

Corporate Currency Mismatch and Sovereign Risk*

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Abstract

Firms are an important part of the tax base. I ask how corporate currency mismatch, foreign-currency debt net of foreign assets, amplifies the sovereign spread's response to the exchange rate. I construct a novel dataset of about 42,000 listed non-financial firms in 57 countries. In emerging markets, the sovereign CDS spread rises 0.16 percentage points more in a 10 percent depreciation per 10 percentage points of mismatch. I develop a sovereign default model, calibrated to Indonesia, where firms deduct exchange-rate losses from taxable income. In a depreciation, mismatched firms pay less tax and invest less, raising the spread. Their foreign-currency debt accounts for almost half of the spread's response, 44 percent of that part through the corporate income tax. Excluding exchange-rate gains and losses from taxable income lowers this response. Firm owners gain 0.26 percent of consumption. Workers are unaffected at Indonesia's tax rates but would lose at higher rates.

JEL codes: E44, F31, F34, F41, G32, H25, H63.

Keywords: currency mismatch, foreign-currency debt, sovereign default, corporate income tax, exchange-rate losses.

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1 Introduction

“FX market stress can spill over to other asset classes, tightening financial conditions and posing risks to macrofinancial stability—especially in countries with significant currency mismatches and fiscal vulnerabilities.” (IMF, Global Financial Stability Report, October 2025)

The Russian ruble collapsed in the fourth quarter of 2014. The price of a US dollar rose from 39 to 56 rubles, a 43 percent rise in three months (Figure 1, top left). Over the same months the credit default swap (CDS) spread on Russian government debt, the price of insuring bondholders against default, nearly doubled, from 2.5 to 4.8 percentage points (top right).¹

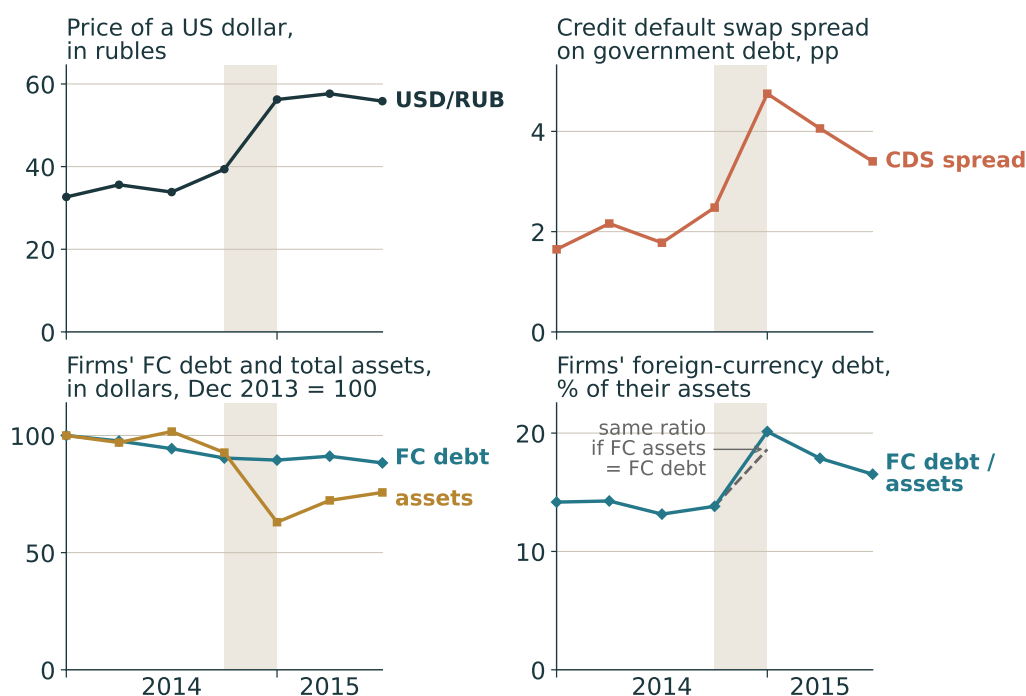


Figure 1: Russia's 2014 ruble crash

Notes: End-of-quarter values from S&P Capital IQ Pro. FC: foreign currency. The bottom panels sum over the privately owned listed non-financial corporations whose debt is classified by currency in every quarter. Shaded: 2014Q4. Dashed: the ratio if the firms' foreign-currency assets had equaled their foreign-currency debt at the end of September 2014, revalued at the exchange rate.

The crash also hit Russian firms. Measured in dollars, the foreign-currency debt of Russia's privately owned listed non-financial firms was about the same in December as in September, while the dollar value of their assets fell by a third, because almost all of those

¹The CDS spread is the annual premium, as a percent of the amount insured, that a buyer pays for insurance against a default by the government.

assets were in rubles. Their foreign-currency debt therefore rose from 14 to 20 percent of their assets in three months (bottom panels). The dashed line shows that, had these firms held as much in foreign-currency assets as they owed in foreign currency, the ratio would have risen less by December. These firms thus had a currency mismatch, which I define as foreign-currency debt net of foreign assets, as a share of total assets.

