The Sovereign-Bank Nexus in Emerging Markets: A Risky Embrace—Online Annexes

Online Annex 2.1. Data Sources and Sample

Online Annex Table 2.1.1. Data Description and Sources

Variable	Description	Source
Macroeconomic and Financial Variables		
Banking crisis	A banking crisis as an event that meets two conditions: i) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations); ii) significant banking policy intervention measures in response to significant losses in the banking system.	Laeven and Valencia (2018); Harvard Business School Global Crises Data by Country
Banks' sovereign debt exposure	Banks' holdings of sovereign debt to total bank assets	IMF, Monetary and Financial Statistics
Credit to GDP	Private sector credit as a share of GDP	World Bank, World Development Indicators
Currency crisis	A currency crisis is defined as an annual depreciation versus the relevant anchor currency (e.g., the US dollar) of 15% or more. An inflation crisis is defined as an annual rate of inflation of 20 percent or more.	Harvard Business School Global Crises Data by Country
Exchange rate depreciation	Change in local currency per US dollar (nominal)	IMF, World Economic Outlook
Expected Default Frequency (EDF)	CDS-implied Expected Default Frequency over a one-year horizon	Moody's analytics
Fiscal shock	Dummy variable equal to one for sovereign CDS greater than 500 basis points	IHS Markit and staff calculation
GDP per capita	Real GDP per capita	IMF, World Economic Outlook
Global financial conditions index	For methodology and variables included in the financial condition index, refer to Annex 3.2 of the October 2017 Global Financial Stability Report. Positive values of the index indicate tighter-than-average financial conditions	IMF staff estimates
Inflation	CPI growth	IMF, World Economic Outlook
Interest payment	General government interest expense in percent of GDP	IMF, World Economic Outlook
Interest rate	Short-term interest rate	IMF, World Economic Outlook
Non-performing loans ratio	Nonperforming loans to total gross loans ratio	IMF, Financial Soundness Indicators
Policy rate	The rate used by central banks to implement or signal its monetary policy stance	IMF, World Economic Outlook
Public debt	General government gross debt (all or in foreign currency)	IMF, World Economic Outlook, Institute of International Finance
Recession	Dummy variable equal to one for two consecutive negative quarter-over-quarter real growth rates	IMF, World Economic Outlook and staff calculation
Short-term external debt-to-reserves	Short-term external debt to international reserves (including Fund position)	IMF, World Economic Outlook
Sovereign CDS Spreads	Markit 5-year sovereign CDS spreads (monthly) with coupon rate of 100 bps	IHS Markit
Sovereign default event	Domestic sovereign debt default or external sovereign debt restructuring based on Reinhart and Rogoff (2009). The dataset is updated by the Harvard Business School	Harvard Business School, Global Crises Data by Country
Sovereign default rating	Standard & Poor's foreign currency long-term sovereign default rating	Standard & Poor's
Stock market capitalization	Stock market capitalization as a share of GDP	World Bank, World Development Indicators
Stock market return	First log difference of the stock market index	Datastream, and staff calculation
Tax revenue	General government tax revenue in percent of GDP	IMF, World Economic Outlook
Term spread	10-year government bond yield minus 3-months government bond yield	Datastream, and staff calculation
Tier 1 capital-to-total assets ratio	Tier1 capital to total assets ratio	IMF, Financial Soundness Indicators
US dollar index	Nominal broad U.S. dollar index	FRED
VIX	CBOE's options-implied volatility index for S&P 500	Chicago Board Options Exchange
Yields of JP Morgan Global Bond index	Spreads correspond to 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	Bloomberg
WEO GDP forecast	Historical forecasts vintages of one year-ahead change in GDP	IMF, World Economic Outlook vintage
Bank-level Variables		
Bank size	Log of bank total assets	Fitch Connect
Borrowing cost	Banks' Interest Expense to Interest-Bearing Liabilities	Fitch Connect
Capital ratio	Book value of total equity divided by total assets	Fitch Connect
Central bank exposure	Total exposure to central bank divided by total assets	Fitch Connect
Deposits to assets	Book value of deposits divided by total assets	Fitch Connect
Government bonds' exposure	Total book value of government bond holdings divided by total assets	Fitch Connect
Government bonds holdings	Total book value of government bond holdings	Fitch Connect
Government ownership	Government ultimate ownership dummy (equals one if government ownership is greater than 50 percent)	Orbis
Interbank ratio	Interbank balance divided by total assets	Fitch Connect
Loans to deposits	Total outstanding gross loans divided by total deposits	Fitch Connect
Net purchases	Log change in banks holding of sovereign debt	Fitch Connect
Noncash ratio	total assets minus cash and due from banks, divided by total assets	Fitch Connect
Profits	Pre-tax profits (operating profits + net non-recurring income + other non-operating income and expenses + equity-accounted Profit/Loss non-operating + change in fair value of own debt)	Fitch Connect
Return on assets	Bank operating income divided by total assets	Fitch Connect

Online Annex Table 2.1.1. Data Description and Sources (concluded)

Support rating floor	Fitch's rating on a potential supporter's propensity to support a bank and of its ability to support it. Support Rating Floors do not assess the intrinsic credit quality of a bank. Rather they communicate the agency's judgment on whether the bank would receive support should this become necessary.	Fitch Connect
Total capital	Book value of total equity ratio	Fitch Connect
Total loans	Total principal amount of all loan facilities extended by the bank to its customers (excluding loans to financial institutions), before the deduction of any loan loss reserves	Fitch Connect
Total stock return index	Equity index that tracks both the capital gains as well as other cash distributions, such as dividends or interest, attributed to the index constituents	Refinitiv Datastream
Additional bank-level data		
Holdings of domestic sovereign bonds and additional breakdowns	The database contains bank-level holdings of domestic sovereign bonds (DSB) across 13 emerging markets. The data was gathered from accounting statements and Pillar III disclosures of individual banks. Whenever disclosed, the sovereign bond holdings were further broken down into the nationality and currency of issuance, the level of the issuing governmental body (central government, regional/municipal governments, government agencies, central bank) as well as type of ownership (proprietary VS retained collateral of REPO counterparties). This granularity allows to extract the precise exposure of banks to DSB, while external data providers usually report gross positions, which in some cases exceed the correct exposure by over 3 times.	Accounting statements and Pillar III banks' disclosures.
Nonfinancial-Corporates-level Variables		
Bound	Dummy indicating whether S&P score of a firm is equal or above its country's S&P sovereign score	S&P Capital IQ and staff calculation
Capex	Capital Expenditure, millions of US dollars	S&P Capital IQ
Investment ratio	The ratio of capital expenditures to lagged net property, plant, and equipment	S&P Capital IQ
Debt issuance ratio	Net debt issuance to lagged total assets ratio	S&P Capital IQ
Cash flow	Cash flow from financing, millions of US dollars	S&P Capital IQ
Cash holding	Cash and short-term investments, millions of US dollars	S&P Capital IQ
Leverage	Companies' total liabilities to total equity ratio	S&P Capital IQ and staff calculation
Government ownership dummy	Dummy indicating whether a company is "Public Company" or a "Government Institution", or a "Public Investment Company"	S&P Capital IQ and staff calculation
S&P outlook	S&P outlook converted to numerical values	S&P Capital IQ and staff calculation
S&P score	S&P rating for companies converted to numerical values	S&P Capital IQ
Tobin's Q	The ratio of (total asset plus total market capitalization minus common equity) to total assets	S&P Capital IQ and staff calculation

Online Annex Table 2.1.2. List of Countries in the Emerging Markets Sample

Emerging market economies		
Albania	Dominican Republic	North Macedonia
Algeria	Ecuador	Pakistan
Angola	Egypt	Panama
Argentina	El Salvador	Peru
Armenia	Georgia	Philippines
Azerbaijan	Ghana	Poland
Bahamas, The	Guatemala	Romania
Barbados	Hungary	Russia
Belarus	India	Serbia
Bolivia	Indonesia	South Africa
Bosnia and Herzegovina	Jamaica	Sri Lanka
Brazil	Jordan	Thailand
Bulgaria	Kazakhstan	Tunisia
Chile	Lebanon	Turkey
China	Malaysia	Ukraine
Colombia	Mauritius	Uruguay
Costa Rica	Mexico	Venezuela
Croatia	Morocco	Vietnam

Note: The list includes economies identified as emerging market by the IMF's Vulnerability Exercise for Emerging Market Economies.

Online Annex 2.2. The Role of Nonbank Financial Institutions in the Nexus

Box 2.2.1. Nonbanks Financial Institutions and the Sovereign-Bank Nexus in Emerging Markets

Nonbank financial institutions (NBFIs) can play an important role in the sovereign-bank nexus if they are a significant part of the financial system. The participation of NBFIs in government bond markets can, on the one hand, help to diversify the investor base, improve liquidity, and weaken the sovereign exposure of banks, while on the other hand, the structural vulnerabilities and procyclical behavior (Garcia Pascual, Singh and Surti, 2021) of some types of NBFIs can amplify vulnerabilities and shock transmission through the nexus, worsening the feedback loop.[1]

In emerging markets (EMs), on average, domestic NBFIs hold almost one-third of total government debt (as of end-2020; Figure 2.2.1, panel 1). But in some countries, such as Chile, India and Mexico, this share is more than 40 percent (Figure 2.2.1, panel 2). Moreover, foreign NBFIs are also playing an increasingly important role in EM government bond markets, with their share in government debt almost doubling over the last decade and amounting to over half of government debt in some cases (for example, Peru).[2]

The rising participation of NBFIs in government bond markets in part follows from the growing importance of NBFIs in the financial system. NBFIs have increased their financing to EMs in the past decade (Figure 2.2.1, panel 3), with the stock of external financing provided by NBFIs growing from around 12 percent of GDP in 2010 to 20 percent of GDP in 2020.

What do the sizable NBFI exposures imply for the sovereign-bank nexus in EMs? Nonbank investors—particularly institutional investors (such as investment funds, insurance companies and pension funds) bring different risk-return preferences and investment horizons to the government bond market compared to banks and can allow the government to spread risk in its debt portfolio and extend the yield curve (IMF, 2018). However, given the relatively shallow local financial markets in several EMs, large foreign nonbank holdings can render EMs more vulnerable to the gyrations in global capital markets as foreign nonbank investors tend to be particularly fickle in times of global financial market stress (Martin and others, 2020; Chari and others, 2020). A sudden retrenchment of these investors from government bond markets could trigger sharp price corrections of government debt, as well as large currency depreciations, imposing substantial losses on the trading books of banks.[2]

Indeed, a relevant lesson from the March 2020 financial market turmoil episode is that borrowing through local currency bonds does not fully insulate EMs from global financial shocks. Mutual funds and ETFs investing in EM assets acted in a highly pro-cyclical pattern as they experienced large outflows, especially those that invested in local currency government bonds (Figure 2.2.1, panel 4).[3] Sovereign rating downgrades may also have added to outflow pressures, particularly when countries lost investment-grade ratings.[4]

Furthermore, as was evident from the "dash for cash" of U.S. fixed-income funds at the onset of the COVID-19 pandemic, some NBFIs may also be prone to selling government securities in times of stress to bolster their liquidity positions or to meet margin calls, contributing to pressures in government bond markets. In addition, NBFIs' liquidity positions could lead to a general de-risking and sales of cross-border holdings of government bonds (CGFS, 2020). This is also supported by the large outflows of domestic currency bonds observed at the onset of the pandemic in EMs (Figure 2.2.1, panel 5).

Thus, NBFIs can play an important role in the nexus and can amplify shocks in times of stress. A more formal analysis examining the extent of spillovers from NBFIs using a sample of 11 EMs shows that during periods of strained financial conditions, movements in the default risk of nonbanks spills over to other sectors of the economy. In line with the events described above, spillovers from NBFIs to other sectors of the economy, especially to the banking and the corporate sectors, increased during the pandemic (Figure 2.2.1, panel 6).

In sum, similar to banks, the holding of government debt by NBFIs may have both pros and cons from a financial stability perspective. Given the significant role that domestic NBFIs play in some EMs, there is an urgent need to address potential financial stability risks stemming from their activity by broadening the reach of macroprudential tools and strengthening their resilience, as well as by enhancing the transparency and data provision on NBFIs' activities in government bond markets. Appropriate regulation of NBFIs in both advanced and emerging market economies will help to lessen the cross-border contagion, a risk increasingly material to financial stability in emerging markets and developing economies.

The authors of this box are Andrea Deghi and Mustafa Yasin Yenice.

[1]For example, the severe stress in government bond markets during the March 2020 market turmoil highlighted the fragilities associated with some types of NBFIs (Hespeler and Suntheim, 2020; Egemen and Wooldridge, 2021).

