issued by central banks, which may be less sensitive to interest rates and sovereign risk and could provide some insulation from a rise in sovereign risk.

[6] Although banks remain generally well capitalized in emerging markets, pandemic-related regulatory flexibility and other supportive financial sector policy measures make it difficult to precisely ascertain the true health of the banking system at this time.

[7] The linkage between sovereign and banking sector risk has been well explored for advanced economies, especially in the context of the euro-area sovereign debt crisis (for example, Acharya and others 2018; Dell'Ariccia and others, 2018). The findings of these studies, however, may not be generalizable to emerging markets, which have different structural characteristics—notably in terms of lower financial sector development, a greater share of foreign currency denominated public debt, and higher sensitivity to external shocks. Gennaioli, Martin, and Rossi (2018) and Feyen and Zuccardi Huertas (2019) document the existence of a sovereign-bank nexus in emerging markets using pre-COVID-19 pandemic data. IMF (2022) discusses the deepening of the sovereign-bank nexus in recent years in the context of South Africa.

[8] Although shocks to the banking sector could also trigger the feedback loop, the elevated fiscal vulnerabilities in emerging markets, combined with the risk of a sharp tightening in global financial conditions as monetary policy normalizes in advanced economies, makes an increase in sovereign stress more relevant at the current juncture.

[9] The core sample of emerging markets comprises 53 economies. The specific sample of economies across empirical exercises and the time period covered depends on data availability. See Online Annex 2.1 for details. All online annexes are available at www.imf.org/en/Publications/GFSR.

- How has the link between the sovereign and banking sector evolved, and how has the COVID-19 pandemic affected that link? What factors motivate the banking sector to hold sovereign debt?
- How strong is the sovereign-bank nexus? How is it affected by adverse shocks such as a tightening in global financial conditions?
- How relevant are the various channels of transmission? To what extent does sovereign stress transmit directly to banks through their exposure to government bonds? How much do banks benefit from government guarantees, especially during episodes of sovereign stress? And to what degree does sovereign stress affect the real—in particular corporate—sector that may in turn affect banks?

Sovereign-Bank Interlinkages: Conceptual Framework

7. The sovereign and banking sectors are connected through three key channels that facilitate the transmission of shocks from one sector to the other, interacting with and magnifying vulnerabilities in each sector and generating adverse feedback loops (Figure 2.4). The first channel stems from the *direct exposure* of banks to sovereign risk through their holdings of government debt. A rise in sovereign spreads could reduce the market value of government debt that banks hold and use as collateral to secure financing. As a result, banks could face higher funding costs and liquidity strains, potentially restricting their capacity to lend to the real economy.[10]

8. The second channel relates to the *safety net*, or government support provided to banks in the form of implicit and explicit guarantees.[11] Sovereign stress could reduce these funding benefits, threatening the stability of banks. A weaker banking sector may in turn increase the need to activate the guarantees, straining fiscal accounts and further aggravating pressures on the sovereign. In some emerging markets, governments hold substantial amounts of banks' equity, which could lead to additional fiscal losses (on top of potential recapitalization needs) if banks face financial pressure.

9. The third channel refers to the indirect feedback loop effect between sovereigns and banks through the broader *macroeconomy*, in particular the corporate sector. A weakening of the sovereign balance sheet could hurt the corporate sector by raising borrowing costs, or through fiscal consolidation (for example, by raising taxes or reducing expenditure) and policy uncertainty. It may also increase the burden on domestic banks to finance government debt, crowding out bank lending to the corporate sector and affecting economic activity.[12] A weaker corporate sector could in turn have a negative impact on banks' balance sheets due to a possible deterioration of its loan portfolio quality and higher credit provisioning. Subsequently, stress in the banking sector could disrupt economic activity even further, impairing government finances and transmitting stress back to the sovereign.

10. These three channels could also work in reverse—that is, stress in the banking sector could lead to sovereign stress by, for example, disrupting the government bond market, activating fiscal backstops, or dampening economic activity. Moreover, these three channels tend to feed into one another as financial conditions tighten, thus transmitting and amplifying shocks from one sector to the other, weakening balance sheets and creating a mutually reinforcing vicious "doom loop."[13]

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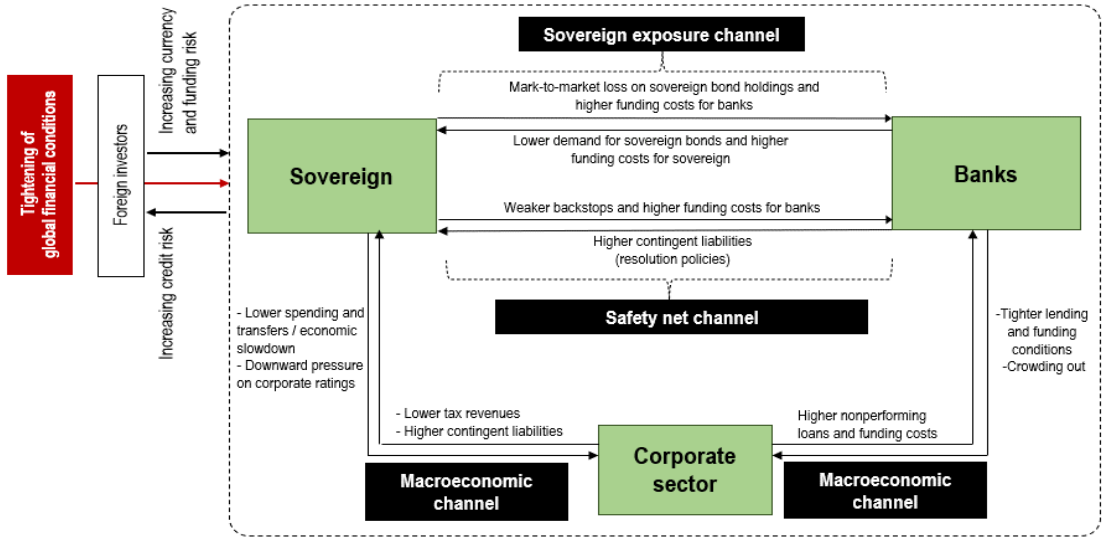
[10] A haircut applied to government debt exposures will lead to capital losses for banks unless the losses have already been absorbed by provisioning and mark-to-market accounting. As noted in IMF (2021), a timely and carefully designed domestic debt restructuring can limit the losses for banks and impact on the broader economy.

[11] Such guarantees are provided to support banks and reduce the likelihood of a financial disruption in case the banking sector comes under severe financial stress. As discussed later in the chapter, this channel is likely to be stronger for domestic state-owned banks—which are also more likely to be financing the fiscal deficit, relaxing the government's borrowing constraint and potentially leading to greater public debt accumulation. As these banks also tend to be subject to limited market discipline and weak governance and supervision, they could pose additional financial stability risks (Feyen and Zucardi Huertas 2019).

[12] Crowding out refers to lower bank credit to the private sector because of increased lending to the government. Sovereign distress may crowd out bank lending as banks may be forced to hold more sovereign debt (moral suasion) when sovereign refinancing needs are typically higher. Banks may also engage in risk-shifting and choose to hold more government debt to profit from higher yields. For emerging markets, there is evidence of lower private sector credit growth during times of sovereign stress.

[13] The extent of the feedback loop may be affected by monetary policy. In an adverse scenario, a loosening of monetary policy (including large asset purchases) could reduce the severity of the loop by supporting economic growth and lowering domestic borrowing costs for sovereigns, banks, and firms. Furthermore, in emerging markets, the strength of the sovereign-bank nexus may also be affected by a "currency channel," whereby an external shock that triggers a currency depreciation could deepen sovereign and banking stress through balance sheet effects.

Figure 2.4. Key Channels of the Sovereign-Bank Adverse Feedback Loop



Source: IMF staff.
Note: A sudden tightening of global financial conditions is one type of shock that may trigger an adverse sovereign-bank feedback loop. Other possible shocks include a terms-of-trade shock that may affect the sovereign, banking, and corporate sectors; a domestic banking crisis triggered by a deposit run that could disrupt credit supply to the corporate and household sectors, reducing economic activity and leading to fiscal sustainability pressures; and a shock to economic activity, for example, because of a health crisis or natural disaster, which could strain sovereign and banking sector balance sheets.

11. That said, well-capitalized banks could also serve as a shock absorber in times of distress by acting as a stable buyer of sovereign debt, especially in countries with a limited domestic investor base. Nevertheless, the overreliance of governments on the domestic banking sector for their financing needs is a source of significant risk—for example, by resulting in a more concentrated investor base and greater potential to amplify shocks.[14]

12. Another source of interconnection between sovereigns, banks, and firms could be due to the role played by domestic nonbanking financial institutions (NBFIs) in many emerging markets. A rise in sovereign (or banking) sector risk may transmit to the NBFIs, which could further amplify vulnerabilities in each sector through direct and indirect exposures (both to banks and firms) and magnify the impact of the shock. While NBFIs hold a nontrivial share of public debt in some emerging markets (see Box 2.2.1 in Online Annex 2.2), potential distress caused by them may be more limited, as financial systems remain largely bank-based in emerging markets.[15]

Relevance of the Sovereign-Bank Nexus in Emerging Markets: Some Stylized Facts

13. Domestic banks have traditionally been important players in sovereign bond markets in emerging markets both as investors and market-makers. Their share in sovereign debt holdings increased gradually from an average of about 20 percent two decades ago to more than 30 percent in 2020 (Figure 2.5, panel 1), but varies considerably across countries. In some economies (such as Uruguay), banks hold less than 10 percent of total sovereign debt, while in others (such as China) this share exceeds 80 percent.[16] In addition to banking sector solvency and liquidity regulations, which incentivize the holding of domestic sovereign debt relative to other claims (BCBS 2017, 2021), several other factors explain banks' exposure

[14] Financial stability risks are also associated with the holding of government debt by nonbanking financial institutions and foreign investors. For example, mutual funds could be prone to selling government securities in times of stress to meet liquidity needs, contributing to pressures in government bond markets. Foreign investors also tend to be skittish, and their quick withdrawal from government bond markets can create liquidity problems. Thus, the investor base needs to be well diversified to avoid overreliance on any one type of investor.

[15] Lack of detailed data on sovereign debt holdings of different types of nonbanking financial institutions in emerging markets (investment funds, insurance companies, pension funds, and so on), as well as on their interconnectedness with other sectors, precludes an in-depth analysis of their role in the sovereign-bank nexus in this chapter.

[16] In some emerging markets, banks' sovereign debt exposure declined over the last decade, as nonresident investor participation in local-currency bond markets rose. This trend, however, reversed during the pandemic (Online Annex Figure 2.3.1).

to sovereign debt, including liquidity management, higher interest rates, lower financial sector development, and government moral suasion (Box 2.1).[17]

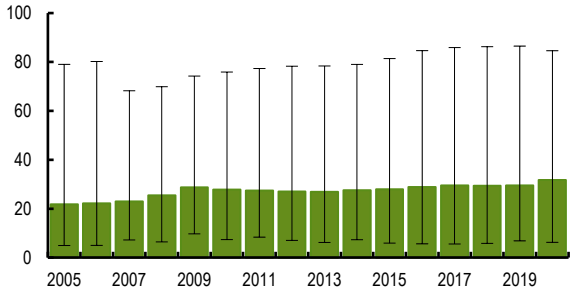
14. The overreliance of governments on domestic banks for their financing needs, and the associated high exposure of banks to sovereign debt, increases the likelihood of shock transmission between the two sectors. Indeed, the default risks of sovereigns and banks—proxied by the expected default frequency (EDF)—tend to move in lockstep in emerging markets (Figure 2.5, panel 2). Importantly, the strength of this relationship varies with the level of distress in the banking sector: at low levels of banks' distress, a 1 percentage point increase in sovereign default risk is associated with a 0.4 percentage point increase in banks' EDF (Figure 2.5, panel 3). However, at higher levels of distress, the association is 10 times stronger. The relationship is also much tighter when global financial conditions are under strain, as is evident from the jump in the correlation between the sovereign and bank default risk during the global financial crisis and at the onset of the COVID-19-related financial market turmoil in March 2020 (Figure 2.5, panel 4).[18]

Figure 2.5. Association between Emerging Market Sovereign and Banking Sector Default Risk

Domestic banks are major players in the sovereign debt market.

1. Share of Domestic Banks' Holding in Total Government Debt, 2005–20

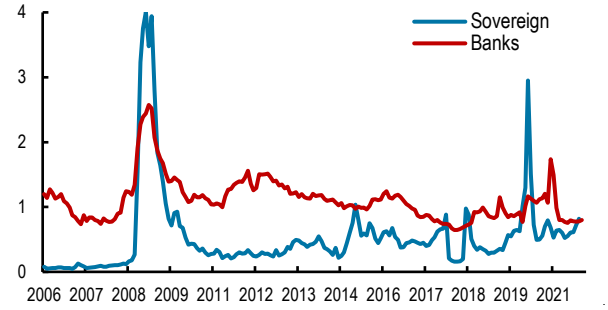
(Percent)



Sovereign and bank default risk move together….

2. Sovereign and Bank Expected Default Frequencies, 2006–21

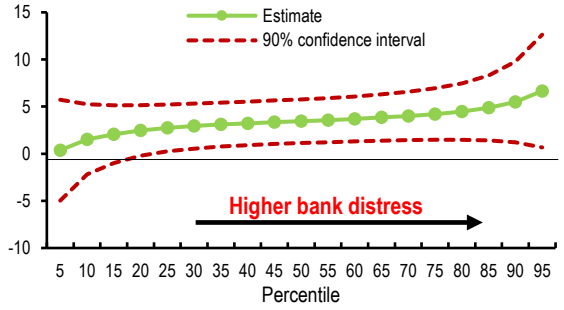
(Percent)



…and the correlation increases at higher levels of bank stress…

3. Relationship between Sovereign and Bank Expected Default Frequencies, 2006–21

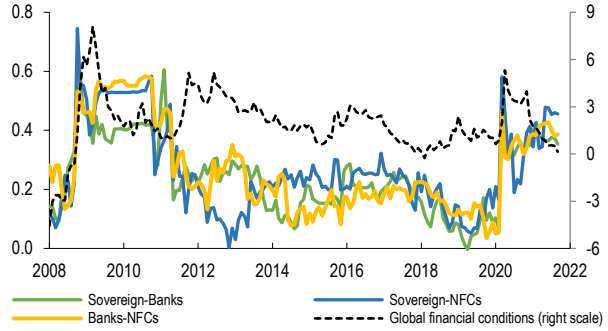
(Percentage change)



…as well as when global financial conditions are strained.

4. Median Correlation between Sovereign, Banks and Nonfinancial Corporate Sector Stress, and Global Financial Conditions, 2008:M1–2021:M9

(Index)



Sources: Arslanalp and Tsuda (2014); Moody's; Thomson Reuters Datastream; and IMF staff calculations.
Note: Panel 1 shows the unweighted average of the domestic banks' share in general government debt. Bands refer to the minimum and maximum value of this share in the sample. In panel 2, banking sector expected default frequency (EDF) is equal to the average EDF of individual banks. Panel 3 shows the strength of the correlation between changes in banks and sovereign default risk at different values of bank stress calculated using a panel quantile regression with country fixed effects. Default risk is measured by the EDF. Higher bank distress refers to periods with larger changes in the banking sector EDF. Dots correspond to the effect of a change in sovereign EDF on the change on banks' EDF as computed by panel quantile regressions with country fixed effects. Panel 4 shows the median time-varying correlation between changes in sovereign, banks and nonfinancial corporates' EDFs across countries using a 24-month rolling window. The median correlation is a number varying between −1 and 1. The global financial conditions indicator refers to the common component of monthly equity prices returns estimated across advanced economies and emerging markets using a factor-augmented vector autoregressive model. NFCs = nonfinancial corporates.

[17] The use of domestic government bonds for liquidity management (such as for accessing central bank liquidity) can be a key driver of banks' preference to hold domestic rather than foreign bonds, resulting in a significant home bias. Asonuma, Bakhache, and Hesse (2015) show that when banks exhibit higher home bias, fiscal consolidation by the sovereign tends to be slower, ceteris paribus.

[18] Similar dynamics are observed for the correlation of sovereign and banking sector stress with nonfinancial corporate sector stress, which provides further evidence of the strengthening of relationships among the three sectors when global financial conditions tighten.

15. The strong association between sovereign and banking sector risks has amplified past financial crises. Banking and sovereign debt crises have been particularly prevalent in emerging markets, frequently occurring at the same time or in succession (Figure 2.6, panel 1). Their incidence typically increases in conjunction with a tightening in global financial conditions, which tends to induce a reversal in cross-border capital flows, making it more difficult for both sovereigns and banks to obtain funding, while also leading to sharp currency depreciations (or a currency crisis) that further strain sovereign and bank balance sheets (Reinhart and Rogoff 2009).

16. These mechanisms were at work in several prominent emerging-market sovereign debt and financial crises of the late 1990s and early 2000s (for example, Argentina, Ecuador, and the Russian Federation). In some cases, governments increasingly relied on domestic banks to fund deteriorating fiscal positions, making a banking crisis unavoidable after the eventual sovereign default.[19] The fiscal cost of restructuring and supporting the financial sector associated with banking crises, however, has also been significant in emerging markets (and on par with advanced economies), suggesting a possible transmission of banking stress back to the sovereign. Furthermore, the deterioration in credit quality (proxied by a high share of nonperforming loans in total loans) during banking crises has been twice as large in emerging markets as in advanced economies, indicating the existence of a strong macroeconomic channel in the former group (Figure 2.6, panel 2).

Figure 2.6. Sovereign Debt and Banking Crises in a Historic Context: Emerging Markets versus Advanced Economies

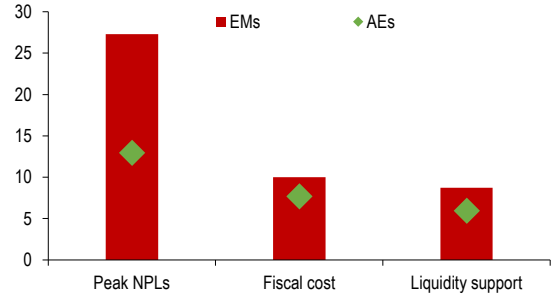
Banking and sovereign debt crises have often occurred together in emerging markets.

1. Frequency of Sovereign Default, Banking, and Currency Crises in Emerging Markets and Advanced Economies, 1971–2016 (Percent)

Type of crisis	EMs	AEs
Sovereign (domestic)	6.3	0.1
Sovereign (external)	18.5	0.5
Banking	15.0	16.1
Currency	25.8	10.9
Banking and sovereign	6.6	0.5
Banking, sovereign, and currency	5.1	0.0

Fiscal costs of banking crises have been significant in emerging markets.

2. Financial and Fiscal Costs of Banking Crises, 1971–2016
(Percent)



Sources: Emerging Portfolio Fund Research; Laeven and Valencia (2018); Harvard Business School Global Crises Data by Country; IMF, Monetary and Financial Statistics database; and IMF staff calculations.
Note: In panel 1, banking, sovereign, and currency crisis are those identified by Global Crises Data by Country updated by the Harvard Business School based on Reinhart and Rogoff (2009). Currency crises are defined as an annual depreciation in the nominal exchange rate of at least 15 percent. The frequency of occurrence of each type of crisis is computed as the total number of country-year observations identified as the corresponding crisis as a percent of total number of country-year observations in the sample. In panel 2, information is sourced from Laeven and Valencia (2018). Fiscal costs refer to outlays directly related to financial sector restructuring. Nonperforming loans (NPLs) are expressed in percent of total loans. Liquidity support is measured as the ratio of central bank claims on deposit money banks and liquidity support from the Treasury to total deposits and liabilities to nonresidents. AEs = advanced economies; EMs = emerging markets; NPLs = nonperforming loans.

Deepening of the Sovereign-Bank Nexus during the COVID-19 Pandemic

17. The relationship between sovereigns and banks in emerging markets has been reinforced during the COVID-19 pandemic, as banks' holdings of local-currency government debt have increased significantly as a share of their assets (Figure 2.1, panel 2; Box 2.1). While this increase has been driven by state-owned banks in several countries, private domestic banks have also played a role (Figure 2.7, panel 1). Excess liquidity in banks, driven by weaker credit demand and a surge in deposits, appears to have been one factor behind banks' decision to purchase more sovereign debt (Figure 2.7, panel 2).

18. Banks in emerging markets are generally well capitalized because of reforms enacted following the global financial crisis and policy support provided during the pandemic.[20] However, sovereign debt exposure constitutes a significant share of regulatory capital in some countries (Figure 2.7, panel 3).

[19] On average, government bond holdings of banks in emerging markets increase by about 7 percentage points after a sovereign debt crisis, while they tend to decline in advanced economies (see Online Annex Figure 2.3.2).

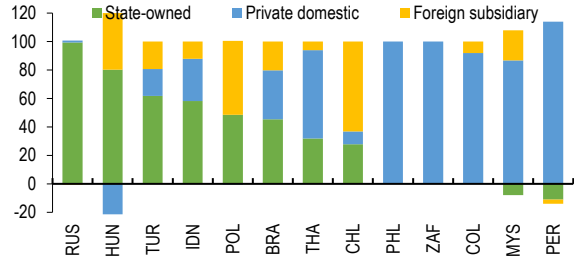
[20] The median capital adequacy ratio across emerging markets stood at 14 percent in 2020 (see Online Annex Figure 2.3.3), but recent global bank stress tests point to relatively lower levels of resilience in emerging markets than in advanced economies.

Importantly, a sizable share of banks' outstanding sovereign debt holdings follows mark-to-market accounting in several emerging markets (Figure 2.7, panel 4), which could potentially undermine banks' capital adequacy if the market value of these assets were to decline.

Figure 2.7. Sovereign-Bank Nexus in Emerging Markets during the COVID-19 Pandemic

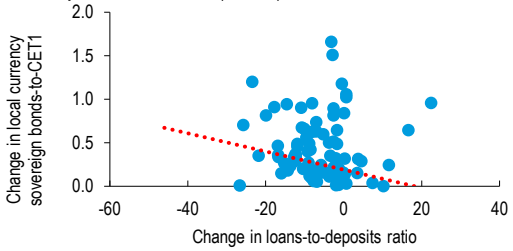
State-owned banks in several countries have been the major buyers of government debt.

1. Share of Net Sovereign Bond Acquisitions by Type of Bank, 2020 (Percent)



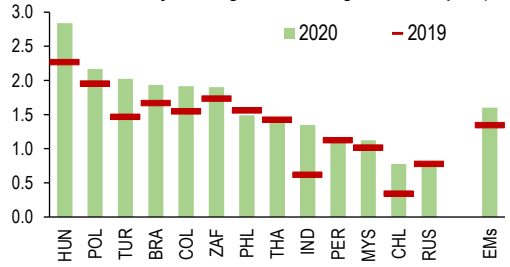
Excess liquidity is associated with banks' increased sovereign bond holdings.

2. Change in Local Currency Sovereign Bonds-to-CET1 Ratio versus Change in Loan-to-Deposit Ratio, 2019–20 (Percent)



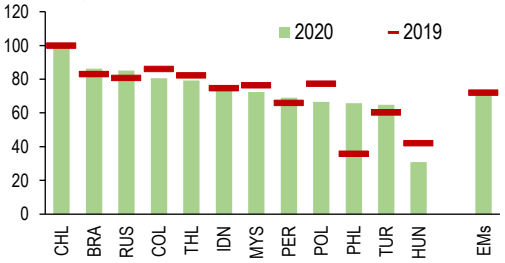
Banks' sovereign exposure relative to capital has increased during the pandemic.

3. Ratio of Local-Currency Sovereign Bond Holdings to CET1 Capital (Ratio)



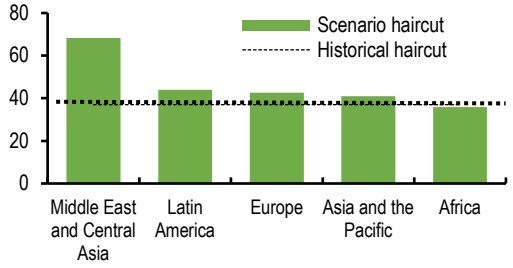
A sizable share of domestic government bond holdings is mark-to-market in major emerging markets, exposing banks to market risk.

4. Share of Mark-to-Market Sovereign Bonds
(Percent of total)



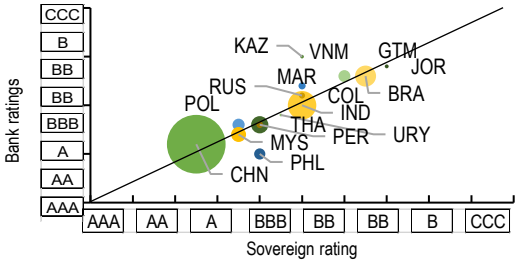
A haircut of about 30 percent–40 percent would breach CET1 capital buffers in some regions

5. Minimum Haircut of Government Securities to Generate a Bank Capital Shortfall
(Percent of government securities holding)



Bank and sovereign credit ratings are closely tied.

6. Banking Sector and Sovereign Credit Ratings
(Rating buckets, as of end of 2020)



Sources: Cruces and Trebesch (2013); data compiled from banks' accounting statements and Pillar III disclosures; Fitch Connect; Haver Analytics; ORBIS; IMF, Monetary and Financial Statistics database; and IMF staff calculations.

Note: In panel 5, historical haircut corresponds to the average direct loss-given-default rates for sovereign debt holders across 68 economies over 1970–2010 as reported in Cruces and Trebesch (2013). Scenario haircut refers to the level of haircut to government securities that would breach the 4.5 percent CET1 capital buffer, assuming other sources of capital are unavailable. This is a strict approach since we assume that only the highest quality capital is accessible. The value of the haircut for each geographical region is computed as a median for banks in individual economies and over regions. In panel 6, bank credit ratings correspond to the median rating across banks in each economy. The size of the dots is proportional to the size of the banking sector. Country labels use International Organization for Standardization country codes. CET1 = Core Equity Tier 1; EMs = emerging markets.

19. This risk is particularly relevant in the current environment of monetary policy normalization in advanced economies and rising global yields.[21] To assess its implications, a simple bank-level scenario analysis is undertaken for individual emerging markets, where the minimum level of haircuts on banks' holdings of domestic sovereign debt is computed that would lead to a breach of the 4.5 percent minimum regulatory Core Equity Tier 1 (CET1) capital ratio (Figure 2.7, panel 5). Averaging the value of these

[21] Higher policy rates and higher term premia will raise yields across the term structure of interest rates, reducing the market value of bond holdings (and capital) in bank balance sheets, even if fiscal conditions are sound.

haircuts across banks in a region, the results show that banking systems in Sub-Saharan Africa are relatively more vulnerable to sovereign distress. On average, haircuts as small as 30 percent, which are probable and have already been observed in the past, would breach CET1 capital buffers in domestic banks in the region.[22]

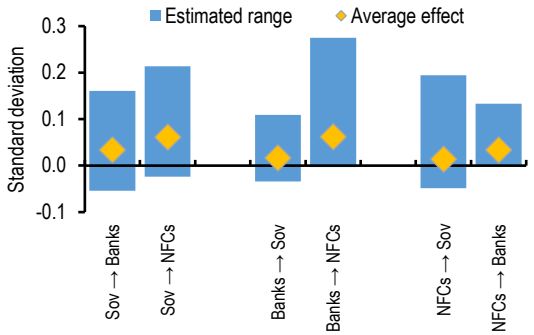
20. Furthermore, banking sector health depends on the viability of banks' corporate borrowers, which have faced strains during the pandemic. In most emerging markets, the sustainability of corporate debt—as measured by earning capacity relative to debt—has declined as corporate revenues have fallen (Online Annex Figure 2.3.4). While it is difficult to fully ascertain the soundness of bank balance sheets at the current juncture because of regulatory flexibility and other financial sector support measures in place,[23] nonperforming loans are more than one-tenth of total loans in some countries (Online Annex Figure 2.3.4) and could edge up as loan-repayment moratoria and other support measures are unwound (Chapter 1). An adverse shock to firms due to a rise in sovereign risk could thus have a significant impact on banking stability through the macroeconomic channel.

21. In this economic landscape, sovereign and bank credit risk remain closely tied in emerging markets, as reflected by the positive correlation between sovereign and bank credit ratings (Figure 2.7, panel 6), indicating that the nexus is highly pertinent. The analysis that follows more formally evaluates the strength of the nexus in emerging markets and some of the key channels of transmission.

Measuring the Strength of the Sovereign-Bank Nexus

22. To assess the overall strength of the nexus in emerging markets, two-way relationships between the sovereign, banking, and corporate sector default risks are examined for individual emerging markets, while taking into account other domestic and external factors that may impact these relationships.[24] Three key findings emerge from this analysis. First, the nexus is strong, on average, with significant feedback effects between sectors (Figure 2.8). Second, the strength of the transmission of risk between sectors varies. For example, spillovers from sovereign default risk to banks are, on average, larger than those in the opposite direction from banks to sovereign default risk. Overall, the largest spillovers are from sovereign and banks default risk to firms. Third, the relevance of the nexus differs across countries, with the transmission of shocks being three to five times higher than the average in some cases.

Figure 2.8. Transmission of Risks through the Sovereign-Bank Nexus: Strength of the Main Channels across Emerging Markets
(Effect of a one-standard deviation shock on other sectors' default risk)
An increase in sovereign, bank, and nonfinancial corporates' default risk transmits across sectors with varying intensity.



Sources: Haver Analytics; Moody's; Thomson Reuters Datastream; and IMF staff calculations.
Note: The figure shows the estimated range of coefficients for individual emerging markets obtained from a structural model using daily data of default risk for sovereign, banking, and corporate sectors. See Online Annex 2.5 for estimation details. NFCs = nonfinancial corporations; Sov = sovereign.

23. The heterogeneity in the size of the transmission of shocks suggests that some country-specific factors, such as the fiscal position and financial vulnerabilities, may be at play in amplifying the impact of an adverse shock. Further empirical analysis supports this observation. For example, after a sharp tightening in global financial conditions, emerging markets with a higher level of public debt and banks' holdings of sovereign debt experience an increase in sovereign and bank default risks that is twice as large as the average increase (Figure 2.9,

[22] For further context, direct loss-given-default rates for sovereign debt holders have varied widely, but Cruces and Trebesch (2013) estimate a 37 percent average haircut for countries over 1978–2010 and a 50 percent average haircut over 1998–2010.

[23] Regulatory flexibility refers to the temporary measures adopted by financial regulators and supervisors during the COVID-19 pandemic to ensure that banks continued to lend to the real economy, such as the release of countercyclical capital buffer to free lending capacity, restrictions in capital distributions, and debt payment moratoria.

[24] To examine the relationships, a structural value-at-risk model is estimated for 15 emerging markets using data over 2006–2020, and identification is achieved through Rigobon (2003). The dependent variable is the expected default frequency (as a proxy for default risk) for the sovereign, banking, and corporate sectors. See Online Annex 2.5 for details on the empirical analysis.

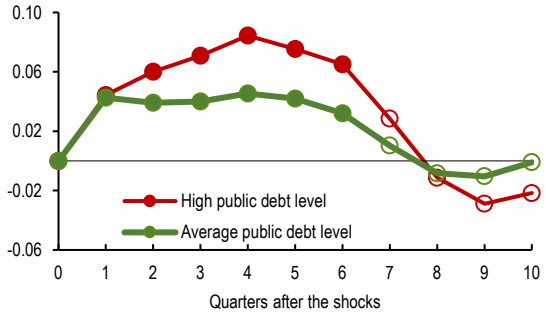
panels 1 and 2).[25] Furthermore, the impact of the shock is persistent and remains larger than the average for up to six quarters after the shock.

24. These findings confirm that the interlinkages underlying the sovereign-bank nexus are relevant in emerging markets. The next section further explores these linkages and examines some of the key channels and vulnerabilities that facilitate the transmission and amplification of shocks across sectors.

Figure 2.9. Sovereign and Bank Default Risk and Tightening of Global Financial Conditions in Emerging Markets

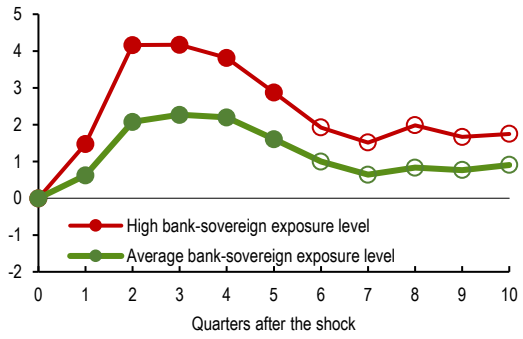
Sovereign default risk rises after global financial conditions tighten, especially in emerging markets with higher public debt…

1. Cumulative Change in Sovereign Default Risk Following a Global Financial Conditions Shock (Percentage points)



…and a higher sovereign exposure of banks.

2. Cumulative Change in Bank Default Risks Following a Global Financial Conditions Shock (Percentage points)



Sources: Haver Analytics; Moody's; Thomson Reuters Datastream; and IMF staff calculations.
Note: Panels 1 and 2 show results from local projection models, where the sovereign, banking, and corporate credit risks at quarterly frequency are regressed on lagged values of each other controlling for other domestic and external factors, including a global financial conditions index and its interaction with an indicator variable identifying countries with high public debt levels or high bank sovereign exposure levels (with high level vulnerability identified as values of public-debt-to-GDP or the ratio of banks' holdings of government debt to total banking sector assets that are one standard deviation above the sample average). Solid dots indicate statistical significance at 10 percent or lower.

Evidence about the Transmission Channels

25. To investigate the importance of the various transmission channels underlying the nexus in emerging markets, this section focuses mainly on the direct shock transmission from the sovereign sector to the banking and corporate sectors. While shocks originating from banks and firms may also be relevant, and may interact with a sovereign shock, shock transmission from the sovereign sector to the banking and corporate sectors appears to be more pertinent at this juncture given the elevated fiscal vulnerabilities in emerging markets that make the sovereign particularly prone to an adverse shock.[26]

Exposure Channel

26. As discussed, banks hold a substantial amount of public debt, including as a share of capital, exposing them to the risk of losses on these holdings. Weaker capital buffers, in turn, can affect banks' default risk and lending behavior. Empirical analysis performed over a large sample of emerging market banks using data for the last two decades confirms this intuition.[27] A sovereign distress event—defined as an explicit default or a period with sovereign credit default swap (CDS) spreads above 500 basis points—is followed within the same year by a significant increase in default risk for banks that have a greater sovereign exposure. For instance, in the event of sovereign distress, banks with a 10-percentage point

[25] For this exercise, a local projection panel regression model is estimated to exploit the cross-country variation in vulnerabilities using the same sample of countries and model specification as in Figure 2.9. High levels of public debt and bank sovereign exposure are defined as one standard deviation above the sample average (equivalent to about 80 percent and 20 percent, respectively, while the mean value is about 50 percent and 9 percent, respectively). See Online Annex 2.5 for further details.