[2] NBFIs can be classified into three main categories: end investors, arbitrageurs or liquidity providers. In principle, some NBFIs can perform more than one of these roles. The extent of participation by different types of NBFIs depends on the depth and liquidity of the market, the risk and return on sovereign bonds, and the presence of arbitrage opportunities. In turn, the influence of different types of NBFIs on government bond markets varies according to their investment strategies and pro-cyclicality of their investments.

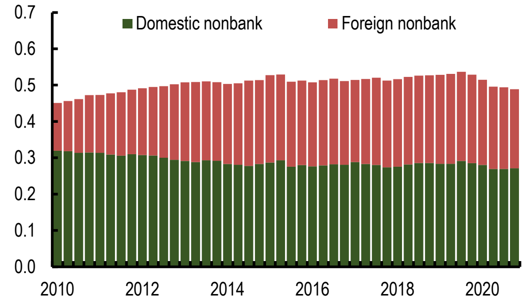
[3] The use of FX swaps to hedge currency mismatches in cross-border investments (especially for NBFIs with long-dated liabilities such as pension funds and insurance companies) could be another important channel of risk transmission. If market stress coincides with a large rollover of FX swaps, widening FX swap basis increases the costs of hedging and in turn risks from currency mismatches, as occurred during the outbreak of the Covid-19 crisis (Barajas and others (2020)).

[4] For example, South Africa sovereign rating changed from investment grade to high yield. This appeared to have played a role in the large capital outflows of the country.

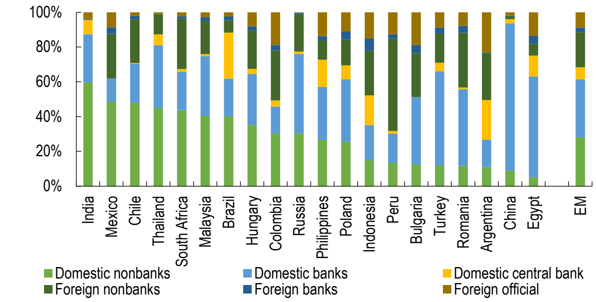
Figure 2.2.1. NBFI financing in Emerging Market Economies

Domestic and foreign NBFIs are major investors in public debt in some EMs…

1. Shares of Domestic and Foreign NBFIs in EMs General Government Debt
(Ratio)

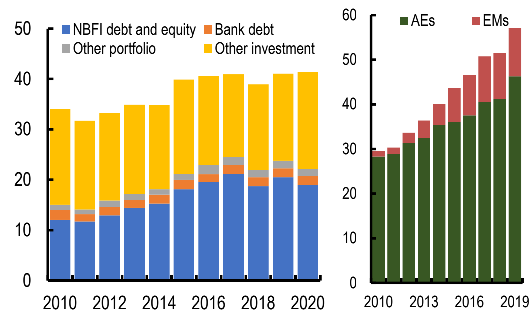


2. EMs General Government Debt Investor Base
(Percent of total general government debt, 2020)



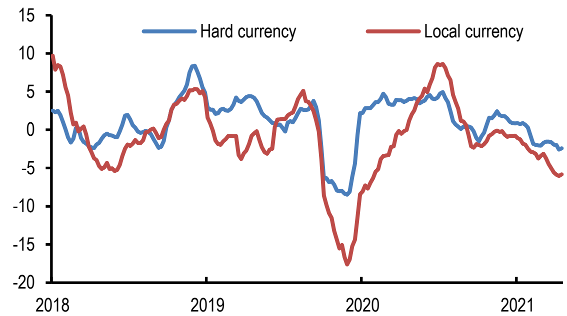
…and their importance in EM financial systems is growing.

3. EMs International Intermediation Liabilities and NBFI Financing
(Left panel, percent of GDP; Right panel, Trillions of US dollars)



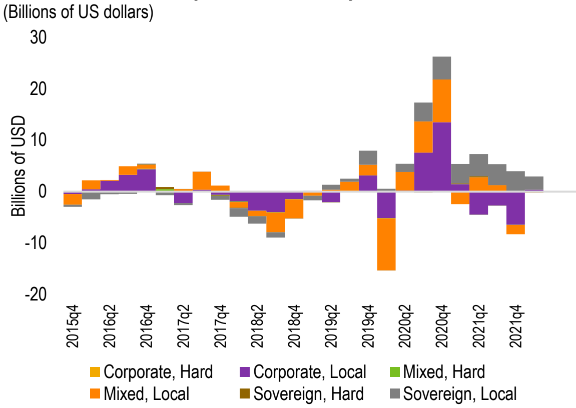
During the COVID-19 pandemic, mutual funds and ETFs investing in EME assets saw large outflows

4. EMs Mutual Funds and ETF net Bond Flows
(Percent of total net assets, 13-weeks rolling sum)



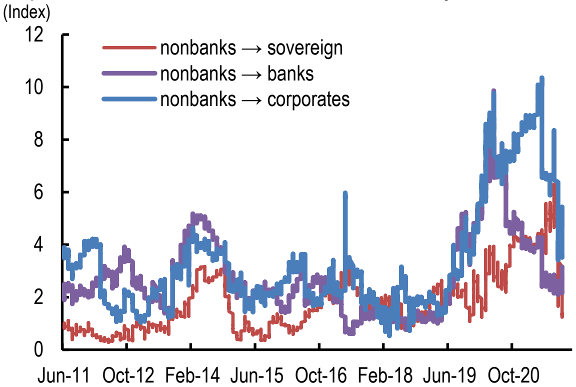
After the initial shock bond flows rebounded, especially those toward sovereign in local currency,,,

5. EMs Bond Fund flows by Sector and Currency
(Billions of US dollars)



…leading to spillover effects to other sectors of the economy

6. Spillovers from Nonbanks to Other Sectors of the Economy
(Index)



Sources: Arslanalp and Tsuda (2014); BIS, EPFR, Haver, Moody's and IMF staff calculations.
Note: In panel 1, the chart excludes China. In panel 3, NBFI financing refers to the total funding of non-bank financial entity types in EMs that authorities have assessed as being involved in credit intermediation activities that might pose bank-like financial stability risks and/or regulatory arbitrage. In panel 4, total EMs mutual funds and ETF bond flows are computed using a thirteen week rolling sum of weekly bond flows as a share of total net assets. Panel 6, shows the average spillover index across EMs in the sample computed as in Diebold and Yillmaz (2014) using daily data of expected default frequency for the nonbanks, sovereign, bank and corporate sectors.The analysis relies on the forecast error variance decomposition from a Vector Auto-Regression (VAR) model to obtain an estimate of the underlying network. The index ranges from 0 to 100. A larger level of the index indicates a larger interconnectedness across sectors. Given data availability, the sample of economies considered in the analysis includes China, Brazil, Chile, Indonesia, India, Malaysia, Peru, Philippines, South Africa, Thailand, and Turkey. EM = emerging market economies; NBFI = nonbanks financial institutions.

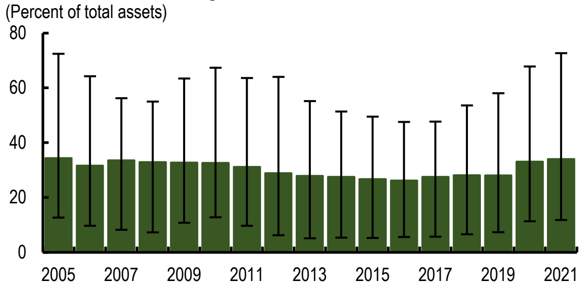
Online Annex 2.3. Additional Stylized Facts

Online Annex Figure 2.3.1. Share of EM Domestic Banks' Local Currency Government Sovereign Bonds

The share of domestic sovereign debt held by banks increased during the pandemic.

1. Government Bond Holdings of Banks

(Percent of total assets)



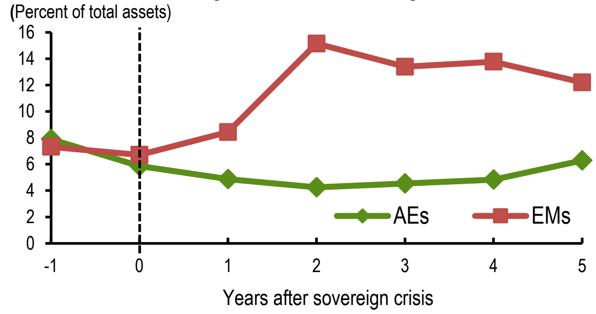
Source: Haver.
Note In the panel, the bar indicates the average government bond holding of banks as percent of total assets. The range indicates the minimum and maximum values in the sample for each year.

Online Annex Figure 2.3.2. Banks' Government Exposures After a Sovereign Crisis

Banks in EMs increase their government exposures more than banks in AEs after a sovereign crisis.

1. Government Bond Holdings of Banks after a Sovereign Crisis

(Percent of total assets)



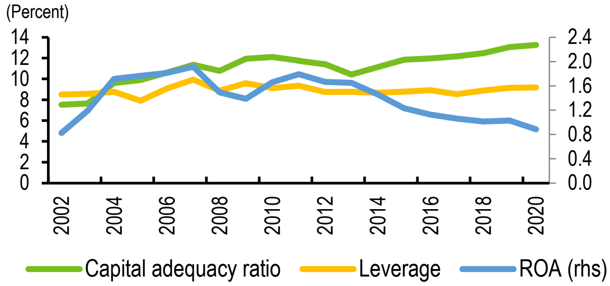
Sources: Haver MFS; Leaven and Valencia (2018); and IMF staff calculations.
Note: AEs=advanced economies, EMs=emerging markets.

Online Annex Figure 2.3.3. Banking Sector Soundness Indicators

EM banking sector continued to improve despite lower profitability in the post-GFC period…

1. Banks' Soundness Indicators

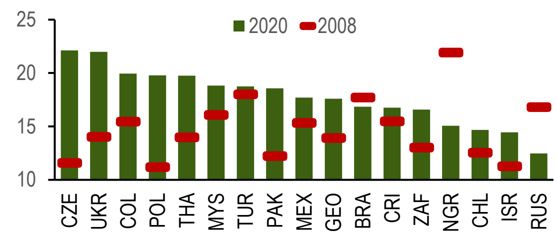
(Percent)



…but there are important differences across emerging market economies

2. Capital Adequacy Ratio

(Regulatory Capital/RWA, in percent)



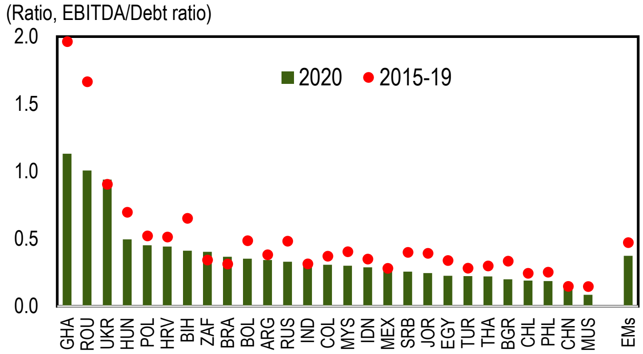
Sources: FSI database; Data compiled from banks' accounting statements and Pillar III disclosures; and IMF staff calculations.

Figure 2.3.4. Nonfinancial Corporate Sector Income to Debt Ratio and Bank Asset Quality in EMs

Corporates' ability to service debt has declined during the pandemic…

1. Corporate Income to Debt Ratio

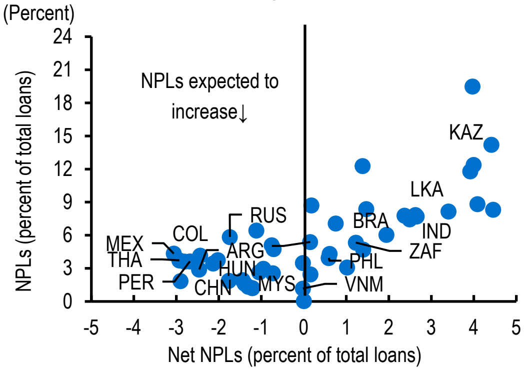
(Ratio, EBITDA/Debt ratio)



…and banks' balance sheets may have different level of resilience if more adverse scenarios were to occur

2. Net and Gross Non-Performing Loan Ratio, 2020

(Percent)



Sources: Haver; Capital IQ; and IMF staff calculations.
Note: In panel 2, net non-performing loan (NPL) ratio is gross nonperforming loan ratio less loan loss provisions to gross loans. Country labels use International Organization for Standardization (ISO) country codes. EBITDA = Earnings before interest, taxes, depreciation, and amortization; NPL = nonperforming loans.

Online Annex 2.4. The Drivers of Banks' Holdings of Sovereign Debt in Emerging Markets

This section describes the empirical methodology used for the analysis presented in Box 2.1 of Chapter 2. The analysis addresses two questions: i) What macroeconomic factors are associated with EM banks' holdings of sovereign debt? ii) What role do moral suasion and risk shifting play in EM banks' purchases of sovereign debt? The analysis proceeds in two steps. First, country-level data is used to analyze the macroeconomic drivers of banks' holdings of sovereign debt. Then bank-level data is used to further explore the moral suasion and risk-shifting channels in EMs.