[26] As multiple channels of the nexus could operate simultaneously, the analysis presented in the following sections is based on granular bank- and corporate-level data to better identify the effects of each individual channel. The results of these exercises, however, may not be strictly comparable and are subject to some degree of estimation uncertainty given that the sample composition varies across analyses, depending upon data availability.

[27] The sample here comprises 525 banks based in 18 emerging markets over 2000–2020. The median CDS spread in the sample is about 250 basis points. Banks' indirect exposure to changes in sovereign stress (such as through economic growth, inflation, or exchange rate) is considered in the analysis by including country-year fixed effects. Furthermore, to address potential reverse causality concerns that sovereign distress in itself may be driven by banking sector stress, alternative definitions of sovereign distress—such as high government refinancing needs during tight global financial market conditions, or large changes in foreign-currency-denominated public debt due to currency depreciation—are also considered for robustness. See Online Annex 2.6 for details.

higher ratio of government debt holdings to total bank assets (relative to average bank holdings of government debt) face an expected default frequency that is, on average, 0.4 percentage points higher (Figure 2.10, panel 1, green bar). Notably, this effect is about twice as large for banks with relatively less capital (Figure 2.10, panel 1, red bar),[28] and is accompanied by a decline in their equity-to-assets ratio (Figure 2.10, panel 2), presumably because more exposed banks face higher funding costs that affect their profits and equity.

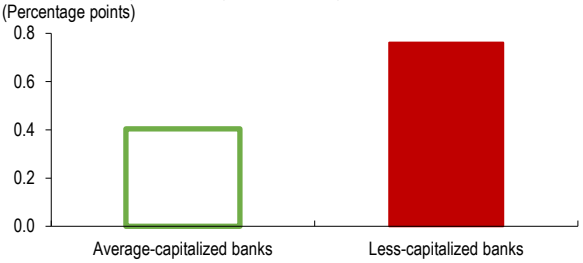
27. Banks with higher sovereign debt exposure also cut back on lending more than their peers following sovereign distress (Figure 2.10, panel 2). The reduction in lending is consistent with losses from sovereign debt exposures tightening banks' capital constraint and thus adversely affecting their lending posture, but it could also be due to possible crowding-out effects, where banks lend more to the government at the expense of firms and households. Indeed, empirical evidence supports this assertion because banks with an average capital-ratio that are more exposed further increase their holdings of government debt when the sovereign is in distress (Figure 2.10, panel 3).[29,30]

Figure 2.10. Transmission of Sovereign Risk through the Exposure Channel

Banks with greater sovereign debt holdings and weaker balance sheets experience a higher default risk following sovereign distress…

1. Change in Banks' Expected Default Frequency following Sovereign Distress for Banks with Higher Sovereign Bond Holdings

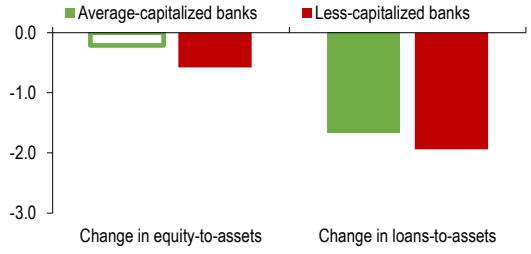
(Percentage points)



…as well as lower capital and lending to the private sector…

2. Change in Bank Capital and Lending following Sovereign Distress for Banks with Higher Sovereign Bond Holdings

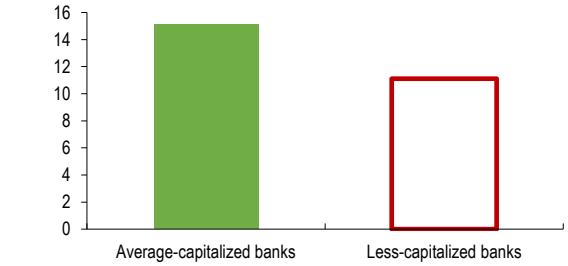
(Percentage points)



…and a further increase in banks' government bond holdings.

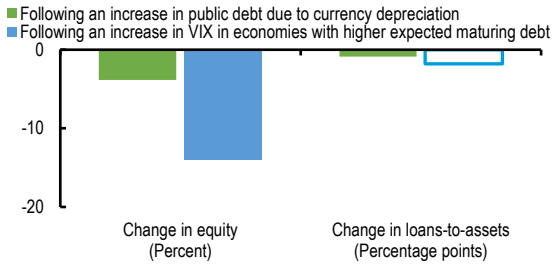
3. Change in Bank Government Debt Holdings following Sovereign Distress for Banks with Higher Sovereign Bond Holdings

(Percent)



Bank capital losses are significant following external shocks.

4. Change in Equity and Loans following Sovereign Distress after an Adverse External Shock



Sources: Bloomberg; Fitch Connect; IMF, World Economic Outlook database; and IMF staff calculations.

Note: Panels 1–4 report results from bank-level panel regressions. The dependent variable is the change in banks' expected default frequency (panel 1); change in equity-to-lagged total assets (panels 2 and 4, left); change in total loans-to-total-assets (panels 2 and 4, right); and log change in total government debt holdings (panel 3). Balance-sheet variables and expected default frequency are based on year-end data. The focus variable is the ratio of banks' holdings of government debt securities to total assets (sovereign exposure), interacted with sovereign distress (or an alternative measure of sovereign stress in panel 4) and the bank capital ratio (total-equities-to-total-assets ratio).The average effect refers to the impact of 10 percentage points higher bank sovereign exposure on the dependent variable for banks with an average capital ratio (which is close to a one-standard deviation in the sample). The impact of "less-capitalized" banks corresponds to banks' capital ratio one standard deviation below the mean. Sovereign distress indicates periods when the monthly average of sovereign credit default swap spread is higher than 500 basis points within a given year, or S&P long-term rating for sovereign foreign exchange debt is CCC- or lower, or the government is in external/domestic default according to the HBS Global Crises Data by Country. In panel 4, the valuation effect on public debt following a currency depreciation is computed by multiplying foreign-currency-denominated gross public debt in year $t-1$ with the change in the exchange rate from $t-1$ to t. The valuation effect is then normalized by total gross public debt in $t-1$. Solid bars indicate statistical significance at 10 percent or lower. See Online Annex 2.6 for further details. VIX = Chicago Board Options Exchange Volatility Index.

[28] These effects appear meaningfully large, as the average expected default frequency in the sample is 1.2 percentage points.

[29] Intuitively, banks may be forced into holding more sovereign debt, as sovereign refinancing needs are typically higher during sovereign distress. But banks may also extend less credit to the private sector during such episodes because of weak credit demand, which is captured by including country-year effects in the regression.

[30] The effects documented in Figure 2.10 (panels 2 and 3) are robust to defining the dependent variables as percentage changes in bank equity and lending, and the results are similar to those reported in the literature on the euro-zone sovereign debt crisis (Acharya and others 2018; Bofondi, Carpinelli, and Sette 2018).

28. The effects on default risk, bank lending, and capitalization tend to grow in magnitude as sovereign distress deepens, pointing to possible nonlinear effects. Thus, for example, the impact of sovereign distress on banks' equity is more than twice as large when sovereign spreads reach 1,000 basis points (Online Annex 2.6). The sovereign's holdings of international reserves act as a buffer, helping to dampen the severity of the shock. On average, domestic banks in countries with a higher stock of foreign exchange reserves relative to short-term external debt experience a significantly smaller decline in capital during episodes of intense sovereign stress than domestic banks in countries with less adequate reserves (Online Annex 2.6), possibly because of a smaller currency depreciation and more limited funding costs increases due to unhedged foreign debt.

29. The analysis also considers the impact of an increase in sovereign risk associated with a tightening in global financial conditions by focusing on two alternative definitions of sovereign distress. The first is a situation where sovereign debt rollover needs are high amid significant volatility in global financial markets. The second is an episode where public debt increases sharply following a currency depreciation. In most of these cases the impact on banks' equity and loans is significantly larger than cases where fiscal vulnerabilities remain low following the external shocks (Figure 2.10, panel 4). Overall, these findings confirm the relevance of the exposure channel in emerging markets and highlight that the nexus is amplified when fiscal, financial, and external vulnerabilities are high and external financial conditions deteriorate.

Safety Net Channel

30. Risks to the banking sector are also intertwined with sovereign risks through the explicit and implicit guarantees, or the safety net, provided by the sovereign to banks. To assess the transmission of shocks through this channel, the analysis relies on bank-level estimates of government support called support rating floors (SRFs)—developed by the Fitch rating agency—which isolate potential sovereign support for banks from other sources of external support.[31] On average, government support proxied through the SRFs is greater in emerging markets than in advanced economies, and it has generally increased since the global financial crisis (Figure 2.11, panel 1).[32]

31. The extent to which banks benefit from the public safety net varies across emerging markets and is importantly associated with bank-specific characteristics (Online Annex 2.7).[33] In general, there is a strong positive relationship between bank size and government support ratings, implying large implicit subsidies for banks that are "too big to fail." In addition, banks with higher SRFs tend to have lower capital ratios (Online Annex 2.7.4, panel 2)—pointing to potential moral hazard concerns—and a majority stake of the government.

32. This safety net provides some protection to banks and their performance in times of financial stress. However, when the sovereign itself is under stress, the perception of a weaker ability to support banks could undermine investor confidence and banks' performance. This indeed appears to be the case: the equity returns of emerging market banks in times of sovereign distress are higher for banks whose SRF is one notch higher than peers (Figure 2.11, panel 2), while in normal times there is no significant difference between the two groups.[34] However, the positive effect of higher implicit guarantees before sovereign distress declines over time, turning negative six months after the shock—potentially suggesting that the weakened sovereign strength eventually hurts the credibility of these guarantees. Accordingly,

[31] The indicator reflects Fitch rating agency's judgment of the propensity and ability of a government to provide support to a bank. Factors used to assess the support rating floor include the size and structure of banking system, sovereign financial flexibility, resolution legislation, support stance, bank systemic importance, bank liability structure, bank ownership, policy role, guarantees, and legal status. The key advantage of this indicator is that it does not incorporate other forms of external support, such as the institutional support of the entity's shareholders. The rating also does not reflect the intrinsic credit quality of the bank.

[32] The contrasting patterns between advanced economies and emerging markets may reflect different implementation stages of their regulatory reforms (for example, capital surcharges for global systemically important banks). The correlation between bank size and the support rating floor in advanced economies has indeed diverged from that in emerging markets and substantially receded since the end of 2015, just before the capital surcharges for global systemically important banks were phased in.

[33] The distribution of government support ratings spans a wide spectrum in emerging markets, ranging from high to no support, but has changed little since 2007 (see Online Annex 2.7).

[34] The sample for this analysis is comprised of 10 major emerging markets covering the period 2007–20. See Online Annex 2.7 for further details of the empirical analysis.

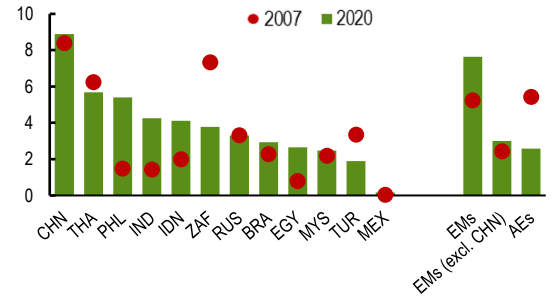
the negative effect on banks with high government support ratings starts sooner and is larger if the economy enters the distress event with a higher public debt burden (Figure 11, panel 2; red line).

33. The strength of sovereign support also matters for the ability of banks to lend following a sovereign distress event. Banks with higher government support ratings experience lower credit growth, particularly after three years (Figure 2.11, panel 3, green line), which is in line with the negative impact on bank stock returns observed after the sovereign distress event. Furthermore, banks with a higher SRF but lower capital expand their loan portfolios more aggressively, with cumulative credit growth about 8 percentage points higher than other banks two years after the distress event (Figure 2.11, panel 3). This increase in lending goes hand-in-hand with a worsening of bank credit quality, suggesting greater risk-taking by these banks. For example, although nonperforming loans do not seem to depend much on the level of the government support rating on average, banks with both a lower capital ratio and a higher support rating experience a significant jump in nonperforming loans in the medium term (Figure 2.11, panel 4).

Figure 2.11. The Banking Sector Safety Net in Emerging Market Economies

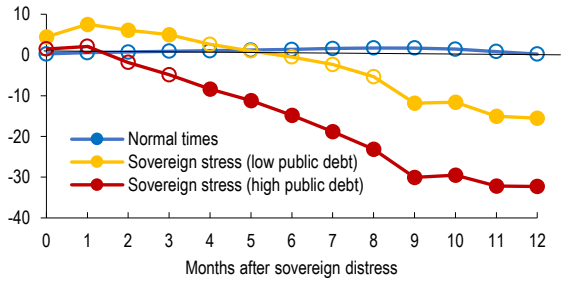
Government implicit guarantees to the banking sector have increased since the global financial crisis.

1. Average Bank Government Support Ratings across Emerging Markets
(Support rating floor on a numerical scale from 0 to 17)



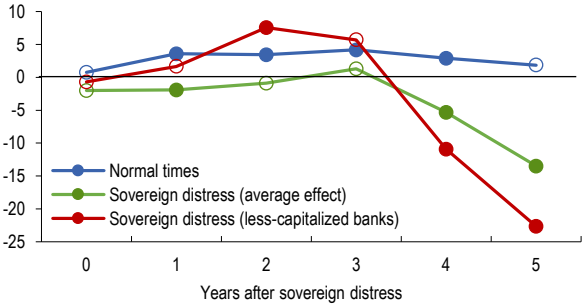
Government guarantees support banks after sovereign distress, but not so much in countries with high public debt.

2. Cumulative Abnormal Returns of Banks with a One-Notch-Higher Government Support Rating in Countries with Different Public Debt Levels
(Percentage points)



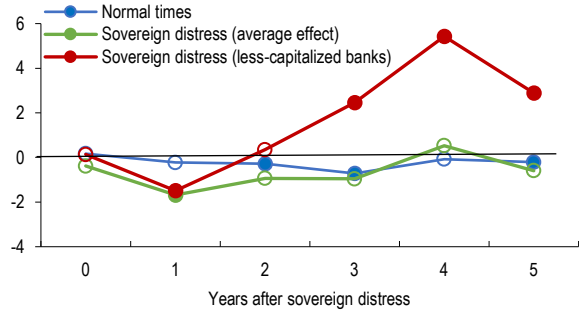
Undercapitalized banks with implicit guarantees increase credit growth following sovereign distress…

3. Cumulative Bank Credit Growth with a One-Notch-Higher Government Support Rating across Banks with Different Capital Buffers
(Percentage points)



…leading to higher levels of nonperforming loans, suggesting increased risk-taking.

4. Cumulative Change in Bank Nonperforming Loan Ratio with a One-Notch-Higher Government Support Rating across Banks with Different Capital Buffers
(Percentage points)



Sources: Fitch; and IMF staff calculations.
Note: Panel 1 shows the weighted average of Fitch support rating floor in major emerging markets, where weights correspond to banks' total assets in US dollars. The support rating floor ranges from AAA to NF and is converted to a numeral scale of 1–17 (higher values correspond to a higher rating or higher likelihood of receiving government support during distress). Panel 2 shows the capital asset pricing model-based cumulative abnormal returns associated with a one-notch- higher support rating floor after sovereign distress using a local projection methodology. Sovereign distress indicates the months with average sovereign credit default swap spreads higher than 500 basis points, or S&P long-term rating for sovereign foreign exchange debt is CCC- or lower, or months when external/domestic debt defaults occurred. Estimated abnormal returns are shown for economies with a sovereign-debt-to-GDP ratio greater than 60 percent ("high public debt") or lower than 60 percent ("low public debt"). Panel 3 shows cumulative bank credit growth associated with one-notch-higher support rating floor up to five years after the sovereign distress or during normal times. The green line shows the impact after the sovereign distress for banks with an average equity-to-capital ratio, while the red line shows the cumulative impact following the same sovereign distress but for banks with an equity-to-capital ratio that is one standard deviation below average. Panel 4 shows results for a similar analysis where the dependent variable is the cumulative increase in the bank nonperforming-loan-to-assets ratio. In panels 1-4, the analysis is based on the sample of firms with available support rating floor information. Solid dots indicate statistical significance at 10 percent or lower. Country labels use International Organization for Standardization (ISO) country codes. AEs = advanced economies; EMs = emerging markets.

Macroeconomic Channel

34. Empirically analyzing the macroeconomic channel—that is, the interconnectedness of sovereigns and banks through the real economy—is particularly challenging because of difficulties in isolating shocks to different sectors (Dell'Ariccia and others 2018).[35] For simplicity, the following analysis focuses on one component of this channel: the transmission of risk from the sovereign to corporate sector.

35. A possible empirical strategy to identify the effect of a rise in sovereign risk on firms is to exploit the uneven effect of sovereign downgrades on firms with different credit ratings. While downgrades of firms and sovereigns may both be driven by a deterioration in economic fundamentals, sovereign downgrades are more likely to cause the downgrades of highly rated firms because of rating agencies' ceiling policies. These policies often require that firms' ratings remain at or below the sovereign rating of their country of domicile.[36] This approach allows the analysis in turn to isolate the direct effect of a sovereign downgrade on firms by comparing the performance of firms subject to ceiling policies ("bound firms"—that is, those with a rating equal or above to that of the sovereign) to that of firms not subject to these policies ("unbound firms"—that is, those with a lower rating than the sovereign) under the assumption that both groups of firms are equally affected by the change in fundamentals.[37]

36. The data confirm that the ratings of bound firms are more affected by sovereign downgrades than the ratings of unbound firms (Figure 2.12, panel 1).[38] A formal analysis of the two groups of firms following a sovereign downgrade shows that a bound corporate's cumulative investment drops by nearly 17 percentage points more than an unbound corporate's cumulative investment (controlling for corporate characteristics) two years after a sovereign downgrade (Figure 2.12, panel 2). Furthermore, the effect on investment is significantly larger if the sovereign downgrade is accompanied by higher sovereign stress, proxied by sovereign CDS spreads greater than 500 basis points (Figure 2.12, panel 3). Overall, these results are consistent with the hypothesis that firms face tighter funding constraints when directly affected by a sovereign downgrade.

37. The negative effects of sovereign stress on firms' borrowing costs and activity may weaken the soundness of their balance sheets. Consequently, banks' loan portfolio quality may be adversely affected, possibly leading them to curtail lending. This would further reduce consumption and investment in the domestic economy, with a consequent drop in aggregate demand and decline in the health of the corporate sector. Hence, disruptions in financial intermediation could act as an amplifier and exacerbate the damage to economic activity following a sovereign downgrade. Empirical evidence supports this intuition: following a sovereign downgrade, banks' nonperforming loans increase more in economies where bound firms play a larger role in the corporate sector, as determined by the share of their assets in total economy-wide corporate assets (Figure 2.12, panel 4).[39]

[35] For example, sovereign and corporate riskiness may be influenced by common factors such as a decline in economic activity.

[36] These policies are set after taking into account the risk of capital and foreign exchange controls, which could hamper a corporate's ability to service its debt. A similar empirical strategy is used in Almeida, Fos, and Kronlund (2016).

[37] It is worth noting that unbound corporates are by definition corporates with lower credit quality than bound corporates. Thus, a key advantage of this empirical approach is that alternative explanations based on changes in fundamentals and credit risk are unlikely to explain the differential impact on firms' performance around the sovereign ceiling.

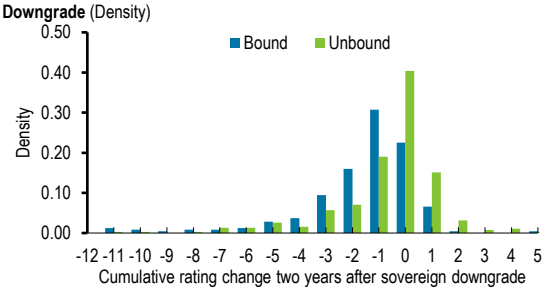
[38] The sample is comprised of 100 sovereign debt downgrades in 29 countries during 1998–2020. For each country, years with banking crises in which the country was downgraded are excluded in order to better isolate the direct real effect of sovereign downgrades (Almeida, Fos, and Kronlund 2016). See Online Annex 2.8 for further estimation details.

[39] These findings are based on a country-level difference-in-differences regression, where banking sector nonperforming loans across countries are regressed on the share of bound firms' assets relative to total assets of the nonfinancial corporate sector, and other control variables (see Online Annex 2.8). The results indicate that a one standard deviation higher value of this share is associated with a 1 percentage point greater change in nonperforming loans two years after the sovereign downgrade. However, these findings are only suggestive—a more direct analysis linking banks' lending behavior to their exposure to bound firms is difficult due to a lack of available data.

Figure 2.12. The Effects of Sovereign Downgrades on Firms

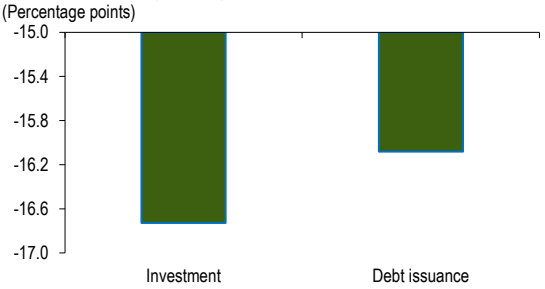
The ratings of bound firms have a higher probability of being downgraded after a sovereign downgrade…

1. Distribution of the Change in Firms' Ratings following a Sovereign Downgrade (Density)



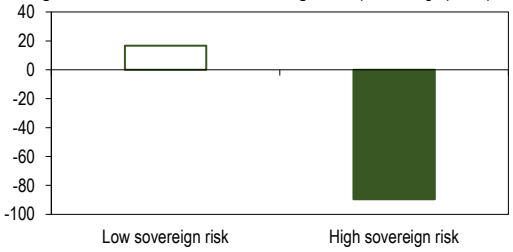
…and bound firms reduce their investment and debt issuance more than unbound firms.

2. Effect of a Sovereign Downgrade on Investment and Debt Issuance (Percentage points)



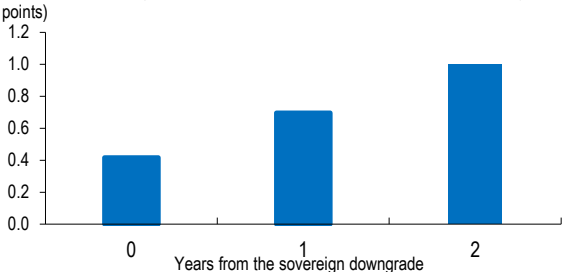
The impact is larger when the downgrade is accompanied by sovereign distress…

3. Effect of a Sovereign Downgrade on Investment following a Sovereign Downgrade at Different Levels of Sovereign Risk (Percentage points)



…and leads to spillover effects on banks' asset quality.

4. Change in the Nonperforming Loan Ratio after a Sovereign Downgrade in Countries with a Higher Share of Bound Firms in the Corporate Sector (Percentage points)



Sources: Capital IQ; Haver Analytics; and IMF staff estimates.
Note: Panel 1 shows the distribution of the change in corporate ratings between the period before the sovereign downgrade and two years after the downgrade for "bound" and "unbound" firms. "Bound" firms are those with a rating equal to or above their sovereign before the downgrade. Panel 2 reports the estimates based on a difference-in-differences model comparing changes in the outcome variable between bound and unbound firms around the sovereign downgrade, where the considered outcome variables are the changes in the corporate's investment ratio and debt issuance between the period before the sovereign downgrade and two years later. The investment ratio is equal to the ratio of capital expenditure to lagged capital stock. Debt issuance is proxied by changes in the net-debt-issuance-to-asset ratio. Panel 3 shows the marginal effect of a sovereign downgrade on bound firms for different levels of sovereign risk. Low sovereign risk refers to periods with a sovereign credit default swap (CDS) spread between 250 and 500 basis points. High sovereign risk refers to periods with a sovereign CDS spread greater than 500 basis points. Panel 4 shows the cumulative effect of a one standard deviation larger share of assets of bound firms in economy-wide corporate assets on the change in banking sector nonperforming loans ratio after two years of the sovereign downgrade. Estimates are based on a country-level difference-in-differences model. Solid bars indicate statistical significance at 10 percent or lower. See Online Annex 2.8 for further details of the empirical analysis.

Conclusion and Policy Recommendations

38. The sovereign-bank nexus has intensified in emerging markets, as banks' exposure to domestic sovereign debt has increased to all-time highs. With public debt also at historically high levels, and with the sovereign credit outlook deteriorating in many emerging markets, there is an increased likelihood that a negative shock to the sovereign balance sheet may trigger an adverse feedback loop between sovereigns and banks that could threaten macro-financial stability. The analysis in this chapter shows that such a loop could occur through multiple channels, including by affecting corporate sector activity, and would be stronger in countries with higher fiscal vulnerabilities and less-well-capitalized banking systems.

39. Emerging markets thus face complex policy trade-offs amid a tightening of global financial conditions on the back of monetary policy normalization in advanced economies as well as heightened economic and geopolitical uncertainty. Growth prospects are weak in several emerging markets, while policy space to support the economy is limited and borrowing constraints have tightened as foreign investor interest in local-currency sovereign bond markets has dwindled and yields have risen. Policymakers also need to remain vigilant to any emerging signs of vulnerabilities in the banking sector and ensure banking sector stability in the event of deteriorating credit quality.

40. Given the strength and multifaceted nature of the sovereign-bank nexus, policy action is required on multiple fronts. Importantly, given the heterogeneity of countries with respect to fiscal and financial vulnerabilities, policy must be tailored to country-specific circumstances. In general, countries with stronger fiscal positions and a sound banking system will be better placed to manage tighter financial conditions. But they should seek to extend maturities of public debt where feasible and avoid a further buildup of currency mismatches to limit balance sheet vulnerabilities (see the January 2022 *World*

Economic Outlook Update). In countries with limited fiscal space and tight borrowing constraints, it is imperative to (1) improve the efficiency and targeting of fiscal spending to support recovery and (2) embed fiscal policy in credible and sustainable medium-term fiscal plans to mitigate the impact of an adverse shock (see the April 2022 *Fiscal Monitor*). Some emerging markets—especially those with larger maturing debt or higher exposure to exchange rate volatility—may need to adjust faster to preserve market confidence and prevent a further intensification of the sovereign-bank nexus.

41. Policymakers should also seek to develop robust resolution frameworks for sovereign debt to facilitate orderly deleveraging and restructuring if needed (IMF 2020a). As domestic debt restructurings may become more frequent in the future following the increase in the share of domestic debt in total public debt in emerging markets, a sovereign considering such restructuring should anticipate, minimize, and manage its impact on the financial system and broader economy (IMF 2021).

42. On the financial sector front, banks' resources should be preserved to absorb potential losses by limiting capital distribution in cases where bank profitability is difficult to assess because of regulatory flexibility. Fully assessing banking sector health remains difficult in many countries due to regulatory flexibility and forbearance. As a result, asset quality reviews may be necessary to quantify hidden losses and identify weak banks once forbearance has ceased. The results from these reviews may guide supervisory actions requiring more robust levels and quality of bank capital, which could be phased in over time in a pre-announced manner to minimize procyclical effects. This is especially pertinent for countries with weak growth prospects and high corporate insolvency risks that could adversely affect financial stability should banks ultimately need to recognize loan losses. Moreover, in emerging markets with inadequate frameworks to deal with corporate bankruptcies, private debt resolution frameworks should be strengthened to prepare for the eventual withdrawal of policy support measures and minimize risks to macro-financial stability.[40]

43. Risk to banks from sovereign exposure can materialize not just in emerging markets but also in more advanced economies, as was the case in Europe following the global financial crisis. Hence, improving transparency and data quality of banks' holdings of government debt to assess risks arising from possible sovereign distress should be a global priority. While current international standards stop short at "encouraging" banks to disclose data on sovereign exposures by jurisdiction, currency denomination, and account classification (BCBS 2021), market discipline will work meaningfully only of this becomes a necessary requirement for all banks. Furthermore, banks could be required to cover the risks of significant sovereign exposures in their stress tests by taking into account the multiple channels of the nexus.[41]

44. Once the economic recovery has taken hold and pandemic-related financial sector support measures have been normalized, both advanced and emerging market economies could consider introducing measures aimed at reducing incentives to hold excessive sovereign debt.[42,43] In this regard, several reform options have been discussed internationally in the aftermath of the global financial crisis, including the establishment of non-zero, risk-sensitive capital requirements (BCBS 2017). So far, however, no consensus has been reached to make any changes to the regulatory capital treatment of risks from sovereign exposures, although the Basel Committee has committed to, and should, continue to pursue this objective expeditiously. An alternative approach could be strict concentration limits, but these are likely to generate negative effects because banks need to hold sovereign bonds for liquidity management. Capital surcharges on bank holdings of domestic sovereign bonds above certain thresholds are more flexible and can target concentration risk if appropriately calibrated. The setting of such a

[40] Liu, Gorrido, and DeLong (2020) discuss in detail the key measures needed for effective private sector debt resolution.

[41] See Jobst and Oura (2019) for recent approaches to stress testing sovereign exposures.

[42] Sovereign debt exposures might become excessive when banks are not fully pricing the risks associated with them, expecting to be bailed out in the event of sovereign distress (Dell'Ariccia and others 2018; Farhi and Tirole 2014). Furthermore, the expectation of intervention might lead to correlated risk exposures across banks as banks expect public support to be more likely in a systemic bank crisis.

[43] In the current regulatory framework, sovereign exposures are treated more favorably than other asset classes, encouraging banks to hold sovereign bonds. The Basel Committee's standardized approach to credit risk provides a regulatory exemption that allows banks to apply zero risk weights on local-currency government bonds regardless of sovereign risk. Other aspects of the regulatory framework, such as the liquidity standards, also favor the holding of sovereign debt.

surcharge should consider the liquidity needs and availability of other liquid assets in domestic currency, along with the perceived risk from excessive concentration.[44]

45. Strengthening banking crisis management frameworks could reduce the need for government guarantees and minimize the costs of resolution to the government, including through the recovery of public funds from the industry. Some emerging markets have made much progress in this regard (Botes and others 2021). Given the economic uncertainty and the eventual unwinding of financial sector measures that have supported bank balance sheets through the pandemic, it is important to act to strengthen the financial safety net, including through deposit guarantee programs, resolution regimes, and central bank liquidity facilities. Preparing contingency plans that detail how the authorities will respond to possible future pressures is critical to support effective policy responses should an adverse scenario materialize (IMF 2020b).

46. Effective governance, regulation, and supervision are necessary to ensure that public banks are safe and sound while achieving their public policy objectives (IMF, forthcoming). Mitigating the risks to financial stability posed by public banks requires closing existing prudential gaps. Deposit-taking public banks directly competing with private banks should be subject to the same expectations and requirements of governance, disclosure, regulation, and supervision as private banks. A key element of the reform agenda should be to promote mechanisms so that arm's length distance can be created between the government as the owner and the management of the bank, which can then run the bank on as much a commercial basis as possible. The government's role as an informed owner should also be separated from the supervisory authority's prudential supervision role.

47. Given that a lack of investor diversity can induce volatility in sovereign debt markets amid sudden changes in risk appetite, policymakers should aim to promote a deep and diversified investor base to strengthen market resilience in countries with underdeveloped local-currency bond markets (IMF 2021). While domestic banks usually play a major role in emerging markets and developing countries both as investors in government bonds and as intermediaries for government bond trading, a highly concentrated banking sector can undermine banks' incentives to trade and impede market liquidity.[45] A developed investor base should thus include a diverse range of bank and nonbank participants with different investment horizons and risk-return preferences, particularly institutional investors, to allow the government to spread risk in its debt portfolio and extend the yield curve.[46] This would also help to mitigate the excessive exposure of banks to the sovereign and weaken the sovereign-bank nexus.

[44] The IMF's Financial Sector Assessment Program for Romania provides an example of systemic risk buffer calibration that aims to ensure resilience of banks with concentrated exposures, while minimizing potential adverse impacts (IMF 2018). The framework applies a marginal scheme, with systemic risk buffer surcharges rising with the ratio of sovereign exposures to risk-weighted assets.

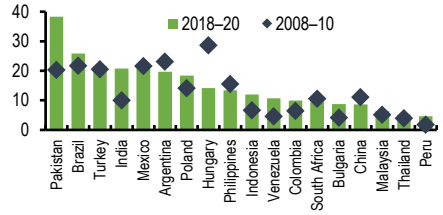
[45] Banks tend to trade securities for liquidity management purposes, which helps bolster secondary market activity. A highly concentrated banking sector can restrict market liquidity in countries with smaller financial systems.

[46] Nonbank investors bring different risk-return preferences and investment horizons to the government bond market compared to banks. For example, pension funds and insurance companies generally prefer longer-dated assets to match their longer-term liabilities, largely determining the ability of the government to issue longer-dated securities and thereby facilitating the extension of the yield curve. See IMF (2021) for detailed guidance on diversifying the investor base and developing local-currency bond markets in emerging market and developing economies.

Box 2.1. The Drivers of Banks' Sovereign Debt Exposure in Emerging Markets

Bank holdings of sovereign debt vary significantly across emerging markets, ranging from about 5 percent of banking sector assets (for example, in Chile and Peru) to more than 25 percent (for example, in Brazil and Pakistan) (Figure 2.1.1). In general, the exposure of emerging market banks to sovereign debt has risen since the global financial crisis, most notably in Pakistan, India, and Indonesia.

Figure 2.1.1. Bank Holdings of Sovereign Debt
(Percent of total bank assets)



Sources: Fitch Connect; IMF, Monetary and Financial Statistics database; and IMF staff calculations.
Note: Given limited country-level data availability, banks' sovereign debt exposures for India and Argentina are computed using bank-level Fitch Connect data.