Macroeconomic Drivers of Sovereign Bond Holdings

The empirical approach follows Dell'Ariccia and others (2018) and considers several factors that may determine banks' incentives to hold sovereign debt. Specifically, the following specification is estimated:

$$\begin{aligned} Sovereign\ Exposure_{c,t} &= \beta_1 Interest\ Rate_{c,t-1} + \beta_2 Public\ Debt_{c,t-1} + \beta_3 Depreciation_{c,t-1} + \beta_4 Inflation_{c,t-1} \\ &+ \beta_5\ Real\ GDP\ growth_{c,t-1} + \beta_6\ Real\ GDP\ per\ capita + \beta_7 Credit\ to\ GDP_{c,t-1} \\ &+ \beta_8 Stock\ Market\ Capitalization_{c,t-1} + \alpha_c + \gamma_t + \epsilon_{c,t} \qquad (1) \end{aligned}$$

where the dependent variable is banks' domestic sovereign debt holdings (in percent of total banking sector assets) in country ***c*** in year t,[1] and α_c and γ_t denote country and time-fixed effects, respectively. If government bonds are used for the purposes of portfolio and liquidity management, then banks would hold more government debt during periods of high interest rates,[2] in countries with weaker institutions (lower GDP per capita), and in countries with limited private sector lending and investment opportunities (proxied by lower private sector credit-to-GDP ratio, or lower stock market capitalization). Thus, we would expect $\beta_1 > 0$, $\beta_6 < 0$, $\beta_7 < 0$, and $\beta_8 < 0$. All independent variables are lagged one period. The model is estimated for a sample of 23 EMs over 2000-2020 using ordinary least squares with clustered standard errors (at the country level).[3] The exercise uses data from the IMF WEO and World Bank WDI databases for the country macro-level analysis as reported in Online Annex Table 2.1.1. Online Annex Table 2.4.1, panel 1, presents the estimation results for equation (1). Banks tend to hold more government debt when interest rates are high indicating that they seek higher returns. An increase by around 6 percentage points (corresponding to 1 standard deviation) in the interest rate leads to about 1.2 percentage points increase in bank holdings of sovereign debt relative to their assets. Banks also hold more government debt when there are fewer private sector lending opportunities, as captured by lower private sector credit to GDP ratio and stock market capitalization to GDP ratio. Bank holdings increase when the sovereign is more indebted (alluding perhaps to moral suasion or risk-shifting motives), and this increase is by about 5 percentage points when the gross public debt-to-GDP ratio increases by around 21 percentage points, or 1 standard deviation.

Moral Suasion and Risk Shifting

Moral suasion and risk shifting are two other potential reasons for banks' holdings of sovereign debt. Moral suasion refers to government pressure on banks to increase their investments in domestic public debt for the purposes of meeting government financing needs. Risk shifting by banks could occur during times of sovereign distress when banks—in particular, those that are less capitalized—increase their purchases of public debt to take advantage of higher sovereign yields and thus potentially improve their positions. Acharya and others (2015) and Ongena and others (2019) provide evidence of these two motives in the context of the euro area sovereign debt crisis.

The empirical analysis to identify moral suasion and risk shifting relies on bank-level data. It exploits the variation in the types of banks that are more likely to be pressurized in EMs during exogenous variations in fiscal need—such as domestic state-owned banks—with a particular focus on less-capitalized banks.[4] Thus, using state-owned banks as the control group and private banks as the treatment group, the working hypothesis to examine the existence of the moral suasion motive is that state-owned banks would be induced to hold more public debt in times of high fiscal

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[1] Total banking sector assets are calculated as the sum of bank reserves, banks' foreign assets, and their claims on central government, state and local governments, nonfinancial public enterprises, the private sector, and nonbank financial institutions.

[2] The results presented here are for the policy rate but remain robust to using the short-term interest rate instead.

[3] The data for this exercise is obtained from the IMF's WEO and World Bank WDI databases as reported in Online Annex Table 2.1.1.

[4] State-owned banks tend to be dominant in EMs, and, on average, hold about one-third of total banking sector assets.

need (where high fiscal need is defined as a large amount of maturing sovereign debt that would need to be refinanced).[5] The motive for risk shifting is examined by looking at whether state-owned banks that are less capitalized purchase more government debt during sovereign distress but not in normal times.

The baseline empirical specification that is estimated is thus as follows:

$$Net\ Purchases_{i,c,t} = \beta_1 High\ Fiscal\ Need_{c,t-1} \times State\ Owned_{i,c,t-1} + \beta_2 Capital\ Ratio_{i,c,t-1} \times State\ Owned_{i,c,t-1} + \beta_3 State\ Owned_{i,c,t-1} + \beta_5 Capital\ Ratio_{i,c,t-1} + \Gamma X_{i,c,t-1} + \gamma_{c,t} + \gamma_i + \varepsilon_{i,c,t} \quad (2)$$

where $Net\ Purchases_{i,c,t}$ denotes the log change in total government debt holdings of domestic bank i in country c from year t-1 to t, $High\ Fiscal\ Need_{c,t}$ is a binary variable that equals 1 if the expected maturing debt to total public debt ratio is above the country-specific 75th percentile over the sample period, $State\ Owned_{i,c,t}$ is a binary variable that equals 1 if a particular bank has more than 25 percent government ownership, $Capital\ Ratio_{i,c,t}$ is measured as the total equity-to-total assets ratio, and $X_{i,c,t}$ is a vector of bank controls mainly following Dell'Ariccia and others (2018) and Ongena and others (2019) that includes deposits-to-total assets ratio, total loans-to-deposits ratio and (log of) total assets.[6] All independent variables are lagged one period. The baseline model includes country-time fixed effects ($\gamma_{c,t}$), which absorb any time-varying country characteristics, and bank fixed effects (γ_i), which absorb any time-invariant bank characteristics. The model is estimated for a sample of about 4,000 banks from 38 countries over 2011-2020 using ordinary least squares, and standard errors are clustered at the bank level.[7]

The model is estimated separately over the full sample and during periods of sovereign distress. The key coefficients of interest are β_1 (moral suasion) and β_2(risk shifting). To identify the presence of moral suasion for state-owned banks, we would expect β_1 to be larger during sovereign distress, as the government pressures state-owned banks to purchase more debt. To identify the presence of risk shifting, we would expect β_3 to be significant only during times of sovereign distress and not over the entire sample period, suggesting that weaker banks would buy riskier debt. Sovereign distress is a dummy variable equal to 1 when the sovereign CDS is higher than 500 bps, or the S&P long-term rating for sovereign FX debt is CCC- or lower, or the government is in external or domestic default according to the Harvard Business School Global Crises Data by Country database.[8]

Online Annex Table 2.4.1, panel 2, presents the regression results. The first two columns report the results for the full sample, while the other two columns show the results for periods of sovereign distress. The results provide suggestive evidence of both moral suasion and risk shifting. As can be seen by the coefficient on $High\ Need \times State\ Owned$, state-owned bank's net purchases of domestic sovereign bonds are around 10 percentage points higher than private banks, during times of high fiscal need. During periods of high fiscal need when the sovereign is in distress, state-owned banks are more than twice as likely to purchase sovereign bonds, as their net purchases are 26 percentage points higher.

Furthermore, during times of sovereign distress the net purchases of sovereign bonds of less-capitalized state-owned banks are over 20 percentage points higher as can be seen by the coefficient on $Capital\ Ratio \times State\ Owned$ (the capital ratio is transformed to its standard deviation in the regressions). While it is possible that EM governments put more pressure on weaker state-owned banks in general, this coefficient is significant only during episodes of sovereign distress and not over the full sample, pointing toward the existence of some risk-shifting activities by more vulnerable banks when sovereign yields spike.

Further analysis shows that moral suasion and risk shifting effects are amplified at higher levels of sovereign distress (Online Annex Figure 2.4.1).[9] State-owned banks' additional purchases of domestic sovereign bonds during high

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[5] Maturing debt is an indicator of the amount of new public debt to be issued and is a plausibly exogenous independent variable.

[6] The variables in the regressions are winsorized at 1 percent in both tails of the distribution to mitigate any undue effects of outliers.

[7] To reduce outlier bias and noise in the data, banks with total assets less than $100,000, or banks with missing information on total assets, with government debt securities-to-total assets ratio greater than 1, loans-to-total assets ratio below 1 percent or above 100 percent, deposits-to-total assets less than 1 percent, and negative total equity or Tier 1 capital, are excluded from the sample. Further, to be included in the dataset, banks are required to have data for at least 5 consecutive years.

[8] Based on data availability, the final model includes 38 countries in normal times and 8 countries during times of sovereign distress. Maturing debt is available from 2011 onward, leading to a regression sample period of 2011-2020. Note also that the dataset does not allow to split sovereign bonds into domestic versus foreign bonds, or by currency. Therefore, it is not possible to analyze the relative attractiveness of foreign versus domestic bonds or the relative attractiveness of investing in foreign currency denominated bonds. While using the overall exposure to government in the analysis corresponds to assuming a strong home bias, the existence of a strong home bias has been reported in previous empirical literature (see, for example, Dell'Ariccia and others, 2016) and the share of foreign banks in government debt holdings is also generally low in EMs (Online Annex Figure 2.2.1, panel 2), such an assumption should not imply any loss of generality in the interpretation of the results.

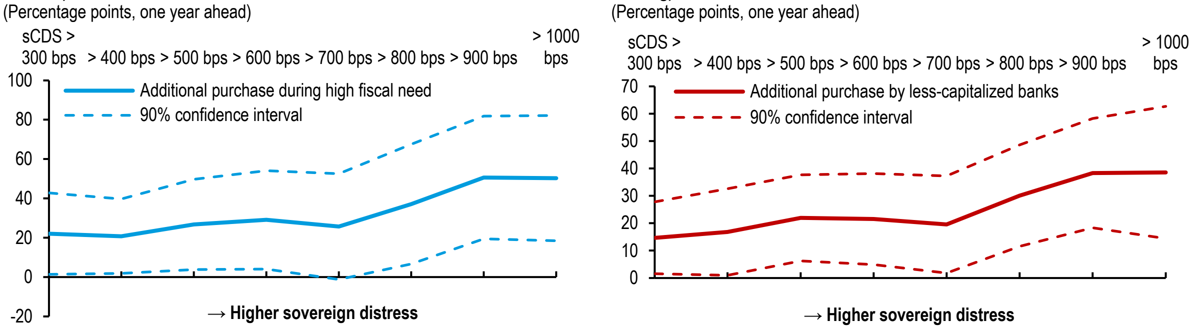
[9] To analyze the non-linear effects of sovereign distress, equation (2) is estimated for different levels of sovereign distress.

fiscal need periods almost double from 26 to 50 percentage points when the sovereign CDS threshold increases from 500 bps to 1000 bps. Less-capitalized state-owned banks' additional purchases increase by over 1.5 times to around 40 percentage points when the threshold sovereign CDS increases from 500 bps to 1000 bps.

Online Annex Figure 2.4.1. Non-Linear Threshold Effects for Moral Suasion and Risk Shifting

1. Net Purchases of State-Owned Banks During High Need Periods (Moral Suasion)
(Percentage points, one year ahead)

2. Net Purchases of State-Owned Banks That are Less Capitalized (Risk-Shifting)
(Percentage points, one year ahead)



Sources: Bloomberg, Fitch Connect, World Economic Outlook; and IMF staff calculations.
Note: The figures summarize results from bank panel regressions with fixed effects. The dependent variable is net puchases of soveriegn debt (log change in bank's sovereign bank holdings). The line for "moral suasion"corresponds to the effect for state-owned banks during episodes of high fiscal need, or when expected maturing debt as a share of total debt is above the 75th percentile for the sample period. The line for "risk shifting" correspondongs to the effect for state-owned banks that have a capital ratio which is standard deviation below the mean. Sovereign distress is a dummy variable equal to 1 when the sovereign CDS is higher than a threshold (300 bpts, 400 bpts, ..., or 1000 bpts), or S&P long-term rating for sovereign FX debt is CCC- or lower, or the government is in external/domestic default according to the Harvard Business School Global Crises Data by Country; 0 otherwise. All regressions include bank controls and bank and country-year fixed effects. Standard errors are clustered at the bank level. Bands indicate 90% confidence intervals.