Why do banks hold government debt? Several factors may be at play, including liquidity management, expected returns, and limited alternative investment opportunities (Dell'Ariccia and others, 2018). Sovereign debt offers a relatively liquid and safe asset status that may be particularly attractive in countries with weaker institutions and enforcement of creditor rights that could lower incentives for banks to lend to the private sector (Holmstrom and Tirole, 1998). Banks may serve as market makers in government bond markets, while their government bond holdings also serve as collateral for securing funding from the central bank. The regulatory treatment of sovereign exposures—which allows banks to apply zero risk weights on local-currency domestic government bonds—also makes them attractive for banks to hold. Moral suasion and risk-shifting are two other potential reasons. Moral suasion refers to government pressure on banks to purchase public debt, while risk-shifting can occur during times of sovereign distress whereby banks increase their sovereign debt exposure to take advantage of higher sovereign yields.[1]

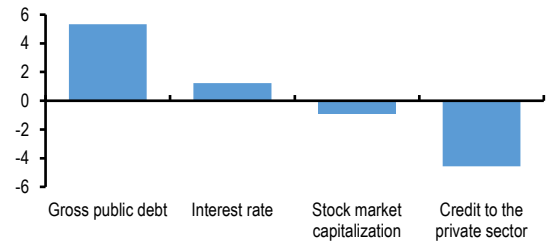
For emerging markets, empirical analysis using country-level data shows that several of the above-mentioned factors are relevant (Figure 2.1.2, panel 1).[2] For example, banks tend to hold more government debt when interest rates are high and the sovereign is more indebted (alluding perhaps to moral suasion or risk-shifting motives), and when there are fewer opportunities to lend to the private sector, as indicated by a higher stock-market-capitalization-to-GDP ratio, as well as a lower private-sector-credit-to-GDP ratio.

Further analysis using bank-level data shows that moral suasion and risk-shifting motives are indeed important in emerging markets. Domestic state-owned banks, generally dominant in emerging markets and potentially more likely to be induced to hold government debt (Ongena, Popov, and Van Horen, 2019),[3] significantly increase their purchase of sovereign debt in times of high fiscal need or when the sovereign is in distress (Figure 2.1.2, panel 2).[4] However, there is no such evidence of government pressure on private banks (Online Annex 2.4). Moreover, less-capitalized state-owned banks are more likely to purchase sovereign debt during periods of sovereign distress (Figure 2.1.2, panel 2). While this pattern is suggestive of the presence of the moral suasion motive, there may also be a possible risk-shifting strategy by these banks, whereby they are more willing to take on additional risk and improve their capital positions by purchasing high-yield debt (Acharya and others 2018).

Figure 2.1.2. Drivers of Bank Holdings of Sovereign Debt in Emerging Markets

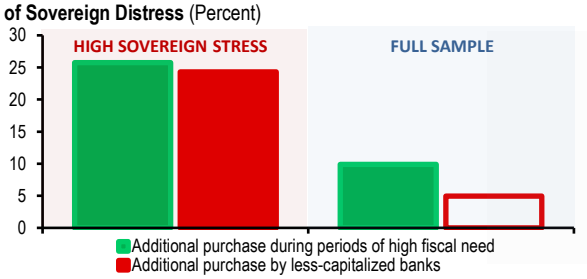
Banks hold more sovereign debt in more indebted and less financially developed economies.

1. Drivers of Bank Holdings of Sovereign Debt (Percentage points)



State-owned banks are subject to moral suasion and engage in risk-shifting.

2. State-Owned Banks: Net Purchase of Sovereign Bonds during Periods of Sovereign Distress (Percent)



Sources: Bloomberg; Fitch Connect; IMF, Monetary and Financial Statistics and World Economic Outlook databases; and IMF staff calculations.
Note: Panel 1 presents results obtained from a cross-country regression for a sample of 21 emerging markets over 2000–20. Aggregate banks' government debt holdings are compiuted from Fitch Connect, if data from Monetary and Financial Statistics are limited The dependent variable is banks' holdings of sovereign debt to total banking sector assets. The bars show the effect of a one standard deviation increase in the value of the regressors on changes in banks' holdings (in percentage points). Panel 2 presents regression results from a bank-level cross-country regression over 2011–20. The dependent variable is banks' net purchases of sovereign debt. (See Online Annex 2.4 for the model and estimation details.) Moral suasion is defined as the additional purchase of sovereign debt by state-owned banks in times of "high fiscal need": that is, the years when the total amount of new debt auctioned by the sovereign (proxied by maturing debt as a share of lagged gross debt) is above the 75th percentile in the sample. Risk-shifting is defined as the additional purchases of sovereign debt by less-capitalized state-owned banks, where less-capitalized refers to the equity-to-assets ratio being one stadard deviation below the mean, which is about 7 percentage points. Solid bars indicate statistical significance at 10 percent or lower.

[1] The flip side of this is that during sovereign distress, domestic banks could incur huge losses that wipe out their capital, leading to a banking crisis.

[2] See Online Annex 2.4 for a detailed description of the model, estimation method, and data used for this analysis.

[3] Domestic state-owned banks tend to be generally dominant in emerging markets. On average, such banks held about 30 percent of total banking sector assets in major emerging markets in 2020, but this ratio exceeded 40 percent in some countries.

[4] High fiscal need is defined as years when maturing sovereign debt (to lagged total debt) is in the top 75th percentile of the distribution, indicating that more new public debt is likely to be issued. Sovereign distress is defined as cases when the sovereign credit default spread exceeds 500 basis points, or the S&P long-term rating for sovereign foreign-currency debt is CCC- or lower, or when the sovereign is in external or domestic default.

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CHAPTER 3

GLOBAL FINANCIAL STABILITY REPORT

The Rapid Growth of Fintech: Vulnerabilities and Challenges for Financial Stability

Chapter 3 at a Glance

- Fintech—technological innovation in financial activities—can reduce costs and frictions, increase efficiency and competition, and broaden access to financial services.
- This chapter focuses on vulnerabilities and financial stability implications of the rapid growth of fintech firms ("fintechs"), accelerated by the COVID-19 pandemic. Their fast growth into risky business segments, combined with inadequate regulation, gives rise to systemic risks and potential financial stability implications.
- Digital banks ("neobanks") are growing in systemic importance in their local markets. A case study on neobanks unveils several vulnerabilities: (1) higher risk-taking in retail loan originations without appropriate provisioning and under-pricing of credit risk; (2) higher risk-taking in the securities portfolio; and (3) an inadequate liquidity management framework.
- Fintech firms not only take on risks themselves but also exert pressure on incumbents. The case study of the US mortgage market presents evidence of a significant negative impact of competitive pressure from fintechs on the income of traditional banks.
- By taking innovation to a new level, a form of financial intermediation based on crypto assets known as decentralized finance (DeFi) has had extraordinary growth in the past two years, potentially offering higher efficiency and investment opportunities. DeFi is increasingly interconnected with traditional financial intermediaries. While its market size is still relatively small, unregulated DeFi poses market, liquidity and cyber risks, against a backdrop of legal uncertainties.
- Policies that target both fintech firms and incumbents proportionately are needed. For neobanks, more robust capital, liquidity, and operational risk-management requirements (at the entity and group level) commensurate with their risks are desirable. For incumbents, prudential supervision may need greater focus on the health of less technologically advanced banks, as their existing business models may be less sustainable in the long term.
- The absence of centralized entities governing DeFi is a challenge for effective regulation and supervision. Regulation should focus on elements of the crypto ecosystem that enable DeFi, such as stablecoin issuers and centralized exchanges. Authorities should also encourage DeFi platforms to be subject to robust governance schemes, including industry codes and self-regulatory organizations. These entities could provide an effective conduit for regulatory oversight.

Introduction

1. Technological change has been reshaping banking services for years, but ground-breaking innovation and widespread adoption have accelerated this process globally. Fintech—technological innovation in financial activities—is increasingly disrupting core financial services traditionally provided by banks and has gained even more momentum during the COVID-19 pandemic (Figure 3.1, panel 1). At the frontier of technological advancement is decentralized finance (DeFi). DeFi is crypto market-based financial intermediation where all financial transactions are performed on a computer network without a central intermediary. DeFi has been growing rapidly, in tandem with the expansion of the crypto ecosystem (Figure 3.1, panel 2).

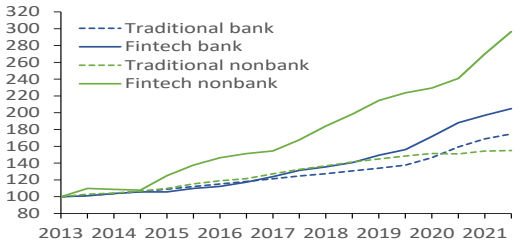
2. Fintech firms herald efficiency gains, progress in financial inclusion, and better customer experience (IMF 2018). Fintech firms (hereafter referred to as fintechs) hold the promise of reducing costs and frictions related to informational asymmetry, increasing efficiency and competition, and broadening access to financial services, especially in low-income countries and for underserved populations. Users of fintech financial services more generally benefit from a better experience through online access to financial services on any device at any time. Taking financial innovation a step further, DeFi has experienced a substantial growth in the last two years, and has the potential to offer even more innovative, inclusive, and transparent financial services due to greater efficiency and accessibility.

3. The speed, reach and profoundness of these changes give rise to systemic risks and pose challenges for financial stability. Fintechs are quickly making inroads into a wide range of critical financial services—sometimes aided by favorable regulatory treatment for specialized financial services. While some individual fintechs are still small, they have the ability to scale up very rapidly—often across both riskier business segments and riskier clients than traditional lenders. The combination of fast growth and the increasing importance of fintech financial services for the functioning of financial intermediation gives rise to systemic risks. The speed and depth of such changes further pose challenges for traditional intermediaries.

Figure 3.1 The Rise of Fintech Firms and Decentralized Finance

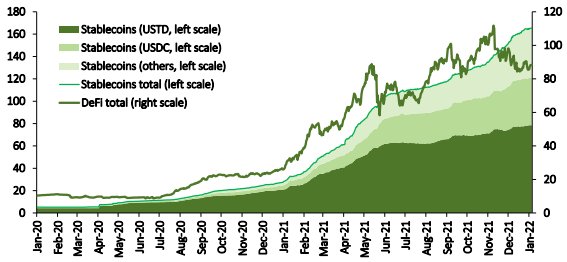
The growth of fintechs has accelerated in recent years…

1. Growth of Assets of Fintech Lenders
(2013:H1=100)



... as has the rise of assets in decentralized finance, driving growth in stablecoins.

2. Total Nominal Value of Assets in Decentralized Finance and Stablecoins
(Billions of US dollars)



Sources: SNL Financial, S&P Capital IQ, and IMF staff calculations.

Note: In panel 1, the sample is comprised of 13 advanced economies and 7 emerging market economies. In panel 2, total nominal value of DeFi is the total value of all DeFi projects—all deposits and governance tokens held in the platform. A stablecoin is a type of crypto asset that aims to maintain a stable value relative to a specified asset or a pool of assets. USDC = USD Coin; USTD =Tether.

4. Additionally, DeFi often involves the building up of leverage, and is particularly vulnerable to market, liquidity, and cyber risks as discussed in this chapter. While DeFi activities are so far mainly taking place in crypto asset markets, they can increase the interconnectedness among crypto investors. With the rapidly increasing adoption of DeFi by institutional investors, the linkages with traditional financial institutions are growing. DeFi may also accelerate the ongoing trend for cryptoization in some economies (see Chapter 2 of the October 2021 GFSR).

5. As financial services move from regulated banks to less, or even unregulated, entities and platforms, as in the case in DeFi, so do the associated risks. This poses challenges for financial authorities in the form of regulatory arbitrage, interconnectedness, and contagion that they require supervisory and regulatory action, including better consumer and investor protection.

6. This chapter takes a deep dive into the vulnerabilities and financial stability implications of the rapid growth of fintech. It focuses on fintechs and fintech platforms (DeFi) that provide core banking services: deposit-taking and credit intermediation. While fintechs have made inroads into a broad range of financial services, deposit-taking and credit intermediation are central to both the functioning of an economy and to financial stability.[1] The chapter first lays out a conceptual framework for the different types of services provided by fintechs. Then it presents two case studies where fintechs are in competition with traditional banks: (1) digital banks (referred to as “neobanks”) in both advanced economies and emerging economies; and (2) the US mortgage origination market. The second half of the chapter focuses on lending services in the novel DeFi ecosystem, with a focus on its opportunities and risks. The chapter concludes with some policy recommendations.

Fintechs in Banking: Conceptual Framework and Risks

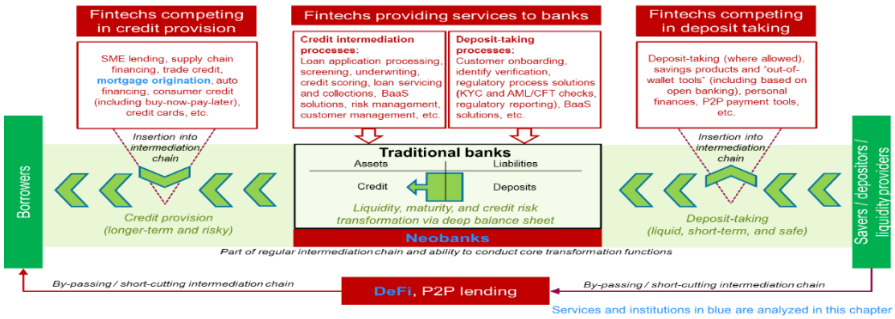
7. The core business model of banks is to both collect deposits and extend credit. In doing so, they fulfill the key economic function of financial intermediaries: the transformation of deposits (savings) into credit (investments), which entails liquidity, maturity, and credit risk transformation.

8. Fintechs insert themselves at various points along the financial intermediation chain, usually by providing specialized services (Figure 3.2). In doing so, fintechs can quickly develop innovative solutions that can offer efficiency gains or better customer experience. The increased competition traditional banks face from fintechs is generally beneficial from an economic point of view. Some fintechs might fall outside traditional banking regulations, as most jurisdictions allow for more lenient regulatory requirements, or can even be unregulated to some extent, such as DeFi. The way in which fintechs insert themselves in the financial intermediation chain therefore has different implications for financial stability risks:

[1] Fintechs have made inroads into many other financial services, including payments, asset management, insurance or crypto assets (Drakopoulos and others 2021), which are beyond the scope of this chapter. On the issue of data privacy concerns raised by technological developments in finance and the rise of large technological firms (Big Techs), the reader is referred to Haksar and others (2021).

Figure 3.2 Fintechs in the Core Banking Intermediation Chain

Fintech insert themselves into the financial intermediation chain or circumvent it in the case of DeFi.



Source: IMF staff.

Note: AMF/CLT = anti-money-laundering/combatting the financing of terrorism; BaaS = Banking as a Service; KYC = Know Your Customer; P2P = peer to peer; SME = small and medium-sized enterprises.

- The most common approach consists of banks cooperating with fintechs by using their services or through mergers and acquisitions (M&A). While banks have been increasing IT-related expenditure,[2] using or acquiring the services of fintechs can be an effective means of technology adoption. Likewise, fintechs have been acquiring and using the services of banks. However, the use of third-party services presents challenges if they are an integral part of risk management, compliance, or fulfilling regulatory requirements, such as Know-Your-Customer (KYC) or Anti-Money Laundering/Combating the Financing of Terrorism (AML/CFT). If a large number of banks rely on the same service providers, outages or cyber incidents could give rise to systemic risks.

- A more notable form of disruption arises from direct competition for the same services. Direct competition is more likely in jurisdictions where banks are less prevalent and in consumer-facing services (Boot and others 2021). In core banking services, some of the largest fintechs have grown very quickly in emerging markets, such as Mercado Libre in Latin America, which offers a range of services, including credit to small and medium enterprises (SMEs). Direct competition in customer-facing services is lucrative for fintechs, as typically higher margins can be earned relative to business-to-business services.

- When fintechs provide bank-like services but operate under less stringent regulations than banks, financial stability risks can arise. The business model of fintechs relies on rapid growth, which—in the absence of appropriate regulations—can lead to excessive risk taking, including by banks trying to defend their market position (see the case study on the US mortgage market). This can lead to capital erosion and higher systemic risks (Vives 2019).

- An important, special case of direct competition with banks is that of digital banks. They are often—but not always—fully licensed banks that compete with traditional banks across a

[2] The largest US global bank is planning to invest $US12 billion in development of technological solutions (JPMorgan plots "astonishing" $12bn tech spend to beat fintechs, *Financial Times*, January 15, 2022).

broad range of core banking services and tend to follow a technology-driven business model with some inherent risks, as documented in the next section's case study.

- The most radical and disruptive approach is for fintechs to *short-cut* the intermediation chain to remove the financial intermediary altogether. Peer-to-peer (P2P) lending platforms, for instance, directly connect savers/investors and borrowers. In this case, investors commit their funds for a given time horizon and effectively assume credit and liquidity risks. In DeFi, liquidity providers—depositors—are exposed to DeFi platforms' run risk, while borrowers provide large amounts of collateral to eliminate credit risks (see DeFi section later in this chapter).