Online Annex Table 2.4.1. Regression Results for the Drivers of Bank's Sovereign Debt Holdings

1. Macroeconomic drivers of banks' sovereign exposure

Sample	Cross-country	
Policy rate	0.24**	0.20*
	(0.10)	(0.10)
Gross public debt, % of GDP	0.24***	0.25***
	(0.03)	(0.03)
Change in NER (LC/USD)	-0.04**	-0.02
	(0.02)	(0.02)
CPI inflation (eop)	-0.17***	-0.24**
	(0.06)	(0.10)
Real GDP per capita	-0.62***	-0.64***
	(0.14)	(0.14)
Real GDP growth	-0.07	-0.16*
	(0.07)	(0.09)
Private sector credit, % of GDP		-0.11***
		(0.02)
Stock market cap, % of GDP		-0.03**
		(0.02)
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	391	359
R-squared	0.85	0.87
No. of countries	23	21

2. Moral suasion and risk-shifting motives

	Bank-level (full)		Bank-level (sovereign stress)	
State Owned	10.06	9.99	26.80***	25.88*
	(7.10)	(6.85)	(8.85)	(14.20)
High Need x State Owned	9.81*	9.88*	26.34*	25.75*
	(5.85)	(5.85)	(14.02)	(13.09)
Capital Ratio x State Owned	-6.63	-4.95	-21.64***	-24.28***
	(5.45)	(5.34)	(8.21)	(8.93)
Capital Ratio	8.92***	5.31*	17.80**	4.35
	(2.55)	(2.72)	(7.53)	(7.73)
Deposits/Assets		-0.11		0.14
		(0.22)		(0.54)
Loans/Deposits		0.03		-0.02
		(0.02)		(0.07)
Total Assets		-14.29**		-92.33***
		(5.73)		(17.65)
Bank FE	Yes	Yes	Yes	Yes
Country FE x Year FE	Yes	Yes	Yes	Yes
Observations	4,087	4,087	529	529
R-squared	0.28	0.28	0.31	0.35
Number of banks	665	665	111	111
Number of countries	38	38	8	8

Sources: Bloomberg Finance L.P.; Fitch Connect; IHS Markit; IMF, Monetary and Financial Statistics and World Economic Outlook databases; Standard & Poor's Capital IQ; and IMF staff calculations.
Note: Panel 1 presents regression results from cross-country panel regressions based on a sample period from 2000-20. The dependent variable is bank holdings of sovereign debt as a fraction of total banking sector assets. All independent variables are lagged. Standard errors clustered at the country level, and country and year fixed effects, are included in all specifications. Panel 2 presents presents results from bank-level panel regressions based on a sample period from 2011-20. The dependent variable is bank net purchases of soveriegn debt, measured as the log change in bank holdings. Sovereign distress is a dummy variable equal to 1 when the sovereign CDS is higher than 500 bpts, or S&P long-term rating for sovereign FX debt is CCC- or lower, or the government is in external/domestic default according to the Harvard Business School Global Crises Data by Country; 0 otherwise. The capital ratio is reported in terms of its standard deviation. All independent variables are lagged and all regressions include bank and country-year fixed effects. Standard errors are clustered at the bank level.

Online Annex 2.5. Measuring the Strength of the Nexus

This section describes the estimation methodology and data used to quantify the overall strength of the nexus in emerging markets (EMs). The exercise is conducted in two steps: first, country-specific SVAR models are estimated to gauge the size of the risk transmission between the sovereign, banking, and corporate sectors. Next, a panel analysis is performed to assess the impact of differences in fiscal and financial vulnerabilities on the strengthen of the nexus in the face of an adverse shock such as a tightening in global financial conditions.

SVAR Analysis

For each country in the sample, a SVAR analysis is performed to estimate the impact of the sovereign, banking, and corporate sectors on each other:

$$Ay_t = \tilde{a} + \tilde{A}_1 y_{t-1} + \cdots + \tilde{A}_p y_{t-p} + \tilde{\Gamma}_0 x_t + \cdots + \tilde{\Gamma}_q x_{t-q} + \epsilon_t \qquad (1)$$

where *t* indicates time, y_t is a vector of endogenous variables including sovereign risk, bank credit risk, non-financial corporate risk, term spread and equity prices. The matrix x_t is a vector of exogenous variables, including a measure of global financial conditions (or U.S. monetary policy shocks) and the return on a trade-weighted dollar index. $\tilde{A}_j$,$\tilde{\Gamma}_j$ are coefficient matrices with $j = 1, \ldots, p$ and ϵ_t is a vector of structural shocks with a diagonal variance matrix $\sum_\epsilon = E\left(\epsilon_t \epsilon'_t\right)$. The matrix, A, contains the contemporaneous effects of structural shocks on the endogenous variables and allows to track the strength of bilateral linkages between the sovereign, bank, and corporate sectors.

The sovereign, bank and corporate credit risks are captured by the expected default frequency (EDF) for each sector. The model controls for exogenous factors to capture global financial conditions, such as VIX or a common component estimated from changes in asset prices across a large sample of global stock markets. To account for non-stationarity of the data, the model is estimated in the first differences of EDF. For stock indices, the log difference is used.

To identify structural shocks to the endogenous variables, the analysis exploits the heteroskedasticity in the data following Rigobon (2003). This identification strategy relies on the fact that changes in the volatility of structural shocks contain additional information on the relationship between the endogenous variables. Thus, a period of large bank risk shocks, for example, contains more information about the response of sovereign risk to bank risk as the covariance between the two types of risks increases. Thus, bank risk shocks can be used as a “probabilistic instrument” to trace out the response of sovereign risk.

Identification Strategy

To estimate the structural parameters, we pre-multiply equation (1) by A^{-1} and define $c \equiv A^{-1}\tilde{c}, A_i \equiv A^{-1}\tilde{A}_i, \tilde{\Gamma}_j \equiv A^{-1}\tilde{\Gamma}_j$, which yields:

$$y_t = c + \mathrm{A}_1 y_{t-1} + \cdots + \mathrm{A}_\mathrm{p} y_{t-p} + \Gamma_0 x_t + \cdots + \Gamma_q x_{t-q} + \mathrm{u_t} \quad (2)$$

Here, $\mathrm{u_t}$ is a vector of reduced-form residuals. It is related to the structural shocks according to $\mathrm{u_t} = A^{-1}\epsilon_t$. The matrices c, A_i, Γ_j and $\sum_u$ of model (2) can be estimated consistently by ordinary least squares. To recover the structural parameters, the impact matrix is first estimated from (1) and (2), $\sum_u = \mathrm{A}^{-1} \sum_\epsilon (A^{-1})'$. In this system, the number of unknowns is larger than the number of independent equations. As additional information, the heteroskedasticity in the data is exploited.

Identification relies on a few relevant assumptions. First, the different types of structural shocks are uncorrelated. Second, the structural shocks are uncorrelated over time. Third, the ratio of the shock variances changes significantly across regimes. Fourth, A is constant across regimes.

The first assumption is common in structural vector autoregressions. Moreover, it is likely to hold in this setup as common effects are controlled for through exogenous variables which can affect the endogenous variables simultaneously. To make the second assumption likely to hold, three lags of the endogenous variables are included. The relatively large number of lags ensures that the reduced-form residuals do not suffer from autocorrelation.[1]

The third assumption can be tested after estimation by formally evaluating the inferred relative changes in volatility. While theoretically two regimes can be enough for identification, in practice larger systems tend to require more

[1] For all variables except stock returns, Portmanteau tests for lags 1 to 5 do not reject the null hypothesis of no autocorrelation at the 10 percent level.

regimes as there are more shocks to be disentangled. More regimes enhance the likelihood of finding a regime for each shock where that shock changes significantly in volatility vis-à-vis the other shocks. For this reason, five volatility regimes are used in the estimations. While four regimes are sufficient for identification, having one additional regime has the advantage that the fourth identifying assumption, the constancy of A, becomes overidentifying.[2] Classification of the regimes follows the approach described in Rigobon and Sack (2003). For each equation, residuals are classified into a high volatility regime when the 8-day rolling standard deviation of a given residual exceeds a threshold of 1, and those of the others do not (see Online Annex Table 2.5.1).

Online Annex Table 2.5.1. Days With Changes in the Volatility Regimes

Country	Δ Sovereign EDF	Δ Bank EDF	Δ NFCs EDF	Term spread	Δ equity prices	No volatility change
ARG	22	99	75	0	146	2,814
BRA	67	136	230	0	294	2,957
CHL	55	62	27	0	328	2,368
CHN	13	10	13	0	32	4,019
COL	81	20	24	64	65	3,275
IDN	7	136	24	83	42	3,829
IND	5	70	21	87	87	2,789
MYS	22	40	53	11	14	3,579
PER	56	8	49	72	52	3,883
PHL	36	78	24	138	86	3,759
POL	23	164	87	224	179	3,445
RUS	0	192	113	143	122	3,318
THA	38	77	5	0	465	3,536
TUR	55	53	223	15	64	3,712
ZAF	0	65	54	365	243	3,395

Sources: Datastream, Haver, Moody's; Datastream; and IMF staff calculations.
Note: columns in the table report the number of days with unique changes in volatility for each endogenous variables described in the baseline model. The classification of the regimes follows the approach described in Rigobon and Sack (2003). Country labels use International Organization for Standardization (ISO) country codes. EDF = expected default frequency.

For robustness, the main results of the analysis are tested against the use of a different number of volatility regimes (four instead of five) and different lag structures (from two to five lags of the endogenous variables). Results remain broadly consistent. Note thus that the identification through heteroskedasticity yields consistent estimates even if the regimes are misspecified (see Rigobon, 2003).

Effect of a Shock on Global Financial Conditions

To examine the effect of global financial shocks and their potential amplification through fiscal and financial vulnerabilities, the following model is estimated on panel data using a panel local projection methodology:[3]

$$y_{c,t+h} = \widetilde{a_h} + \tilde{A}_{1,\mathrm{h}} y_{c,t-1} + \cdots + \tilde{A}_{p,h} y_{c,t-p} + \tilde{\lambda}_{0,h} GFC_{t-q} \text{ x } \mathrm{Vulnerability}_{\mathrm{c,t-q}} + \cdots + \tilde{\lambda}_{q,h} GFC_{t-q} \text{ x } \mathrm{Vulnerability}_{\mathrm{c,t-q}} + \tilde{\gamma}_{0,h} \mathrm{Vulnerability}_{\mathrm{c,t-1}} + \cdots + \tilde{\gamma}_{q,h} \mathrm{Vulnerability}_{\mathrm{c,t-q}} + \tilde{\Gamma}_{0,\mathrm{h}} x_t + \cdots + \tilde{\Gamma}_{q,h} x_{t-q} + \epsilon_{c,t,h}\ , \quad (3)$$

where $y_{c,t+h}$ is the projection of endogenous variables at different time horizons *h*; *c* is a country*;* x_{t-q} refers to a vector of exogenous factors as described in the previous section and including an index of global financial conditions (GFC). $\mathrm{Vulnerability}_{c,t-q}$ indicates a pre-shock financial or fiscal vulnerability such as a high public debt-to-GDP ratio or high banks' government bond holdings-to-total assets. A high level of vulnerability corresponds to a value of the

[2] Two prominent alternative identification strategies in principle could be used. First, we could use zero restrictions on A, arguing for delayed responses of some endogenous variables to others. This seems too restrictive, however, as financial markets are likely to respond to each other in nearly continuous time. Second, we could use sign restrictions. They allow for contemporaneous effects among all variables. However, neither theory nor empirical evidence gives unambiguous predictions for the signs of several key parameters and it is the aim of the exercise to determine the signs empirically.

[3] This model is estimated using data at a quarterly frequency to maintain consistency between the observable frequency of the macroeconomic and financial variables.

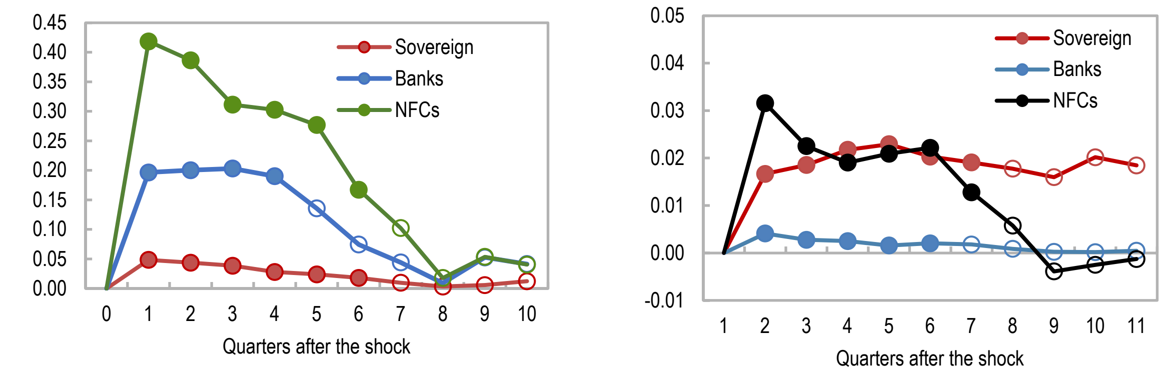
metric one standard deviation above the average of the sample distribution. Results from this model are shown in Figure 2.9 of Chapter 2.