Case Study: Neobanks

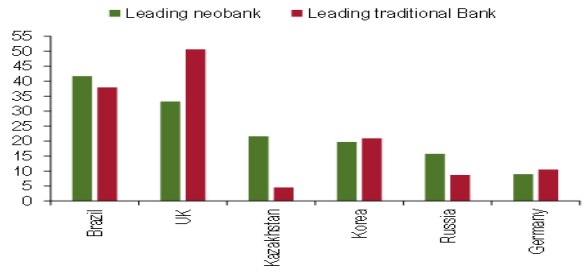
9. Digital banks or *neobanks* are direct—branchless—banks that acquire and serve customers primarily through digital touchpoints such as mobile apps.[3] They aim to distinguish themselves from traditional banks through digital technologies, such as cloud computing, application programming interfaces (APIs), big data, and artificial intelligence (AI), making banking services available on any device at any time. Neobanks tend to target financially underserved clients.

10. Neobanks are growing in systemic importance in their respective local markets. They have reached market capitalizations that are nearly as large as some of the largest traditional banks (Figure 3.3, panel 1). Despite their currently relatively modest balance sheet size, the high valuations of some neobanks are driven by expectations for strong loan growth, particularly in the unsecured retail segment (Figure 3.3, panel 2).

Figure 3.3. The Increasing Relevance of Neobanks

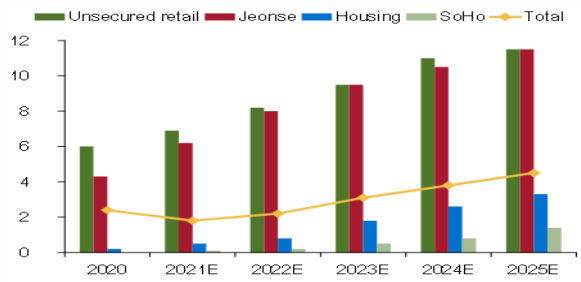
Some neobanks are among the largest players in their local markets and have large valuations…

1. Valuation of Selected Leading Neobanks
(Billions of US dollars, as of January 11, 2022)



…driven by expectations for strong loan growth, particularly in the unsecured segment.

2. Korean Digital Banks: Loan Market Share
(Percent of loans outstanding, 2021–25, expected)



Sources: Bloomberg Finance L.P., Morgan Stanley Research, SNL Financial/S&P Capital IQ, and IMF staff.

Note: Panel 1 shows the largest neobanks based on market capitalization or private valuation data. The leading traditional banks are the largest domestic banks per assets (the second largest for Germany, Russia, and the United Kingdom).
In panel 2, *SoHo* refers to small professional businesses; *Jeonse* refers to special housing lease contracts in Korea.

[3] This case study is based on 37 neobanks and 640 traditional banks in 18 economies. Neobanks, which have a higher-than-average risk profile (Figure 3.4), are compared against the asset-weighted average of the universe of traditional banks in their respective local markets (a measure of average bank risk). With the exception of one neobank regulated as a payment company, all other neobanks in our sample have banking licenses. Online Annex 3.1 describes both the data and methodology.

11. Rapid scaling may be a source of value, but it may also carry higher operational risks. Rapid scaling is a key feature of neobanks, and of young firms more generally, as future growth is their main source of value. Rapid growth may also translate into the buildup of operational risks. Furthermore, evidence points to higher and increasing fraud through digital channels (UK Finance 2021), suggesting that neobank clients may be more vulnerable to fraud than traditional bank clients.

Credit Risk: High, Under-provisioned, and Under-priced

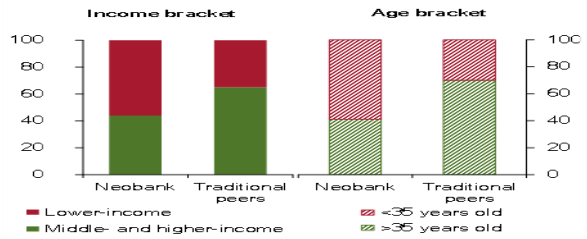
12. Neobanks target borrowers with a riskier credit profile. Neobanks tend to explicitly address financially underserved clients across the consumer/credit card and SME segments in the context of heavily skewed/concentrated—less diversified—loan portfolios. In practice, this means serving younger individuals[4] with lower incomes (Figure 3.4, panel 1) and lower credit scores, by granting them loans that are mostly unsecured (Figure 3.4, panel 2) or concentrated around risky sectors, such as commercial real estate (for example, SME loans by UK neobanks).

Figure 3.4. Client Profile of Neobanks

Clients are younger and have lower incomes …

1. Brazilian Banks: Customer Breakdown

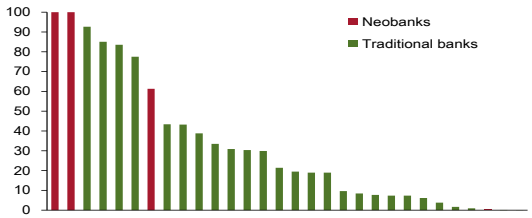
(Percent, share of loans)



… and there is more focus on unsecured lending.

2. UK Banks: Unsecured Exposures

(Percent of total loans, 2020; bars depict individual banks)



Sources: Nu Holdings, SNL Financial/S&P Capital IQ, Company Filings, and IMF staff.

13. Despite greater credit exposure, neobanks' overall credit risk coverage level remains significantly below that of traditional banks. Higher credit risk (Figure 3.5, panel 1) should translate into a higher expected loss and, in turn, into higher coverage ratios. However, neobanks' loan loss reserves (LLRs) as a proportion of their overall (risk-weighted) assets is well below that of traditional banks (Figure 3.5, panel 2), implying relatively looser provisioning standards or practices.[5]

14. Neobanks also seem to be under-pricing credit risk. Neobanks feature asset yields that are typically higher than banks. This seems to be driven by a higher yield on their securities portfolio rather than yields on their loan book, as the latter is broadly equal to that of banks. A meaningfully negative risk-adjusted net interest margin (NIM) points to an under-pricing of credit risk in their lending business in parts of our sample as well as in some regions (Figure 3.6, panel 1). This could be due to competition vis-à-vis traditional banks and/or other neobanks. Importantly, their risk-adjusted loan margins would be even

[4] While neobanks' exposure to relatively younger populations with lower incomes and credit scores pose risks, it may not only represent a higher appetite for risk but could also reflect a higher technological literacy in this demographic group.

[5] Neobanks also seem to operate with higher leverage (total equity/assets) ratios relative to traditional banks. This, however, seems related to the fact that they are young companies in their growth phase that are still loss-making for the most part (Figure 3.6, panel 3); hence they initially need higher equity. For mature neobanks, the capital advantage disappears.

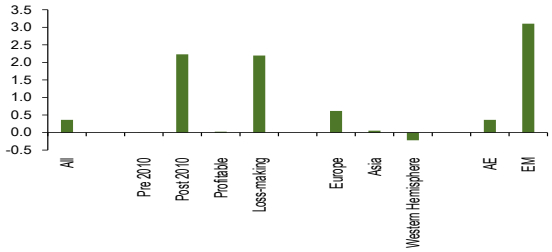
lower if their cost of risk adequately reflected their riskier credit-risk profile, and their lower loan-related fee income was also accounted for (more on this later in the chapter). Ultimately, higher asset yields and overall NIMs reflect an implicit cross-subsidy through neobanks' high-yielding (riskier) securities portfolio.

Figure 3.5. Credit Risk Profile

Neobanks have high credit costs and a riskier client base…

1. Neobanks: Cost of Risk (CoR)

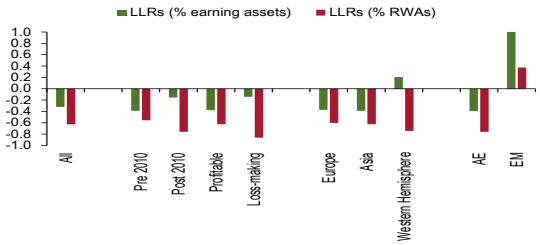
(Loan loss provisions/gross loans; in number of standard deviations vs. banks)



…but coverage falls short of traditional banks.

2. Neobanks: Coverage

(Loan loss reserves; in number of standard deviations vs. banks)



Sources: SNLFinancial/S&P Capital IQ, Company Filings, and IMF staff.

Note: The panels show neobanks' distance (median number of standard deviations) from (the asset-weighted average of) traditional banks (see details in Annex 3.1). In panel 1, a positive (negative) number implies a higher (lower) cost of risk for neobanks compared to their respective traditional-bank peer group; the related exposures should be viewed as riskier (less risky). In panel 2, a positive (negative) number implies a higher (lower) coverage level at neobanks compared to their traditional-bank peer group, consistent with a higher (lower) expected loss. AE = advanced economies; EM = emerging markets; LLRs = loan loss reserves; RWA = risk-weighted assets.

Liquidity Risks: Lower Liquidity Coverage Adds Risk

15. Lower liquidity coverage may pose additional risks. On the one hand, neobanks' client base is younger (Figure 3.4, panel 1) and likely to be less loyal, implying that their deposits could be less sticky. Therefore, caution would call for neobanks to operate with higher liquidity coverage ratios, in line with Basel III requirements.[6] Instead, their ratio of liquid assets over total deposits—a measure of liquidity risk—is lower than that of banks (Figure 3.6, panel 4). On the other hand, the composition of their liquid asset portfolios shows that neobanks have a much larger share of interbank loans than traditional banks. This also suggests that neobanks are more interconnected than traditional banks with the rest of the banking system.

Weak Retail Banking Returns

16. Neobanks display higher operating expenses and lower potential for fee income generation. Somewhat counterintuitively, neobanks appear to be less cost-efficient than traditional banks (Figure 3.6, panel 2).[7] This is driven by persistently higher non-staff expenses[8] on the back of either higher customer

[6] For the calibration of the liquidity coverage ratio (LCR) under Basel III, "less stable deposits" (including "internet deposits") are assigned a run-off rate of at least 10 percent (3 percent for "stable deposits"); supervisors can assign higher rates.

[7] Our results are similar when looking at overall operating expenses as a proportion of either total income or business volumes. Mature neobanks (defined as those established before 2010) remain more inefficient, but the difference is lower.

[8] Staff expenses are defined as "compensation & benefits" expenses for all (neo)banks with data available in the SNLFinancial/S&P Capital IQ database. Non-staff expenses are defined as the difference between staff and total operating expenses.

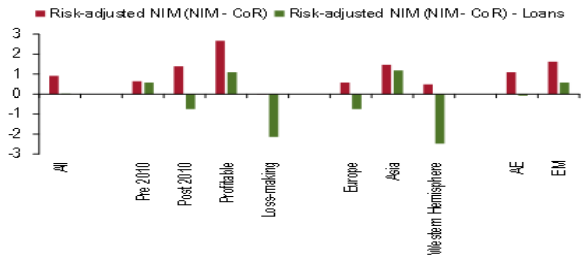
acquisition costs (such as marketing)[9] and/or higher compliance-related costs (such as those related to anti-money laundering and cybersecurity). Also, the lower income profile of neobank customers limits neobanks' potential for cross-selling insurance, wealth management, and other fee income-generating products.[10] If securities income is excluded, neobanks' margin advantage fades (Figure 3.6, panel 1). Overall, neobank returns appear weak (Figure 3.6, panel 3), with only a few neobanks generating profits.

Figure 3.6 Margins, Profitability, and Liquidity Profiles of Neobanks

High net interest margins are driven by the securities portfolio.

1. Neobanks: Net Interest Margin (NIM)

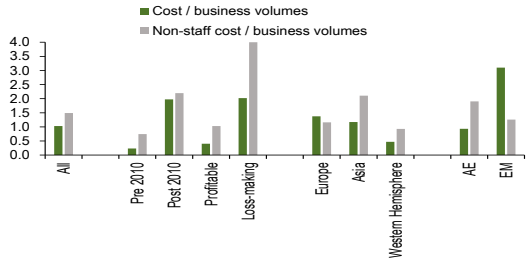
(Percent of earning assets; in number of standard deviations vs. banks)



Neobanks' tend to be less efficient…

2. Neobanks: Operating Expenses

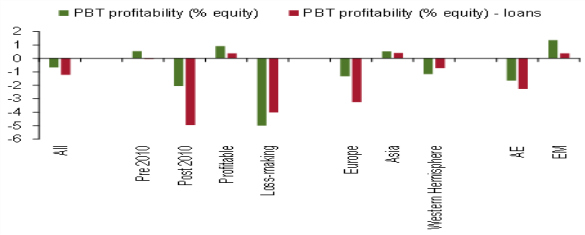
(Percent of business volumes; in number of standard deviations vs. banks)



…and have underwhelming banking returns…

3. Neobanks: Pre-tax return on equity (ROE)

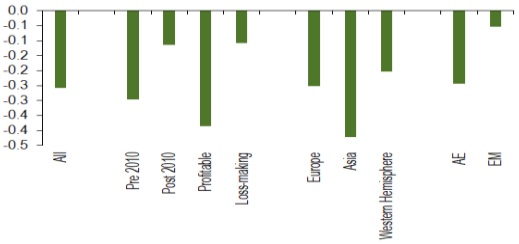
(% of total equity; in number of standard deviations vs banks)



… as well as weaker liquidity ratios.

4. Neobanks: Liquid Assets over Deposits

(% of deposits; in number of standard deviations vs banks)



Sources: SNLFinancial/S&P Capital IQ, Company Filings, and IMF staff.

Note: The panels show neobanks' distance (median number of standard deviations) from traditional banks
In panel 1, a positive (negative) number implies a larger (lower) net interest margin relative to traditional banks. In panel 2, a positive (negative) number implies lower (higher) cost efficiency relative to traditional banks. In panel 3, a positive (negative) number implies a larger (lower/negative) return on equity than at traditional banks. In panel 4, a positive (negative) number implies a higher (lower) coverage than traditional banks. AE = advanced economies; CoR = cost of risk; EM = emerging markets; LLR = loan loss reserves; NIM = net interest margin; PBT = profit before tax.

17. Overall, emerging market neobanks tend to fare better than advanced economy neobanks. Emerging market neobanks display relatively lower liquidity risk compared to advanced economy neobanks with a stronger revenue profile and wider loan and fee margins. This seems to be related to life-cycle factors (in light of the larger portion of "mature" neobanks in the emerging market sub-sample), but also to business models (given the relatively strong performance of Chinese neobanks).[11]

[9] These costs might constitute an initial investment needed to build up market share.

[10] Group-level consolidated data are used, with a few exceptions where only unconsolidated data were available.

[11] In China, neobanks and Big Tech overlap, with the three Chinese neobanks in our sample being backed by major local Big Techs.

Case Study: Fintechs in the US Home Mortgage Market

18. Fintechs in the US home mortgage market have been active for more than a decade. Fintechs remove the need for physical branches in mortgage origination. The main advantage of fintech mortgage originators is arguably the use of technology (Buchak and others 2018). This has afforded them efficiency gains, as they process applications about 20 percent faster than other lenders (Fuster and others 2019). A fintech firm has been the single largest originator for several years, even though banks have continued to wield a substantial market share (Figure 3.7, panel 1).[12]

19. Fintechs pursue an aggressive growth strategy and serve younger and riskier borrowers. Their mortgage originations have tended to substantially outpace those of banks and other non-banks in periods of overall market expansion (Figure 3.7, panel 2).[13] Their ability to grow rapidly due to their technology and Internet-based business model is highlighted by the rapid growth of recently established fintech mortgage firms. Fintech mortgages, and particularly those originated by younger fintech firms, are more popular among relatively younger borrowers, who tend to have lower incomes (Figure 3.7, panel 3). Fintechs also originated riskier mortgages with higher loan-to-value (LTV) ratios during 2018–20 (Figure 3.7, panel 4). At the same time, fintechs improve access to mortgages in less affluent neighborhoods (see Online Annex 3.2, which also provides a data description and details on the empirical analyses).[14]

20. Fintechs directly compete with banks, raising financial stability challenges. Fintechs are present in all locations, including those with a higher density of bank branches (Figure 3.7, panel 5 and Online Annex 3.2). Critically, competitive pressure from fintechs—measured as the (previous period) increase in fintech market share (by mortgage origination amount) in ZIP code areas where a given bank is active—appears to have had a significant effect on banks' interest income from mortgages (Figure 3.7, panel 6). A 1 percentage point rise in the composite market share of fintechs is associated with a 0.4 percentage point decline in (gross) mortgage interest income—this is more than 2.5 percentage points of the sample median of 16.8 percent. Importantly, expenditure by banks related to data processing (operation or purchase of IT services and software) can offset the loss of mortgage-related income.[15] This points to the importance of technological adoption for traditional banks—either through organic solutions or third-party services (these results are robust across alternative specifications, see Online Annex 3.2).

21. Banks have not faced a full-scale disintermediation despite intense competition from fintechs. The share of mortgage assets does not seem to have been significantly affected during 2007–20. This is also due to the limited role of fintechs as originators, whereas banks retained about 40 percent of the mortgages they originated on their balance sheet (Online Annex 3.2). Banks also continue to attract deposits, as fintechs in the mortgage-origination market are not deposit-taking institutions.

[12] The analysis uses Home Mortgage Disclosure Act (HMDA) data from 2007–20, covering more than 100 million US mortgage originations (see Online Annex 3.2).

[13] Non-banks are financial institutions that do not take deposits. All fintechs are non-banks.