The Online Annex Figure 2.5.1 shows the average effect of a global financial condition shock (proxied by a global financial conditions index[4] and the VIX index) as computed from the baseline model without interaction effects. The results show that, following a tightening in global financial conditions, banks and corporates are the most affected. For example, a tightening in global financial conditions corresponding to half of the magnitude observed during the March 2020 financial market turmoil is associated with, on average, a 0.4 percentage point increase in corporate default risk.[5] Furthermore, the effect is persistent, lasting at least four quarters after the shock.[6]

Online Annex Figure 2.5.1. The Effect of a Global Financial Shock on Default Risk across the Nexus

1. Change in Credit Risks Following a Shock to Global Financial Conditions (Percentage point)

2. Change in Credit Risks Following a Shock to VIX (Percentage point)



Sources: Haver Analytics; Moody's; Refinitiv Datastream; and IMF staff calculations.
Note: Solid dots indicate statistical significance at 10 percent or lower. The global financial condition shock is equal to about one unit change of the index (about one standard deviation).

Data

The SVAR analysis uses daily data for 15 major EMs over 2006-2020, while the panel model is estimated using quarterly data from 2006 to 2020. See Online Annex 2.1.1 for data sources. The EDF for sovereigns is CDS-implied, while for the banking and corporate sectors, it is computed as a simple average of the EDFs for individual banks and nonfinancial corporations, respectively, in a given country. The sample for this analysis comprises Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Malaysia, Peru, Philippines, Poland, South Africa, Thailand, Turkey, and Russia.

[4] See Annex 3.2 of the October 2017 Global Financial Stability Report;

[5] The effect of a tightening in global financial conditions on sovereign EDF is statistically and economically significant. For instance, the median sovereign edf is equal to 0.1 percent. The effect of a tightening in global financial conditions on one quarter ahead sovereign edf is thus more than half of the median value of the sovereign EDF.

[6] These results are broadly robust to using a different number of volatility regimes and lag structures.

Online Annex 2.6. Exposure Channel Analysis

Banks hold significant amount of sovereign debt**,** exposing them to fluctuations in sovereign creditworthiness.[1] To identify the effect of sovereign distress on banks' default risk, equity, and lending, cross-sectional variation in banks' holdings of government debt is exploited, following the extant literature (e.g., Acharya and Steffen 2015; Bofondi *et al.* 2017; Acharya *et al.* 2018; Gennaioli *et al.*, 2018).

Empirical Methodology

The estimated baseline empirical model is as follows:

$$\begin{aligned} Y_{i,c,t} = {} & \beta_1 Sovereign\ exposure_{i,c,t-1} \times Sovereign\ Distress_{c,t} \\ & + \beta_2 Sovereign\ exposure_{i,c,t-1} \times Sovereign\ Distress_{c,t} \times Capital\ Ratio_{i,c,t-1} \\ & + \beta_3 Sovereign\ exposure_{i,c,t-1} + \beta_4 Sovereign\ exposure_{i,c,t-1} \times Capital\ Ratio_{i,c,t-1} \\ & + \beta_5 Sovereign\ Distress_{c,t} \times Capital\ Ratio_{i,c,t-1} + \Gamma X_{i,c,t-1} + \gamma_{c,t} + \gamma_i + \varepsilon_{i,c,t} \qquad (1) \end{aligned}$$

where $Y_{i,c,t}$ alternatively reflects (i) change in bank's expected default frequency (EDF); (ii) change in pre-tax profits divided by lagged total equity; (iii) log change in total equity; (iv) change in total gross loans-to-total assets ratio; (v) log change in total gross loans; (vi) log change in total government debt holdings, of domestic bank *i* in country *c* from end-of-year *t-1* to end-of-year *t*.

$Sovereign\ exposure_{i,c,t-1}$ is total government bond holdings divided by total assets in *t-1* (year-end). $Sovereign\ Distress_{c,t}$ is an indicator variable equal to one if the sovereign is in distress in year *t* (or *t-1* for robustness). Specifically, it is equal to one if the sovereign CDS premium exceeds 500 bps (at least once on a monthly average basis during year *t*), or is in outright default (based on Harvard Business School Global Crises Data by Country or S&P rating of long-term foreign-currency debt of CCC- or lower); and zero otherwise. To explore possible non-linearities in the impact of sovereign stress, we consider more severe stress episodes, such as a higher threshold for CDS spreads (up to 1000 bps; as in Pescatori and Sy, 2007), as well as less severe episodes (based on a lower threshold for CDS spreads).[2]

$Capital\ Ratio_{i,c,t-1}$ is defined as total equity-to-total assets ratio in *t-1* (year-end). $X_{i,c,t-1}$ denotes bank-level control variables—lagged by one year—such as size (log of total assets), liquidity (non-cash assets-to-total assets ratio), profitability (return on assets), exposure to central bank-to-total assets, interbank balances (interest-earning balances with central and other banks-to-total assets), and loans outstanding-to-total assets. As in Gennaioli et al. (2018), (lagged) loans-to-total assets ratio in interaction with the sovereign stress variable is also included.

The model includes country-year fixed effects ($\gamma_{c,t}$) which absorb any time-varying country characteristics (potentially also controlling aggregate demand-side effects) and global factors (e.g., global risk aversion or foreign interest rates), and bank fixed effects (γ_i) absorbing any time-invariant bank characteristics. The model is estimated using ordinary least squares, and standard errors are clustered at the bank level.

Empirical Results

The key hypotheses are that banks with higher holdings of sovereign debt experience worse outcomes following a sovereign distress, and that banks with lower capital ratios face amplified effects. Effects of higher government exposures are estimated at the mean capital ratio and compared with banks with one standard deviation lower capital ratio than the mean. The analysis focuses on the immediate impact of sovereign distress, that is, the effect of a sovereign distress on bank outcome variables up to one year, to limit the potential bias through other competing factors that could potentially affect bank performance following sovereign distress events. The results are also qualitatively robust to studying alternative bank capital ratios, e.g., Common Equity Tier 1 capital ratio (though this significantly reduces the sample size). The results are presented in Online Annex Figure 2.6.1 and discussed below.

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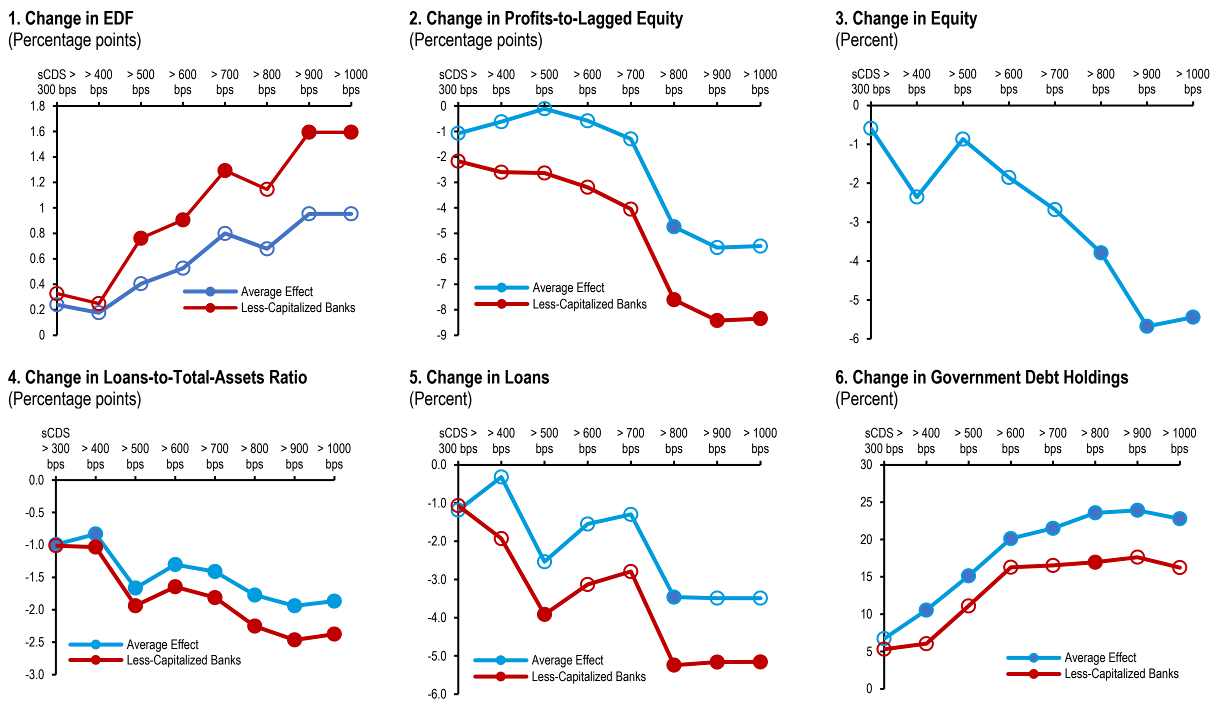
[1] A sovereign distress, for instance, could have a direct and immediate adverse impact on their income through mark-to-market valuation losses on those holdings. Banks' exposure to sovereign arises from various other channels, including through loans to or receivables from the government, government guarantees, or more broadly, indirect macroeconomic effects driven by exchange rate movements or changes in aggregate demand conditions (Acharya *et al.* 2018; Dell'Ariccia *et al.*, 2018; Gennaioli *et al.*, 2018; Feyen and Zuccardi (2019); and references therein).

[2] Non-linear effects may be driven by the non-linearity in sovereign bond price dynamics, as noted by Gennaioli et al. (2018), likely due to psychological factors (Pescatori and Sy, 2009) and change in marginal investors as sovereign distress increases.

Bank expected default frequency (EDF) (panel 1). Banks with ex-ante higher sovereign bond holdings experience a significantly higher increase in EDF following sovereign distress. Quantitatively, an ex-ante 10-percentage-points higher government debt holdings-to-total assets ratio (about 1 standard deviation higher holdings) relative to average bank holdings implies a greater than 0.4 percentage points increase in EDF when sovereign CDS premium is above 500 bps, with twice larger effects for less capitalized banks. For more severe sovereign distress events (higher thresholds for CDS spreads), the results are more robust, especially for less capitalized banks.[3]

Bank profits (panel 2). Higher bank EDF would transmit into higher borrowing spreads. Together with mark-to-market losses due to government debt holdings, banks with higher holdings would likely experience lower profits following sovereign distress. Panel 2 confirms this intuition, with the differential effect is driven by banks' government bond holdings being statistically significant for more severe sovereign stress events. Quantitatively, banks with ex-ante 10-percentage-points-higher government debt holdings-to-total assets ratio experience 5.5 percentage points decline in profits-to-lagged equity ratio following a severe sovereign distress (sovereign CDS premium above 1000 bps), with stronger effects for less capitalized banks (8.5 percentage points, close to ½ standard deviation of profit-to-equity ratio).

Online Annex Figure 2.6.1. The Effect of Sovereign Distress on Banks



Sources: Bloomberg Finance L.P.; Fitch Connect; IMF, World Economic Outlook database; IHS Markit; Standard & Poor's Capital IQ; and IMF staff calculations.
Note: The dependent variables change in EDF (panel 1), change in pre-tax profits-to-lagged equity (panel 2), log change in equity (panels 3), change in total loans-to-total assets ratio (panel 4), log change in total loans (panel 5), and log change in total government debt holdings (panel 6). Balance-sheet variables and expected default frequency are based on year-end data. The average effect is evaluated at the mean capital ratio (and given 10 percentage points higher bank sovereign exposure, which is close to one-standard deviation in the sample (11 percent)). The effect for "less capitalized" banks correspond to the effect at the capital ratio one standard deviation below the mean. The fiscal shock is a dummy variable equal to 1 when sovereign CDS is higher than a threshold (300 bps, 400 bps, ..., or 1000 bps) within a given year, or S&P long-term rating for sovereign FX debt is CCC- or lower, or the government is in external/domestic default according to the Harvard Business School Global Crises Data by Country; 0 otherwise. All regressions include bank controls to capture size (log of bank total assets), liquidity (non-cash assets to total assets), profitability (return on assets), exposure to central bank-to-total assets ratio and interbank balances-to-total assets ratio. All regressions include bank and country-year fixed effects. Standard errors are double clustered at the bank level. Filled markers denote statistical significance at 10% or lower. EDF = expected default frequency.

Bank equity (panel 3). Intuitively, lower profits could transmit into losses in equity. This is a key step to verify the balance-sheet-hit channel, as loss in equity would likely translate into lower risk-taking capacity and lending. Panel 3 confirms this intuition. Different from the main text of the chapter (which reports results for the change in equity divided by lagged total assets), here results are reported in percent change in total equity. The results show that banks with 10-percentage-points higher government debt holdings experience about 6 percent decline in equity

[3] The data for this exercise is based on a more limited sample of mostly larger banks (118 banks) compared to that in the other exercises in this section (525 banks).