[14] Jagtiani and others (2021) find fintechs having high market shares in areas with low credit scores and high mortgage denial rates.

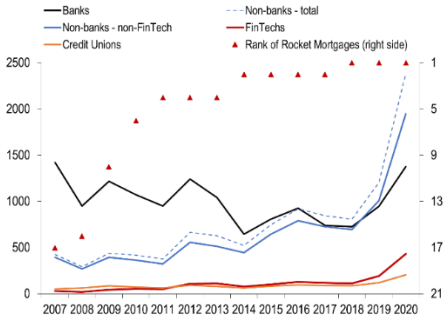
[15] The regression results shown imply that banks with an IT expenditure that is higher by about 3.7 percent of bank equity can fully make up for the loss of income from a one percentage point increase of the fintech composite market share. There is, however, no evidence that IT expenditures can reduce the marginal effect of competition itself—it can only offset the effect on income.

Figure 3.7 Fintechs in the US Home Mortgage Market

Fintechs and other non-banks have been a long-standing feature of the mortgage market…

1. Annual US Home Mortgage Originations

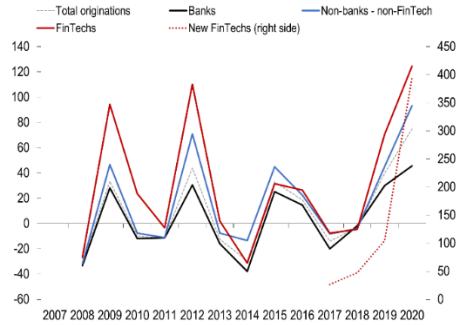
(Billions of US dollars, left scale; rank, right scale)



Originations by fintechs have been growing faster than banks, particularly in high growth periods.

2. Growth in US Home Mortgage Originations

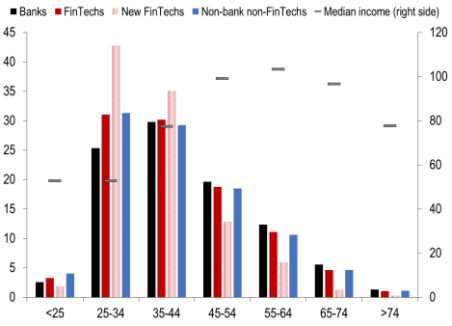
(Percent per year)



Fintechs are more prevalent among younger and lower-income borrowers.

3. Age Distribution of Mortgage Borrowers

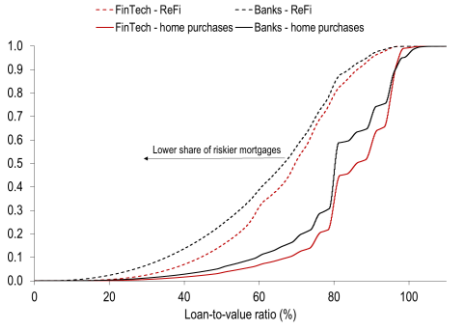
(Percent, left scale; thousands of US dollars, right scale)



Fintechs have tended to originate riskier mortgages.

4. Distribution of Loan-to-Value Ratios, 2018–20

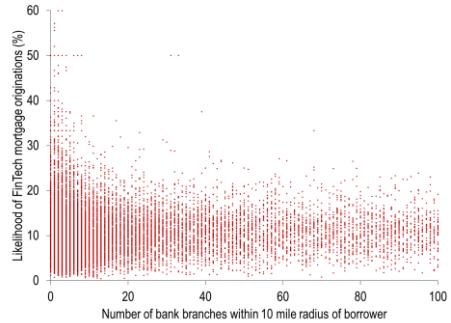
(Smoothed cumulative distribution)



Fintech mortgage origination is only marginally lower in areas with high bank penetration

5. Fintech Origination vs. Density of Bank Branches

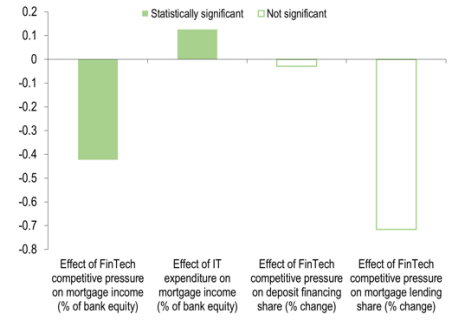
(Percent)



Competitive pressure from fintechs has had a significant effect on banks' mortgage income.

6. Effect of Competitive Pressure from Fintechs on Banks

(Percentage points)



Sources: FDIC, NBER ZIP Code Distance Database, US CALL reports, US Census Bureau, US HMDA, and IMF staff calculations.

Note: Originations include both refinancing and new purchases of 1–4 family homes. Variable definitions and model specifications for panel 6 are provided in Online Annex 3.2. IT = information technology.

Decentralized Finance: Vulnerable Efficiency

22. Decentralized finance (DeFi) refers to financial applications processed by computer codes called smart contracts on a blockchain with limited or no involvement of centralized intermediaries. Key features of DeFi are the automated and decentralized nature of its record-keeping, risk-taking, and decision-making within the crypto ecosystem (Table 3.1). Operations within DeFi are automated via smart contracts, and all the contractual and transaction details are recorded on the network. Decisions, such as changing collateral requirements or distributing profits, are made by users with voting rights that often can be obtained by using the platform. Consequently, DeFi offers broad access to players of any size and has no need for custodian service, potentially improving efficiency and financial inclusion.

23. Three key technological advances have contributed to the expansion of DeFi. First, the launch of blockchain technology provided a digital infrastructure for the storage of value on a distributed system that is open to anyone, and where transaction records of crypto assets are proven without having a single trustful entity. This is a type of distributed ledger technology (DLT).[16] Second, the invention of the smart contract opened up the possibility for blockchain technology to change the manner of financial intermediation. The smart contract is a computer code that can perform transactions on blockchains. DeFi is the application of smart contracts for financial intermediation such as deposit-taking, lending, derivative-trading, and the exchange of crypto assets. Third, the offerings of stablecoins pegged to existing sovereign currencies was a key innovation. Stablecoins are used in DeFi as a unit of account, medium of exchange, and storage of value. The growth of stablecoins and DeFi have evolved in tandem (Figure 3.1, panel 2).

24. DeFi has the potential to offer financial services with even greater efficiency, becoming a gravitational force that attracts a large number of crypto investors. However, it may also come at the cost of greater risks and uncertainties. This section will analyze some of the key risks and opportunities of DeFi lending and discuss how authorities should prepare for it.

Table 3.1. Comparison of Decentralized Finance and Traditional Financial Services

	Decentralized finance	Traditional financial services
Access	World Wide Web Permissionless and anonymized	Branch office Compulsory Know Your Customer/Anti-Money Laundering
Operation	Automated by smart contract	Mostly manual
Instruments	Crypto assets including stablecoins	Fiat-denominated financial assets
Record keeping	Distributed ledger (verified by multiple network participants)	Centralized ledger (verified by a single trustful entity that operates the platform)
Decision making	Voting by users who own governing stakes	Governed by top management (such as the bank executive board)
Risk taking	Distributed to users	Concentrated in a single trustful entity

Source: IMF staff.

A Primer on DeFi Lending

25. DeFi has expanded rapidly, offering blockchain-based financial services in the crypto ecosystem. Among many DeFi services, the debt outstanding of DeFi lending has seen an extraordinary increase since 2020, supported by the wider use of stablecoins (Figure 3.8, panel 1). DeFi provides crypto asset holders the opportunity to earn interest by depositing crypto and/or borrowing more crypto by posting collateral.

[16] Distributed ledger technology enables a single, sequenced, standardized, and cryptographically secured record of activity to be safely distributed to, and acted upon by, a network of varied participants. Blockchain is a type of distributed ledger technology. See Garrido and others (2022).

26. DeFi lending platforms receive crypto assets as deposits and lend them out to borrowers who meet certain collateral criteria. A DeFi lending service works as follows:

- *Deposits.* Users can earn interest by depositing their crypto asset in a "liquidity pool" specific to each type of crypto asset. Users with deposits in the same assets receive the same interest rates. In exchange, the depositor receives a platform-specific utility token that works as a certificate of deposit[17] (Figure 3.8, panel 2, step 1). The token has a value equivalent to the underlying asset deposited but is interest-bearing. A depositor can withdraw the deposit anytime (Figure 3.8, panel 2, step 2).

- *Borrowing.* A user with deposits (that is, a user who owns the utility token) can borrow a crypto asset from a liquidity pool by posting the deposited asset as collateral (Figure 3.8, panel 2, step 3). The lending interest rate varies, depending on the level of utilization for the borrowing asset.[18]

- *Collateral.* Collateralization is the key to safeguarding the platform from market risks associated with lending. Lending platforms often require over-collateralization by setting a discount factor (called a collateral factor) typically ranging from 0 to 0.8 across different types of assets. For example, when the collateral factor is 0.8, borrowers can borrow up to 80 percent of the collateral value posted; instead, when a collateral factor is zero, as in the case of Tether (USDT) in some DeFi platforms, the user cannot borrow using the asset as collateral.

- *Repayment and Liquidation*. Borrowers can repay the debt at any time (Figure 3.8, panel 2, step 4). However, the borrowers need to meet the collateral requirements at all times. If at any time the collateral requirement of a borrower falls below the required threshold due to adverse price movements, the liquidation can be triggered by a liquidator who repays the debt and acquires the collateral in exchange for rewards—the liquidation bonus (Figure 3.8, panel 3).

27. *Leveraged longs* and *short selling* are frequent strategies employed by DeFi users. DeFi lending platform offers services where investors with crypto assets can borrow other cryptos. Investors can form a *leveraged long* position (borrow stablecoins to buy risky crypto) or form a *short sell* position (borrow risky crypto and buy back later). The most typical position is to borrow stablecoins against volatile collateral. More than 90 percent of DeFi lending is denominated in stablecoins, while 75 percent of the collateral is denominated in volatile crypto assets (Figure 3.8, panel 4). As of the end of 2021, volatile crypto assets such as Ethereum and Wrapped-Bitcoin were the dominant collateral. These use cases are often seen in activities such as trading and market making, which brings higher market liquidity and efficiency, but also helps to build up leverage and destabilize the market if it is used for speculation. Considering its potential and ongoing trend for cryptoization in some economies (see Chapter 2 of the October 2021 GFSR), the usage of DeFi lending could soon be expanded to broader financial activities such as mortgage lending,[19] consumer finance, and so on.

28. Similar to traditional lenders, DeFi is not free from market, liquidity, credit, operational, and cyber risks. DeFi lending can incur losses under unfavorable market conditions, while liquidity mismatches can

[17] For example, if a user deposits Ethereum (underlying asset) in a DeFi platform, such as Aave and Compound, the user will receive aETH and cETH (tokens), respectively.

[18] The utilization rate of a crypto asset is the ratio of the total amount of loans to the total deposits of that asset in the platform. The lending rate is lower when the platform has more available liquidity in the deposit pool.

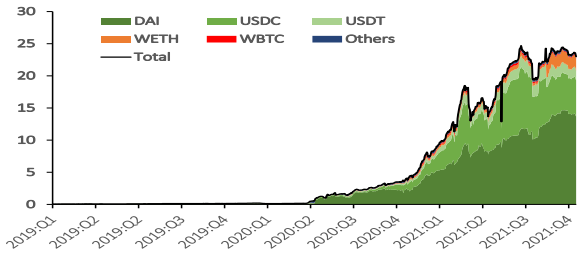
[19] MakerDAO, one of the largest DeFi platforms, has already started offering mortgage loans against existing real estates.

be a cause for failure to meet redemption requests. Moreover, it appears to be more vulnerable to cyber risks and AML/CFT risks, due to loopholes of computer codes and the anonymity of the platform.

Figure 3.8 Recent Development of DeFi Lending

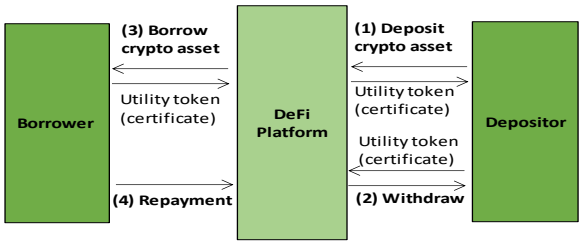
The volume of DeFi lending has increased rapidly, supported by wider use of stablecoins.

1. Total Debt Outstanding of DeFi Lending
(By type of crypto asset, billions of US dollars)



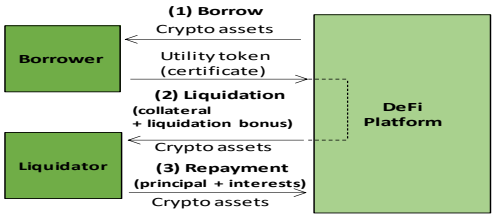
DeFi lending platforms receive crypto assets as deposits and provide collateralized loans.

2. The Flow of a DeFi Lending Transaction



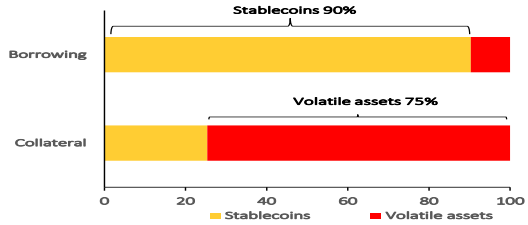
If a borrower fails to maintain the required level of collateral, the position is liquidated.

3. Liquidation



Most lending is against stablecoins backed by volatile crypto assets.

4. Composition of Borrowing and Collateral
(Percent)



Sources: Aave v2, Compound v2, C.R.E.A.M. Finance, DeFi Pulse, DeFi Lhama, The Graph, and IMF staff calculations.
Note: In panel 1: DAI, USDC, USDT, WETH, and WBTC represent DAI, USD Coin, Tether, wrapped Ethereum, and wrapped Bitcoin, respectively.

Market Risks: Vulnerable to Crypto Market Volatility

29. Volatile crypto asset prices lead to frequent liquidation of DeFi loans (Figure 3.9, panel 1). Liquidation is triggered when a borrower fails to maintain the collateral requirement, or when the borrower's loan-to-value (LTV) breaches a certain threshold. The LTV is marked-to-market and can swing considerably during volatile market conditions. Large liquidations have happened during sharp declines in crypto asset prices. In the January 2022 crypto sell-off, liquidation across platforms surged to the highest level since May 2021, erasing $50 billion of asset value borrowed (Figure 3.9, panel 1). When the collateral shortfall is large during periods of high market volatility, liquidation can be costly. Without timely liquidation, the shortfall will be left unaddressed and could potentially undermine platform solvency.[20,21]

30. Indeed, the asset quality of DeFi lending varies considerably across assets and borrower risk profiles. Similar to the concept of default probability in traditional loans, this section attempts to estimate

[20] Another source of liquidation risk comes from the precision of the information source used in the platform to value its loans and collateral. If the platform is misinformed about the asset prices used in loans and collateral, it may trigger a cascade of liquidations.

[21] The deterioration of the loan quality of the platform may not materialize as a credit loss. This is because the loan has no maturity, and there are no accounting rules for provisioning or recognition of fair value loss. However, it can potentially reduce the interest.

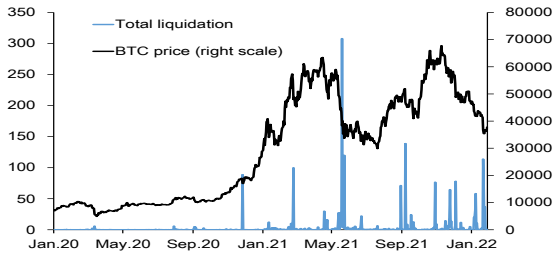
the *probability of liquidation* through a stochastic model. A liquidation is triggered when the total value of borrowing exceeds the threshold, defined as the total of collateral values discounted by the collateral factors (see Online Annex 3.3 for details). The modeled probability of liquidation reflects the trend and volatility of the underlying crypto assets, as well as the initial balance of debt outstanding (the leverage). The *expected loss* mainly reflects the loss of collateral value upon liquidation. The results indicate that the one-year probability of liquidation is 24 percent on average, reflecting high volatility and a rising trend in crypto prices (Figure 3.9, panel 2). In particular, riskier (highly leveraged) borrowers tend to exhibit higher liquidation probability. The expected loss is largely mitigated by overcollateralization, but still averaged around 0.9 percent, with larger losses incurred by riskier borrowers.[22]

Figure 3.9 Decentralized Finance Market Risks

High volatility of crypto asset prices leads to frequent liquidation of DeFi lending.

1. Liquidation Volume and Bitcoin Price

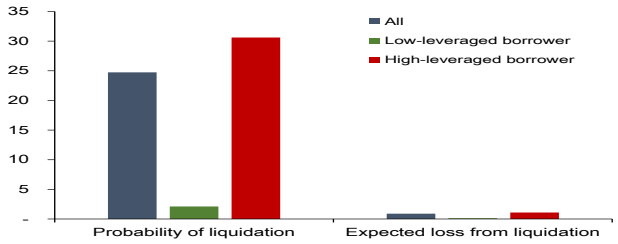
(Millions of US dollars; US dollar per bitcoin)



Lending by riskier borrowers tends to get liquidated more often with larger losses.