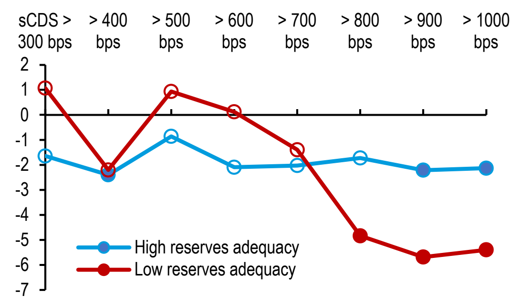
following a severe sovereign distress (premium above 1000 bps).[4] The estimated decline in equity reported here is close to balance-sheet-hit-driven equity losses observed during the euro area sovereign debt crisis (Acharya and others, 2018).

Bank total loan growth (panels 4 and 5). The results show that banks with ex-ante 10-percentage-point higher government debt holdings have 2.5 percentage-points-lower loans-to-total assets ratio (about 1/3 of a standard deviation). In line with the above findings, the results are stronger for less capitalized banks (4 percentage points) and for more severe distress episodes. There is also a 3.5 to 5 percent decline in total loan growth (for average and less-capitalized banks, respectively) during severe sovereign distress events (which is close to the magnitude observed for domestic banks in Italy during the European sovereign debt crisis (6 percent), as reported by, e.g., Bofondi *et al.* (2019).

Bank government debt holdings (panel 6). The result also shows that banks with ex-ante higher government debt holdings increase their holdings even more during sovereign distress times (especially after when sovereign CDS premium raises above 600 bps). This potentially reflects moral suasion, as during distressed times, governments face the greatest challenges in re-financing their debt, and given likely lower demand by international investors, it is most likely that domestic players are taking a greater role in the market during such times (see also Acharya *et al.,* 2018; Ongena *et al.,* 2019). The increase in government debt holdings is mostly similar (if anything, lower) for less capitalized banks, implying no strong evidence for risk-shifting, i.e., weakly capitalized banks' greater tendency to increase government debt holdings during those times to earn higher yields (see also Online Annex 2.4).

International reserves adequacy. External vulnerabilities also matter for the strength of shock transmission through the exposure channel in EMs. The adverse effects of sovereign stress on banks through their holdings of public debt are in general stronger in countries with lower international reserves adequacy (Online Annex Figure 2.6.2). A 10-percentage-point higher share of government debt holdings in banks domiciled in countries with low reserve adequacy leads to a nearly 5.5 percent additional decline in bank equity in the aftermath of a severe sovereign distress event (CDS spread above 1000 bps). Possible reasons for this effect include more limited policy space or greater associated stress in foreign exchange markets transmitting into stronger funding stress for domestic banks, more severe balance sheet effects (on banks or the non-financial sector) and worse aggregate demand conditions. This finding also underlines the importance of strong international reserve buffers.

Online Annex Figure 2.6.2. Change in Equity for Banks with Higher Government Exposure as a Function of the Country's Foreign Reserves Adequacy
(percent)



Sources: Bloomberg Finance L.P.; Fitch Connect; IMF, World Economic Outlook database; IHS Markit; Standard & Poor's Capital IQ; and IMF staff calculations.
Note: The figure shows results from bank panel regressions where the dependent variable is the log change in total equity. The focus variable is the ratio of holdings of government debt securities to total assets (sovereign exposure) interacted with sovereign distress dummy variable and a dummy variable indicating reserves adequacy (that is equal to 1 if short-term-external-debt-to-international-reserves ratio is above the sample average in the year prior to the sovereign distress (on average close to 0.5), and 0 otherwise. All other set of controls and fixed effects are as in the baseline empirical specification.

Robustness Analysis

Endogeneity concerns.

To mitigate potential endogeneity concerns between sovereign and banking sector stress events, alternative proxies of sovereign distress are considered. The first is an increase in fiscal debt due to an exchange rate depreciation, following Panizza and Presbitero (2013). This variable is computed by multiplying the volume of foreign-currency denominated public debt (in year *t-1*) with the log change in the exchange rate (from *t-1* to *t*) and normalizing this measure by total public debt (in *t-1*). One-year lag of this variable is used in the computations to further mitigate endogeneity concerns. Importantly, given that banks may differ in their exposure to changes in the exchange rate, (lagged) net open foreign currency position in the model (in

[4] The results are stronger if a stricter definition of sovereign distress is used. For example, using annual average of sovereign CDS to define distress years, rather than assuming sovereign distress if the CDS premium breaches the threshold in at least one month during the year, implies stronger effects (6-10 percent decline in equity). This, however, reduces the set of distressed countries/years substantially.

levels and in interaction with "increase in fiscal debt due to FX depreciation") are used as additional controls in the regressions.[5]

Second, we consider the volume of maturing debt as an exogenous measure of sovereign stress (à la Almeida *et al.*, 2009; Ongena *et al.*, 2019), as that is determined sufficiently in advance and is likely to be independent of stress in the banking sector. Specifically, our indicator variable takes a value 1 for a country in episodes where expected maturing debt-to-total fiscal debt is high (upper 1/3 of the distribution); and 0 otherwise. We multiply this measure with change in the (log of) VIX, given that a deterioration in global risk appetite (largely exogenous to EMs) would reduce international investors' demand for EM sovereign debt and increase debt rollover risks.

The results for these exercises with the change in equity-to-asset ratio and loan-to-asset ratio as dependent variables are presented in the main chapter, Figure 2.10, panel 4. Results for the other variables are also broadly in line with the findings above. Following a local currency depreciation inducing higher fiscal debt, banks with ex-ante higher government bond holdings experience a higher perceived expected default (albeit not significantly at conventional levels of statistical significance), and lower profitability, lower equity, and lower lending. Similarly, when global risk aversion is high (higher VIX), exposed banks in countries with high rollover risks experience lower profits, lower equity, and loans-to-total assets ratio, with increasing (but not significant) effect on bank default probabilities.[6]

Additional control variables. Banks are exposed to fluctuations in sovereign creditworthiness through various channels. For example, sovereigns' perceived repayment capacity could affect key macroeconomic variables (e.g., interest rates or exchange rates) and aggregate demand conditions, which affect interest- or exchange rate-sensitive bank balance sheet items, as well as credit demand and quality. To help account for these factors, additional control variables are added to the specification for robustness. Results are robust to controlling for expected real GDP growth (obtained from WEO vintages) and exchange rate depreciation interacted with sovereign distress to account for potential aggregate demand effects. Results are also broadly robust to using alternative exposure measures, such as the sensitivity of bank stock returns to sovereign bond yields, controlling for domestic macroeconomic and global factors.[7]

Data

The exercise in this section uses detailed annual unconsolidated financial statements for a large set of financial institutions from 18 EMs from 1998 to 2020.[8] The final data includes 525 domestic banks from 18 EMs (Argentina, Brazil, China, Colombia, Egypt, India, Indonesia, Malaysia, Pakistan, Peru, Philippines, Poland, Romania, Russian Federation, South Africa, Thailand, Turkey, and Vietnam). The data are complemented with various bank-level variables, including expected default frequency from Moody's, detailed ownership data from Orbis and yearly country-level information as described in Online Annex Table 2.1.1.

[5] As a full breakdown of currency denomination of external debt is generally not available for EMs, this analysis assumes that foreign-currency fiscal debt is denominated in US dollars. However, this should not affect the generality of the results considering that: i) US dollar is the dominant currency in EM sovereigns' hard-currency debt issuance and ii) EM bilateral exchange rate vis-a-vis the US dollar typically closely follows those vis-a-vis other major currencies due to strong presence of a common factor in foreign exchange markets.

[6] The full set of results are not reported here for brevity but are available upon request.

[7] In addition to sovereign bond holdings, lending to (or receivables from) governments and state guarantees could also expose bank balance sheets to sovereign creditworthiness. Such exposures could in fact be stronger in countries with less developed financial markets, e.g., EMs compared to advanced countries (Jobst and Oura, 2019). Due to lack of data, such exposures are not captured. To the extent that banks which hold more sovereign bonds also lend more to the government or are subject to state guarantees, our results should hold. Furthermore, due to lack of data, the analyses cannot reflect on the liability-side implications of government deposits at banks.

[8] To reduce outlier bias and noise in the data, banks with total assets less than $100,000, or banks with missing information on total assets, with government debt securities-to-total assets ratio greater than 1, loans-to-total assets ratio below 1 percent or above 100 percent, deposits-to-total assets less than 1 percent, and negative total equity or Tier 1 capital, are excluded from the sample. Further, banks with data set for at least 5 consecutive years are used. Despite this data cleaning, about 94 percent of total assets relative to the raw dataset is still preserved.

Online Annex 2.7. Safety Net Channel Analysis

This annex provides details of the bank-level data and econometric models used to analyze the association between EM banks' government support rating with their equity returns and risk-taking behavior.

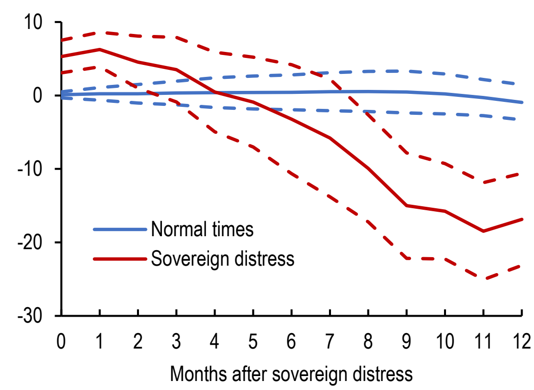
Empirical Methodology

The baseline (local projection) specification underlying Figure 2.11 of the chapter is as follows:

$$CAR_{i,c,t-1,h} = \beta_{1,h} SRF\ purge_{i,c,t-1} + \beta_{2,h} SRF\ purge_{i,c,t-1} \times Sovereign\ Distress_{c,t} + \lambda_h Controls_{i,c,t-1} + \theta_{c,t,h} + \lambda_{i,h} + \epsilon_{i,c,t-1,h} \quad (1)$$

where the dependent variable $CAR_{i,c,t-1,h}$ is the cumulative abnormal returns of bank i's stock from month $t-1$ to $t+h$, and the abnormal returns are derived from a capital asset pricing model (CAPM). Among the explanatory variables, $SRF\ purge_{i,c,t-1}$ is the one-month lagged Support Rating Floor (in numerical values) that is purged of domestic financial conditions, and $Sovereign\ Distress_{c,t}$ is a dummy variable that is equal to 1 if country c is in sovereign distress in month t.[1] The control variables are as of the end of the previous calendar year (t-1) and include the same set of variables as in the exposure channel analysis (equation 1). In addition, banks' government-bond-holdings-to-total-assets ratio is added to control for the impact of the exposure channel. The econometric model also includes country-month and bank fixed effects.

Online Annex Figure 2.7.1. Cumulative Abnormal Returns Associated with one Notch Higher Government Support Rating
(Percentage points)



Sources: Fitch Connect; IHS Markit; Refinitiv Datastream; Standard & Poor's Capital IQ; and IMF staff calculations.

The Online Annex Figure 2.7.1 presents the baseline estimates of $\beta_{1,h}$ and $\beta_{1,h} + \beta_{2,h}$, showing the relationship between banks' government support rating and future abnormal returns after the sovereign distress event and in normal times. In addition, the analysis includes interactions with pre-distress fiscal vulnerabilities (i.e., a dummy variable equal to 1 if the public-debt-to-GDP ratio is higher than 60 percent),[2] the results for which are shown in Figure 2.11 panel 2 of the chapter.

The econometric model underlying Figure 2.11 panel 3-4 in Chapter 2 is as follows:

$$Risktaking\_Indicator_{i,c,t-1,h} = \beta_{1,\mathrm{h}} SRF\ purge_{i,c,t} + \beta_{2,h} Bank\ Char_{i,c,t-1} + \beta_{3,\mathrm{h}} SRF\ purge_{i,c,t} \times Sovereig\ Distress_{c,t} + \beta_{4,\mathrm{h}} SRF\ purge_{i,c,t} \times Ban\ Char_{i,c,t-1} + \beta_{5,\mathrm{h}} SRF\ purge_{i,c,t} \times Ban\ Char_{i,c,t-1} \times Sovereign\ Distress_{c,t} + \lambda_h Controls_{i,c,t-1} + \theta_{c,t-1,\mathrm{h}} + \lambda_{i,\mathrm{h}} + \epsilon_{i,c,t-1,h} \quad (2)$$

where the dependent variable is either cumulative growth in bank i's gross loans from year t-1 to year t+h or the cumulative change in the non-performing loan ratio over the same period, both of which are taken as proxies for the intensity of banks' risk-taking activities. $Bank\_Char_{i,c,t-1}$ represents bank i's risk-taking related characteristics (i.e., capital-to-asset ratio), lagged one year. The model is estimated using annual frequency data using the ordinary least squares approach, with standard errors clustered at the bank level.

Additional Analysis

To examine whether the effect of government support on bank returns varies by the extent of sovereign stress, equation (1) is estimated at different thresholds of sovereign distress. The Online Annex Figure 2.7.2 shows the estimated cumulative abnormal returns associated with one notch higher Support Rating Floor for sovereign distress as defined in the baseline (CDS spreads greater than 500 bps), as well as for sovereign CDS spread over 400 bps (green) and 700 bps (red line). The findings confirm the presence of nonlinear effects—for instance, ten months after the sovereign distress, banks' abnormal returns decrease twice more if the sovereign was under extreme stress (i.e., CDS above 700 bps) relative to the baseline.

---

[1] The criteria for sovereign stress are same as those in the exposure channel analysis.

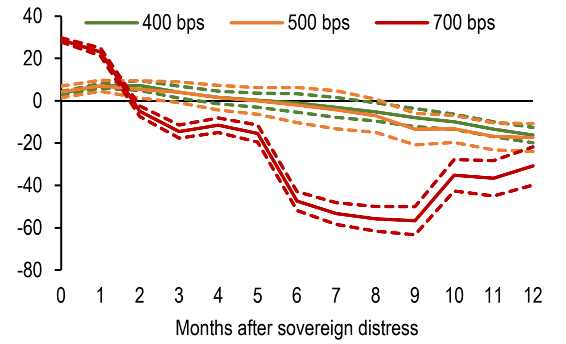
[2] We interpolate quarterly public-debt-to-GDP ratio from the International Institute of Finance to convert it proportionally to monthly frequency.

In addition, to confirm that the adverse projected impact of sovereign distress on bank stock returns is not due to prior (prolonged) sovereign stress, we include lagged (up to 12 months) sovereign stress dummies to isolate the projected impact of current sovereign stress from that of past sovereign stress events and estimate the following specification:

$$CAR_{i,c,t-1,h} = \sum_{s\in\{0,3,6,9,12\}}\left(\beta_{1,h,s} SRF\ purge_{i,c,t-s-1} + \beta_{2,h,s} SRF\ purge_{i,c,t-s-1} \times Sovereign\ Distress_{c,t-s}\right) + \lambda_h Controls_{i,c,t-1} + \theta_{c,t,h} + \lambda_{i,h} + \epsilon_{i,c,t-1,h} \quad (3)$$

where the dependent variable is bank i's abnormal return from month $t-1$ to t, and the explanatory variables are lagged Support Rating Floor and its interactions with sovereign stress shocks. The red line in Online Annex Figure 2.7.3 panel 1 shows the cumulative impact on higher government support rating banks' stock returns of more recent sovereign stress from this exercise, which confirms that the baseline results are not necessarily driven by prolonged sovereign distress.

Online Annex Figure 2.7.2. Cumulative Abnormal Returns of One Notch Higher Government Support Rating for Different Threshold of Sovereign Distress
(Percentage points)



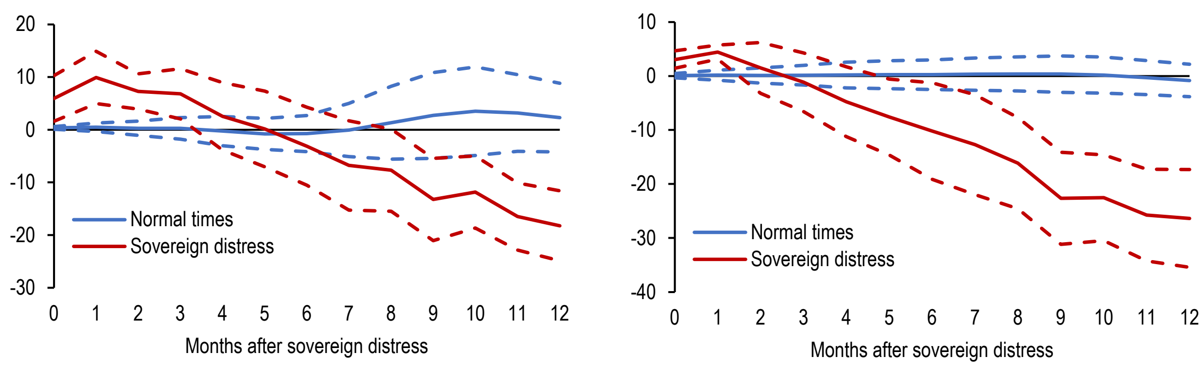
Sources: Fitch Connect; IHS Markit; Refinitiv Datastream; Standard & Poor's Capital IQ; and IMF staff calculations.
Note: The figure presents the relation between one-notch higher government support rating and future abnormal returns after sovereign distress under different degrees of severity. Lines in green, yellow, and red respectively represent the impact when the sovereign CDS spreads are above 400 bps, 500 bps, and 700 bps respectively. Dashed lines represent 90 percent confidence intervals.

Furthermore, to address the concern that banks' risk exposure could be time-varying especially after large shocks such as sovereign distress, a rolling-window CAPM is considered to compute abnormal stock returns.[3] As shown in Online Annex Figure 2.7.3 panel 2, the results of the baseline specification hold (and in fact get stronger after allowing for time-varying risk exposure by banks).

Online Annex Figure 2.7.3. Alternative Specification That Tests the Impact of Persistent Sovereign Stress

1. Cumulative Abnormal Returns Associated with one Notch Higher Government Support Rating (Robustness Test 1)
(Percentage points)

2. Cumulative Abnormal Returns Associated with one Notch Higher Government Support Rating (Robustness Test 2)
(Percentage points)



Sources: Fitch Connect; IHS Markit; Refinitiv Datastream; Standard & Poor's Capital IQ; and IMF staff calculations.
Note: Panel 1 presents the association between banks' abnormal return and Fitch Support Rating Floor when including quarterly lags of Support Rating Floor and its interaction with the sovereign stress dummy. The blue line is based on the estimates of $\beta_{1,h,0}$ and the red line shows $\beta_{1,h,0} + \beta_{2,h,0}$. In panel 2, abnormal returns are computed based on 24-month rolling-win,dow CAPM. In both charts, dashed lines represent 90 percent confidence intervals.

Data

In this analysis, the bank-level Support Rating Floor is downloaded from Fitch, with the ratings converted to discrete numerical values from 1 to 17 (higher values represent higher ratings). Unconsolidated bank-level annual financial

[3] Specifically abnormal returns are re-estimated based on a 24-month rolling window CAPM model. Banks' risk exposure to the market excess returns is estimated in each month based on the past 24-month excess returns. The intuition of this alternative test is based on the fact that banks' risk exposure could likely be time varying especially after large financial shocks such as sovereign distress. Thus, adopting rolling-window abnormal returns controls for banks' time-varying risk changes in the projection horizon. Results remain overall robust.

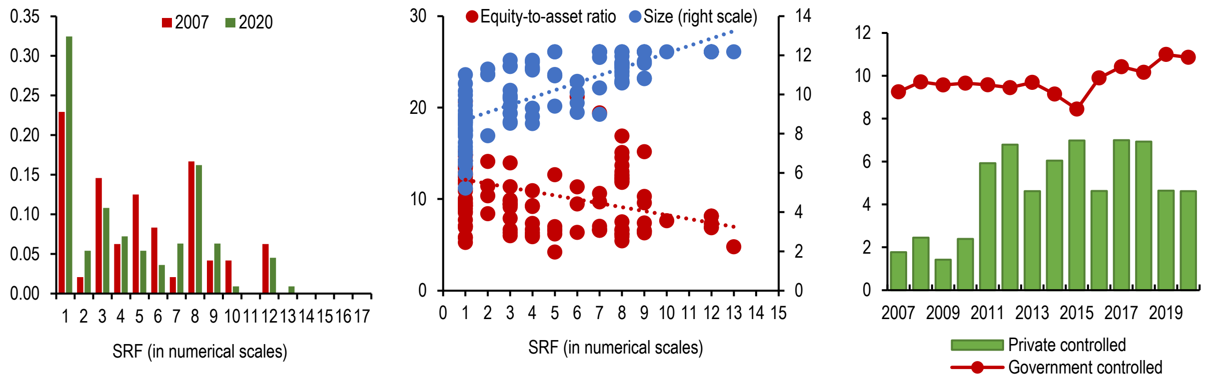
statements data are used.[4] In the baseline results in Figure 2.11 the sample covers 54 banks from 10 EMs, with monthly data available for monthly stock returns, bank-level Support Rating Floor and balance sheet data over the period September 2007-December 2020.

Online Annex Figure 2.7.4. Stylized Facts on Support Rating Floor in EMs

1. Distribution of Emerging Market Banks Across Notches of Support Rating Floor
(Support Rating Floor on a numerical scale from 0 to 17)

2. Relationship Between Support Rating Floor, Capital Ratio and Size
(Support Rating Floor on a numerical scale from 0 to 17)

3. Weighted Average of Support Rating Floor by Government Ownership
(Support Rating Floor on a numerical scale from 0 to 17)



Source: Fitch Connect; and IMF staff calculations.
Note: In panel 2, each dot represents one bank in the sample. In Panel 3, the weighted average is calculated based on bank total assets. Government-controlled banks are those with government ownership greater than 50 percent. The Support Rating Floor ranges from AAA to NF and is converted to a numeral scale of 1-17 (higher values correspond to higher rating or higher likelihood of receiving government support during distress).

The chapter's key safety net strength measure, Support Rating Floor (SRF), captures the propensity of receiving government support during bank distress. Since the Global Financial Crisis, the distribution of EM banks across the spectrum of these ratings has stayed broadly similar (Online Annex 2.7.4 panel 1).[5] The extent to which EM banks benefit from the public safety net varies across EMs and is importantly associated with bank-specific characteristics.

In general, there is a strong positive relationship between bank size and government support ratings, implying large implicit subsidies for too-big-to-fail banks (Online Annex Figure 2.7.4 panel 2, blue dots). In addition, banks with higher SRFs tend to have lower capital-to-asset ratios (Online Annex Figure 2.7.4 panel 2, red dots), pointing to potential moral hazard concerns. State-ownership is also closely tied to EM banks' level of government support: banks with a greater than 50 percent government ownership stake have notably higher SRFs (Online Annex Figure 2.7.4 panel 3).

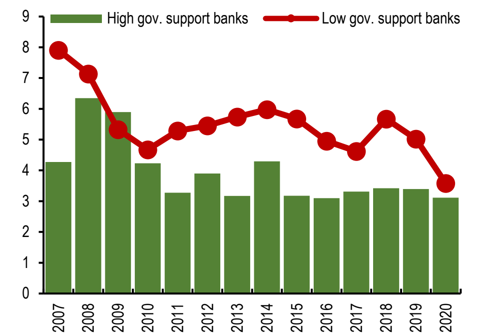
Banking sector's safety net appears to contribute to lower bank funding costs. With stronger implicit guarantees against future tail risks, depositors or creditors may require less risk premium on banks' funding. Conceptually, such safety net protection lowers banks' funding costs more substantially during normal times, when the cost of capital is most sensitive to the expectation of future distress (and implicitly also the expectation of future guarantees). During systemic bank distress, however, the funding cost advantage associated with safety net fades, as the large-scale systemic guarantees provide blanket "put" to the whole system.

[4] The exercises in the section use unconsolidated financial statements data in order to be consistent with other sections. However, stock returns and government support may be more related to a consolidated financial entity. In robustness checks that exploit consolidated financial statements data, the results still hold.

[5] By contrast, a large shift is evident for banks in advanced economies to the lowest rating, "no floor" (NF), which could at least partly be attributed to the implementation of too-big-to-fail (TBTF) resolution reforms post-2016. For instance, the Global Systemically Important Banks (G-SIBs) have been required both capital surcharges and reporting and disclosure requirements. In addition, all advanced-economy jurisdictions that are home to G-SIBs have imposed external Total Loss-Absorbing Capacity (TLAC) requirements. Thus, advanced economies, where most G-SIBs are based in, may see diminishing TBTF relations in the banking sector that precede these trends in EMs. Simple correlations between bank size and SRF support this and show that TBTF subsidies were similarly strong in both country groups before 2015. However, in advance economies, the TBTF subsidies have weakened notably since end-2015, reflecting market's anticipation of the TBTF resolution reforms in these countries.

Such time-varying funding cost advantage is supported by the evidence based on emerging market banks' interest expense. In "normal times" between the Global Financial Crisis and the COVID-19 Crisis, high-government-support banks featured remarkably lower total interest expense to total interest-bearing liabilities ratio. However, the difference in funding costs between the two groups became negligible during the Global Financial Crisis and the COVID-19 Crisis (Online Annex Figure 2.7.5).