2. Liquidation Probability and Expected Losses

(Percent)



Sources: Aave v2, Bloomberg Finance L.P., CoinGecko, Compound v2, C.R.E.A.M. Finance, The Graph, and IMF staff estimates.
Note: For panel 2, see online Annex 3.3. for details on the probability and expected loss calculation.

Liquidity Risks: Heavily Concentrated

31. Liquidity could become insufficient during periods of market stress. Depositors provide liquidity to DeFi lending platforms, which facilitates lending these deposits to borrowers. The total amount of loans that can be lent out is thus capped by the total amount of deposited assets, or liquidity, on each platform. Similar to the loan-to-deposit ratio in traditional banking, the *utilization rate* measures how much of the liquidity for a particular crypto asset has been loaned out on each DeFi platform (Figure 3.10, panel 1).[23] When demand for borrowing a crypto asset increase, the utilization rate for its liquidity pool rises accordingly. However, a very high utilization rate could create problems for redemptions when many depositors try to withdraw at the same time. To minimize this risk, DeFi platforms set a *threshold utilization rate* above which the lending rate goes up steeply to discourage higher utilization. The median utilization rate is typically high for stablecoins and low for volatile assets; however, there have been instances for both types of assets when utilization rates approached 100 percent during periods of market volatility (Figure 3.10, panel 1).

[22] Even though DeFi lending is overcollateralized, the value of borrowing and repayment depends on the remaining balance of collateral relative to the debt outstanding at the time of liquidation. If the value of the borrowed token and/or collateral change abruptly, timely liquidation will fail, resulting in liquidation losses.

[23] Each DeFi platform has its own interest rate model that determines loan and deposit rates based on the utilization rate.

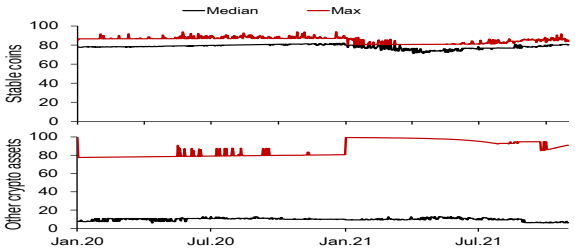
32. Liquidity provision is highly concentrated, making DeFi platforms ironically less decentralized than expected.[24] On average, half of the deposits are provided by fewer than 10 accounts, with even more concentrated in smaller and more volatile crypto assets (Figure 3.10, panel 2) (see also Aramonte and others 2021, and Gudgeon and others 2020). With higher concentration, an idiosyncratic withdrawal of funds by any of those large depositors can have a material impact on the liquidity condition of the platform. This, in turn, can exacerbate liquidity exhaustion, as illustrated by the occasional spikes in the utilization rate.[25] A more extreme outcome would be equivalent to a bank run when participants rush to withdraw liquidity from the platform.

Figure 3.10 Decentralized Finance Liquidity Risks

Liquidity could become insufficient during periods of market volatility.

1. Distribution of the Utilization Rate across Assets and Platforms

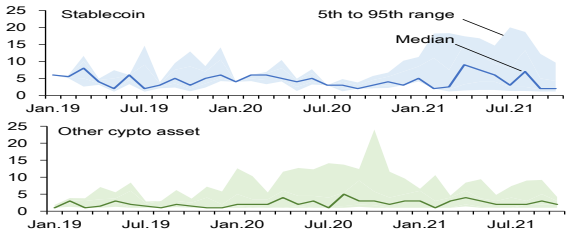
(Median and maximum value)



Liquidity is highly concentrated in a small number of accounts.

2. Liquidity Concentration: Number of Accounts Providing 50 percent of Liquidity

(Distribution of liquidity concentration by assets)



Sources: Aave v2, Compound v2, C.R.E.A.M. Finance, The Graph, and IMF staff estimates.

Note: The utilization rate of a crypto asset is the ratio of total loans to total deposits of that asset in the platform.

Cyber Risks: A Critical Risk of Decentralized Finance

33. Cyberattacks increased substantially in mid-2021 and remain elevated. The attacks are mostly associated with compromised wallet keys, vulnerabilities in computer codes, and scams by developers (Figure 3.11, panel 1).

34. Cyberattacks cause large and often persistent losses. An event analysis shows a substantially adverse impact of cyberattacks on the excess growth of total value locked that represents the total value of crypto assets supplied to the platform, most of which are deposits.[26] The estimate suggests that, in most cases, 30 percent of the total value locked is lost or withdrawn (Figure 3.11, panel 2). Cyberattacks not only steal assets but also undermine the reputation of a platform, often triggering withdrawals by depositors as they fear not being able to redeem the deposit.[27] As indicated by the lower tail of the interquartile range, an entire platform can collapse in the aftermath of an attack.

[24] The liquidity providers cannot be identified due to the DeFi's anonymous nature.

[25] A spike can be triggered by other factors, such as changes of threshold utilization rate of the interest rate model.

[26] In addition to deposits, TVL includes governance tokens (staking token) that is locked to the platform.

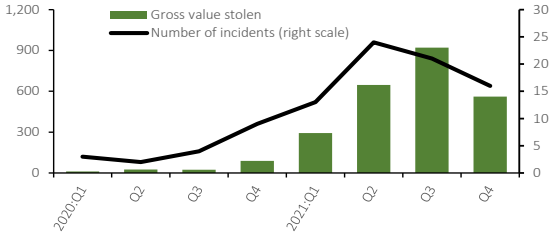
[27] When a DeFi platform falls short of liquidity, depositors likely cannot withdraw and lose their assets. Deposits in DeFi platforms are not eligible for any deposit insurance or central bank liquidity support measures.

Figure 3.11 Cyberattacks on Decentralized Finance

The frequency and scale of cyberattacks surged in 2021 and remain elevated.

1. DeFi-Related Cyberattacks

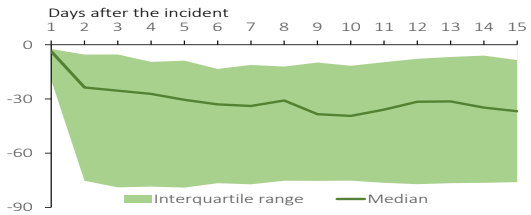
(Billions of US dollars)



In most cases, more than 30 percent of the deposit was lost or withdrawn after attacks.

2. Cumulative Abnormal Returns after Attacks

(Percent)



Sources: Chainalysis, CoinGecko, CryptoSec.info, DeFi Lhama, ImmuneFi, Rekt, and IMF staff

Efficient but Risky

35. DeFi has the potential to exhibit cost-efficient financial intermediation by bypassing and shortcutting the intermediation chain. However, comparing costs and prices between DeFi and traditional financial institutions is complex because the two currently operate in different ecosystems. To address this issue, price-cost margins and marginal costs are estimated, taking into account their distinct cost structures. Following Berger and others (2009), prices are proxied by the ratio of total revenue to total assets, and marginal costs are estimated using a panel regression model of total cost functions.[28] The analysis shows that DeFi has the lowest marginal cost compared to incumbents in both advanced economies and emerging markets, indicating the highest cost-efficiency (Figure 3.12, panel 1). The low marginal costs of DeFi are due to their automated and unregulated operation, which stands in contrast to the high share of labor and operational cost of traditional financial institutions—which includes (at least in part) costs related to regulatory compliance (Figure 3.12, panel 1).[29] However, DeFi bears high funding costs that likely reflect higher risks, such as lack of access to central bank liquidity support, AML/CFT risks, and legal and jurisdictional uncertainties.

36. However, the low margins of DeFi raise concerns about under-pricing risks. DeFi charges substantially lower margins compared to traditional financial institutions, offering favorable prices to borrowers (Figure 3.12, panel 1). DeFi currently needs to offer relatively high deposit rates while keeping lending margins low to attract depositors and borrowers. Narrow margins are in part possible because DeFi does not have to maintain regulatory buffers. To assess margins against risk exposure, the estimated average expected losses of DeFi platforms are compared with those of banks. This comparison suggests that DeFi is significantly under-pricing the riskiness of its lending (Figure 3.12, panel 2). Although lower margins can increase the popularity of DeFi, it comes at the cost of thinner reserve

[28] In the empirical approach used, liabilities are an intermediate input in the production of loans; total assets are the output; and the revenue associated with the output is interest and non-interest income. The marginal cost is defined as an incremental cost of additional loan production, and the margin is the difference between the price and marginal cost. See Annex 3.4 for details.

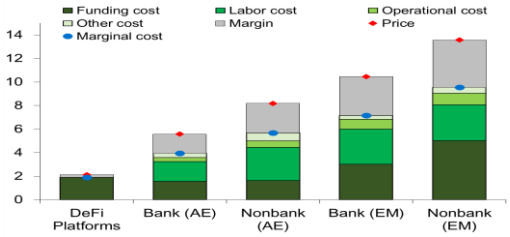
[29] DeFi platforms can also bear episodic operational costs against cyberattacks or program bugs. For example, about $90 million was mistakenly distributed to Compound users due to program bugs after an update on October 1, 2021. While the founder made a plea to users to voluntarily return the tokens, the value of tokens not retrieved would be conceived as costs to the platform.

buffers, building up vulnerabilities during periods of market stress. At the same time, it may pose a significant competitive pressure to the incumbents unless a (regulatory) level playing field is provided.

Figure 3.12 Efficiency and Risks of Decentralized Finance

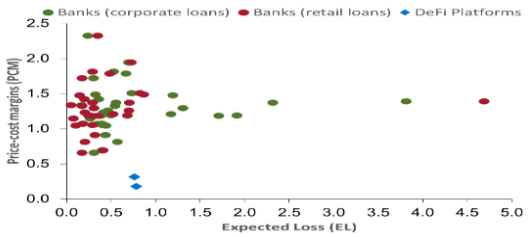
DeFi has the lowest marginal costs due to the absence of labor and operational costs.

1. Estimated Marginal Costs and Margins
(Percent)



Despite high cost-efficiency, DeFi is exposed to riskier borrowers.

2. Margins and Expected Losses
(Percent)



Sources: Aave, CoinGecko, Compound, EBA Risk Dashboard, Fitch Connect, and IMF staff estimates.

Note: In panel 1, The sample is comprised of banks from 37 advanced economies (AEs) and 100 emerging markets (EMs); nonbanks from 20 advanced economies and 26 emerging markets; and two DeFi platforms (Aave and Compound). See Online Annex 3.4 for technical details. In panel 2, expected losses of DeFi platforms are the estimates from Figure 3.9, panel 2. Each dot represents the average expected loss for banks in a country.

Financial Stability and Policy Issues

37. The acceleration of digitalization in core banking services brings opportunities and risks. On the one hand, by strengthening and broadening financial development, fintechs can support more inclusive economic growth. On the other, the rapid growth of fintechs raises the risk of bank disintermediation. This is not necessarily a financial stability concern if fintechs are subject to appropriate regulatory oversight to ensure a level-playing field. However, the rapid growth of fintechs does raise financial stability issues, including a potential buildup of vulnerabilities in new corners of the financial system and challenges to adapt regulatory and supervisory rules to new actors.

Regulatory Differences

38. Neobanks are generally subject to simpler and less comprehensive regulation. While neobanks in many jurisdictions may be subject to banking requirements, these are generally simpler than Basel III rules applicable to internationally active banks, mainly due to their current size. Conversely, in some jurisdictions neobanks operate without a banking license, some are not subject to liquidity risk requirements, and they may be subject to different loan classification and lower provisioning. Less comprehensive requirements may incentivize risk-taking in loan underwriting and securities investment.

39. These regulatory approaches may have been designed to be both conservative and simple for small and traditional banks. However, as the analysis in this chapter indicates, neobanks tend to be more aggressive than traditional banks in terms of loan underwriting, investments in riskier securities, and liquidity management. This suggests that while authorities may have targeted a proportional approach to regulation so as not to hinder innovation, in practice some of this proportionality is not sufficiently risk-based to address different business models and the risk-taking appetite of neobanks.[30]

[30] Many neobanks are not subject to group-wide supervision, which creates regulatory arbitrage opportunities.

Adapting Policies to Address Risks in Neobanks and Fintech Mortgage Firms

40. The rapid growth of fintechs globally has led to interconnectedness within the financial sector, which could exacerbate financial stability challenges. The neobank case study unveils vulnerabilities across at least four dimensions: (1) higher risk-taking in retail loan originations without appropriate provisioning and pricing standards; (2) higher risk-taking in the securities portfolio as a way to cross-subsidize their lending business in order to support its price-competitiveness vis-à-vis traditional banks; (3) potential under-spending in critical functions (such as AML/CFT and IT/cybersecurity) as they fail to match market expectations for meaningful efficiency gains down the road; and (4) liquidity buffers that appear to be not well calibrated to the lower stickiness of neobanks' retail deposit base. In addition, neobanks are providing funding to traditional banks through the interbank market. Moreover, a small number of fintech firms provide critical services (such as cloud services) to financial institutions.

41. Even if regulation delivers a level-playing field for fintechs and incumbents, the scalability of technology-enabled business models allows fintechs to grow fast, creating pressures for incumbents. The competitive pressure on traditional banks can be significant. As the case study of the US mortgage market shows, there is strong evidence of a negative impact on bank's income due to competition from fintechs. Importantly, evidence also shows that banks adopting fintech-like technologies are less affected. Excessive risk-taking by both fintechs and incumbents to gain or defend market shares could lead to a fast buildup of systemic risks (Vives 2019).

42. Policy action is needed to address rapidly changing risks in fintechs as well as enhanced monitoring of incumbents. First, prudential regulations at both the entity and group level should be reviewed to address the key risks of fintechs in a forward-looking manner. This is likely to mean more robust capital, liquidity, and operational risk-management requirements, commensurate with the risk taken by neobanks in several jurisdictions. Second, the health of technology laggards and smaller banks could be particularly at risk as they may not have the resources and know-how to adapt to technological changes. This may require supervisors to closely monitor less technologically advanced incumbents.

Regulating Decentralized Finance

43. DeFi poses unique challenges to regulators. While DeFi's elevated market, liquidity, and cyber risks might need an adjustment to the regulatory perimeter, DeFi's anonymity, lack of a centralized governance body, and legal uncertainties make the traditional approach to regulation ineffective.

44. Growing interconnectedness among DeFi, stablecoins, and traditional financial entities will require enhanced regulatory surveillance and globally consistent regulatory frameworks. Stablecoins are backed or collateralized by cash and financial instruments, and regulated financial institutions are increasing their exposure to and funding from stablecoins (Aramonte, Huang, and Schrimpf 2021). This linkage can create a stronger interconnectedness between DeFi and the financial sector. The Basel Committee on Banking Supervision (BCBS) proposals on crypto asset exposures for banks are an important development toward global standards that would also help address some cross-border issues.[31]

45. As a first step, regulation should focus on some elements of the crypto ecosystem that have enabled the development of DeFi. These include stablecoin issuers (which define technical specification and use cases), centralized crypto exchanges and hosted wallet service providers (which connect crypto

[31] The BCBS is consulting on the prudential treatment of banks' exposures to crypto assets. The proposed standards reflect the high risk of some crypto assets, while taking a more proportional approach to those that are anchored on real-world assets.

markets with the broader financial system), and reserve managers, network administrators, and market makers (which play important roles in operationalization and stability). These entities would benefit from robust and comprehensive national regulatory frameworks delivered through common global standards by standard-setting bodies. Those centralized entities in the crypto asset ecosystem could provide an effective liaison for regulators to address the risk of rapid growth in DeFi.

46. As a second step, authorities can directly regulate key functions within DeFi. To manage the risks generated by protocol developers, measures could include public-private collaboration on code regulation through either ex-ante provision of guidelines on operation and risk parameters (including operational and cyber resilience), or ex post measures of code reviews and audits that can identify areas vulnerable to risk and help deliver policy objectives. Ex ante measures can be combined with greater disclosures and user education to help identify platform-specific risks, closing the information gap between retail and institutional investors.

47. Authorities should encourage DeFi platforms to adopt robust governance through industry codes and build effective public-private collaboration to establish self-regulatory organizations (SROs). Having a transparent and credible governance scheme in place could improve risk management, facilitate good conduct of financial transactions, and eventually make the platforms attractive to more users and capital. Such a governance scheme could be a natural entry point for regulators to interact either directly or through the development of industry codes or SROs. For example, their governance tokens can form decentralized autonomous organizations (DAOs) with voting rights, like traditional securities.[32] DAOs may provide authorities with a conduit for regulatory oversight, ensuring that DeFi platforms enhance disclosure and have suitable controls. Similar to traditional securities markets, establishing SROs for centralized crypto exchanges would lead to more robust listing standards for (tokens of) DeFi platforms and thereby improve the governance and quality of DeFi platforms. Regulators should monitor the effectiveness of industry codes and self-regulation and enhance supervision intensity when necessary.

48. Enforcing regulations—including restrictions—in DeFi markets is challenging, as experience from crypto markets shows.[33] One potential approach is to restrict the exposure of regulated firms to DeFi markets (especially markets not subject to proper regulation or self-regulation), which could slow the pace of growth while addressing the risks of interconnectedness with regulated markets.

[32] In some jurisdictions, such as the state of Wyoming in the United States, DAOs are considered legal entities.

[33] Despite implemented restrictions, an estimated 1.7 million Egyptians hold crypto assets (Triple A 2022). Many crypto asset service providers operate offshore while users can use virtual private networks (VPNs) to obscure location, demonstrating the difficulty in enforcing regulations.

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