Online Annex Figure 2.7.5. Weighted Average Total Interest Expense to Interest Bearing Liability Ratio
(Percent)



Source: Fitch Connect; and IMF staff calculations.
Note: The chart shows the weighted average total interest expense to interest bearing liability ratio for high Support Rating Floor banks and low Support Rating Floor banks. The weights are banks' current year total assets. The Support Rating Floor is considered to be high if it is higher than or equal to the median in the year. Otherwise, it is treated as low likelihood of receiving government support.

Online Annex 2.8: The Macroeconomic Channel Analysis

This annex explores the impact of sovereign rating downgrades on nonfinancial corporates' (firms, henceforth) investment and debt financing decisions. Following the identification strategy used in Almeida and others (2016), the analysis studies whether sovereign downgrades have had significant effects on EM firms' actions as a consequence of the sovereign ceiling policies that rating agencies typically apply. These policies imply a cap to firms' ratings at or below the sovereign rating of their country of domicile for these corporates. This is because rating agencies take into consideration macroeconomic risks such as capital and foreign exchange controls which could hamper a company ability to service its liabilities. The chapter's identification strategy is therefore based on a quasi-natural experiment where firms with a rating equal to or above their sovereign rating prior to the downgrade ("bound" firms) would be generally more likely to be downgraded after a sovereign downgrade than firms rated below their sovereign ("unbound" firms). Based on the asymmetric effect of sovereign downgrades on bound and unbound firms, the behavior of firms in terms of investment and debt issuance is studied.

Empirical Methodology

To estimate the direct impact of sovereign downgrades on the real economy, the chapter uses a difference-in-difference approach to compare changes in annual company investment ratio and net debt issuance between bound and non-bound firms around the time of a sovereign downgrade:

$$\Delta_h y_{c,j,s,t} = \beta_{1,h} Bound_{c,j,s,t-1} + \beta_{2,h} Sovereign\ Downgrade_{c,t} + \beta_{3,h} Bound_{c,j,s,t-1} \times Sovereign\ Downgrade_{c,t} + \beta_{4,h} Controls_{c,j,s,t-1} + \lambda_{s,h} + \gamma_{c,h} + \eta_{t,h} + \epsilon_{c,j,s,t,h} \quad (1)$$

where subscripts c, j, s, and t represent the country, firm, sector, and time, respectively. $\Delta_h y_{c,j,s,t}$ denotes the cumulative change in firms' investment or debt issuance over the next h years relative to the pre-downgrade period. The control variables are firms' size, Tobin's Q, cash flow, cash holdings, leverage, and government ownership. The regressions also include sector $\lambda_{s,h}$, country $\gamma_{c,h}$ and year fixed effects $\eta_{t,h}$. The working hypothesis is that bound firms cut investment and reduce debt issuance more than non-bound firms ($\beta_{3,h}$< 0) in the aftermath of a sovereign downgrade. Since some sovereign debt and banking crises happened simultaneously, we exclude those observations from the baseline sample. The banking crisis indicator used for this purpose are taken from Laeven and Valencia (2018).

Data and Stylized Facts

The data for this exercise relies on firms' consolidated data from S&P Capital IQ. The data comprises 84 unique sovereign downgrade events in 29 EMs, including 717 firms.

Online Annex Figure 2.8.1 (panel 1) shows the distribution of firm ratings by level of sovereign rating. As can be seen, a few firms have ratings above their respective sovereign ratings which are considered as the "bound" firms in the analysis, constituting 20.4 percent of the sample. The figure indicates that their ratings are higher by only a few notches at most with respect to sovereign ratings of their countries. Panel 2 in Online Annex Figure 2.8.1 shows the distribution of the difference between firms and sovereign ratings. The figure confirms again the rating discontinuity around the sovereign ceiling policies for firms.[1]

The discontinuity shown in these figures should be strictly related to sovereign downgrades and credit agencies ceiling rules. If other factors such as macroeconomic fundamentals where responsible, then the only explanation would be that these factors increased the credit risk for bound firms more than non-bound firms which would be counterintuitive. Since non-bound firms have by definition lower credit quality compared to bound firms, other explanations based on changes in fundamentals and credit risk cannot explain why the change in firms' investment and debt issuance is discontinuous around the sovereign ceiling.

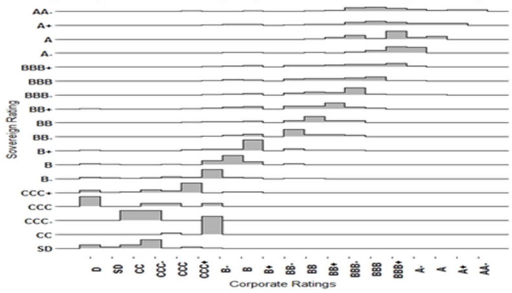
Online Annex Figure 2.8.1. panels 3 and 4 depict the evolution of investment and net debt issuance to asset ratios two years before and after sovereign downgrade events, respectively (the downgrade occurs at t=0). The panels

[1] The analysis here relies on the intuition based on Figure 2.12, panel 1, for the identification strategy in the assessment of impacts of sovereign downgrade on firms' ratings. The panels show the distribution of the cumulative change in firm ratings two years after a sovereign downgrade. It appears that the distribution of bound firms is more skewed to left as these firms have been downgraded more with respect to unbound firms, two years after a sovereign downgrade. As such, bound firms are more likely to be downgraded than unbound firms following a sovereign downgrade.

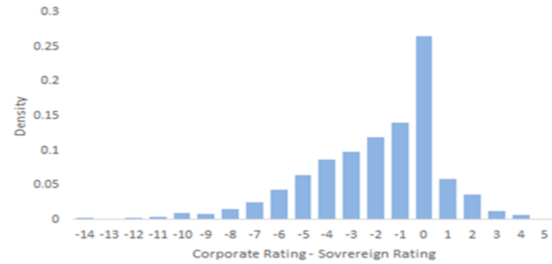
show that while bound and unbound firms have followed parallel trends before sovereign downgrade events, this tends not to be the case afterwards.

Online Annex Figure 2.8.1. Sovereign Downgrades and Bound vs. Unbound Firms in EMs

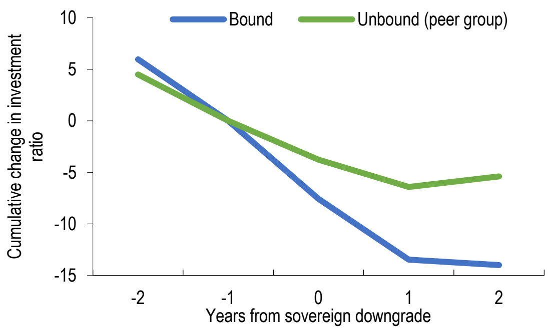
1. Frequency of Firm Ratings by Level of Sovereign Rating



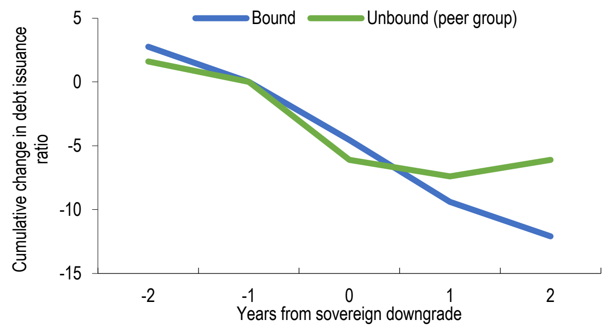
2. Distribution of Difference Between Firm and Sovereign Ratings



3. Change in Firm-Level Investment after a Sovereign Downgrade
(Percent)



4. Change in Firms-Level Debt Issuance after a Sovereign Downgrade
(Percent)



Sources: Haver Analytics; IHS Markit; Standard & Poor's Capital IQ; and IMF staff calculations.

Additional Analysis

To check the sensitivity of the baseline results, several robustness tests are conducted.[2] First, the estimates reported in Figure 2.12, panel 2 of Chapter 2 pertain to the cumulative change in investment ratio two years after a sovereign downgrade. However, further analysis shows that the difference across bound and unbound firms' cumulative change in investment ratio 3 years after a sovereign downgrade remains statistically significant. Thus, sovereign downgrades have a protracted impact on bound firms. Second, we formally test the assumption of parallel trends before a sovereign downgrade by considering the lagged values of "bound" firms, "sovereign downgrade" and their interaction term. The results show that the coefficient on lagged interaction term is not statistically significant when the cumulative change to the investment ratio two years after a downgrade is considered—suggesting no significant difference between the two groups in the pre-downgrade period. In addition, we also consider a stricter definition of bound firms compared to the baseline, by defining such firms as those whose ratings are higher than or equal to their sovereign ratings and the outlook for their government obligations is "negative" pre-downgrade. The results hold with this exercise, and compared to the baseline, the impact is 4.5 percentage points larger.

To rule out that the results may be driven by macroeconomic factors other than the sovereign downgrade, several placebo tests are conducted. For example, sovereign downgrades that are combined with recession years (two consecutive quarters with negative quarter-over-quarter real GDP growth rate) are excluded from the analysis, which does not make a significant difference to the results. In an alternative specification, the sovereign downgrade variable is replaced with an indicator variable for recession, but in that case, no statistically significant difference is found between bound and unbound firms in terms of investment ratio before and after the recession. In another test, the analysis considered the global financial crisis period (2008-2010) and sovereign downgrades that occurred during this period from the analysis were excluded. Finally, currency crisis episodes that are not accompanied by a sovereign downgrade are considered to address the concern that bound firms' liabilities might be more exposed to exchange

[2] The full results for these robustness exercises are available upon request.

rate movements than of unbound firms (due to possibly greater access to international capital markets). Again, both exercises point to no statistical differences between bound and unbound firms during these currency crises.[3]

As the number of bound firms is relatively small compared to the sample size of firms in EMs, for robustness bound firms are matched with comparable firms among unbound firms with the use of a matching technique. For this purpose, the analysis uses an estimator which isolates the bound firms during the periods of sovereign downgrade (treated firms) and then, from the population of non-treated firms, selects matched observations with similar covariate distributions to treated firms.[4] The covariates are firms' size, cash holding, cash flow, leverage, Tobin's Q, capital stock, investment ratio (ratio of capital expenditure to lagged capital stock), change in investment ratio, government ownership, year and country. The results of a difference-in-difference estimation around a sovereign downgrade by comparing the change in the variable of interest between the treatment (bound firms) and control (unbound firms) groups confirm that bound firms cut their investment and debt issuance by around 17 percentage points more than their peers two years after a downgrade.

The Indirect Impact of Sovereign Downgrade on Banks through Firms

The adverse impact of sovereign downgrades on non-financial firms' investment and debt issuance could in turn impact banks' balance sheets by affecting the credit risk of borrowers. In line with the sovereign downgrade impact on investment and debt issuance, the analysis in the chapter 2, figure 2.12, panel 4 investigates the impact of downgrades on banks NPL ratio through the importance of bound firms in the NFC sector. The sample covers 25 EM countries from 1995 to 2021. For this purpose, the section estimates the following equation:

$$\Delta_{\mathrm{h}} NPL_{c,t} = \beta_{1,h} Sovereign\ Downgrade_{c,t} + \beta_{2,h} (share\ of\ bound\ firms'\ assets\ to\ total\ assets)_{c,t-1} + \beta_{3,h}\ Sovereign\ Downgrade_{c,t} \times (share\ of\ bound\ firms'\ assets\ to\ total\ assets)_{c,t-1} + \beta_{4,h} Controls_{c,t} + \gamma_{c,h} + \eta_{t,h} + \epsilon_{c,t,h} \quad (2)$$

$\Delta_{\mathrm{h}} NPL_{c,t}$ is the change in the aggregate banking system in country c over the next h years from the pre-downgrade period. Sovereign downgrade is the same variable as in the previous analysis. In addition, the exercise uses the share of bound firms' asset to total corporate sector assets as a measure of the importance of bound firms in the macroeconomy. Controls include Financial Indicator Conditions (FCI), banks' equity to asset ratios, real GDP growth as well as double interaction terms and individual terms of the triple interaction in eq. (2). The coefficient of interest is $\beta_{3,h}$. The results show that in countries with a more dominant presence of bound firms in the corporate sector, banks' NPL ratio increase after the sovereign downgrade and the effect persists at least two years after the sovereign downgrade occurs. To rule out that the increase in NPL is due to smaller firms, an alternative specification is tested that controls for the country-median debt affordability (debt-to-EBITDA ratio) of small and mid-size firms,[5] as well as the lag of NPLs ratio to control for the past dynamics of NPLs. The results remain broadly consistent and statistically significant.

[3] The currency crises indicator is taken from the Harvard Business School Global Crises Data by Country.

[4] For this exercise, the estimator proposed in Ho, Imai, King, and Stuart (2007) is adopted. The estimator applies a genetic algorithm in the estimator to minimize the distance between the covariate distribution of treated and non-treated firms to match control firms. The estimator produces the exact number of matches for treated firms while it allows control firms to match more than one time with a given treatment observation.

[5] Small and mid-size companies are defined as firms with a number of employees equal or below 250.

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