Could the firms' currency mismatch explain part of the jump in the government's spread? This paper asks how the firms' mismatch amplifies the response of sovereign risk to the exchange rate. The link this paper proposes is the tax channel. Firms are an important part of the government's tax base, directly through the corporate income tax and indirectly through taxes on their sales. In the median emerging market, the corporate income tax alone raised 17 percent of tax revenue in 2024. A depreciation that hits mismatched firms lowers their tax payments in two ways. In the year of the depreciation, the firms deduct their exchange-rate losses from their taxable profit. In the following years, they invest less, so they produce and earn less than they otherwise would.

To answer these questions, I first construct a novel firm-level dataset that measures this mismatch for listed non-financial corporations in 57 countries from 2010Q1 to 2025Q4. I document that mismatch is an emerging-market phenomenon. In every advanced economy in the sample, listed firms hold more foreign assets than foreign-currency debt on average.

The main empirical finding is that, across emerging markets, sovereign risk moves more with the exchange rate where overall corporate mismatch is higher. A 10 percent real depreciation goes with a CDS spread 0.35 percentage points higher where mismatch is zero, and a further 0.16 percentage points higher where mismatch is 10 percentage points higher.

Firm-level data and aggregate tax data support the tax channel. In a depreciation, mismatched firms earn lower profits, are more likely to report a loss, and invest less over the following year. The corporate income tax, the tax on these profits, is the most volatile tax in emerging markets. Most emerging markets let firms deduct an exchange-rate loss from taxable profit in the year the loss is booked. In those countries, firms with foreign-currency debt book a loss in a depreciation and owe less tax that year. And when aggregate corporate income tax revenue falls relative to GDP, the sovereign spread tends to rise the following year.

Motivated by the empirical findings, I develop a sovereign default model of a small open economy in the tradition of [Eaton and Gersovitz \(1981\)](#). Firms borrow from two pools

of financiers, one lending only in local currency and the other only in foreign currency, and their total borrowing is limited to a portion of the value of their capital. They hold a share of their capital abroad, sell a share of their output in foreign currency, and deduct their exchange-rate losses from taxable income, the rule in most emerging markets. The government borrows long term in foreign currency and cannot commit to repay. In a depreciation, mismatched firms deduct their exchange-rate loss from taxable income and, since they cannot borrow to make up for the net worth they lose, choose to invest less. Both leave the tax base smaller than otherwise, and the sovereign spread rises.

I calibrate the model to Indonesia, a large emerging market whose listed firms are among the most mismatched in the sample and whose tax code, like the model, deducts exchange-rate losses in the year they are booked. As an untargeted moment, the paper's main regression, run on panels simulated from the Indonesian economy, gives an amplification within one standard error of the one found in the data. To see how much of the spread's response to a depreciation comes from the debt side of the firms' mismatch, I compare the calibrated economy with one in which the same lenders lend only in local currency. The firms' foreign-currency debt accounts for almost half of the spread's response, and 44 percent of that part comes from the corporate income tax and the rest from lower investment and output the next year.

The results could depend on three features of Indonesia: its high mismatch, tax revenue of only 12 percent of GDP, and a corporate income tax that raises a third of that revenue. I therefore also calibrate the model to Brazil. In Brazil, listed firms hold more assets abroad than foreign-currency debt, tax revenue is 32 percent of GDP, and the corporate income tax raises a tenth of it. Brazil's spread responds less to a depreciation than Indonesia's, and foreign-currency borrowing adds less to it. When the Brazilian economy is given Indonesia's corporate mismatch, most of the gap between the two countries' responses closes, so the gap comes mainly from the firms' balance sheets.

I then use the model to evaluate three policies, one in the tax code and two that limit foreign-currency borrowing. Excluding exchange-rate gains and losses from taxable income, as in the tax codes of some economies, lowers the spread's response to a depreciation in both countries, with capital almost unchanged. A tax on foreign-currency borrowing or a cap on it also lowers the response, but at a welfare loss, because the firms lose credit and capital.

Who gains from excluding exchange-rate gains and losses depends on the tax rates. Firm owners gain in both countries, 0.26 percent of permanent consumption in Indonesia. Each

firm ignores that its borrowing raises the premia that all firms pay their financiers, so firms borrow more than is efficient. Under the policy, firms borrow slightly less, which in Indonesia lowers the premia they pay to foreign financiers. They also borrow more in foreign currency when they expect an exchange-rate gain, and that gain is no longer taxed. For workers, the policy moves revenue in two opposite directions. Revenue no longer falls with the firms' exchange-rate losses in a depreciation, so the transfers workers receive from the government fall less. But the government no longer taxes the firms' exchange-rate gains either, and the higher the tax rates on profits and sales, the more revenue it loses this way. At high tax rates, this loss outweighs the gain from steadier transfers, and workers lose. In Brazil, whose tax rates are higher, workers lose 0.20 percent. In Indonesia, workers' welfare does not change, so this change in the tax code lowers the spread's response without a welfare loss.

The government's exposure to the exchange rate thus includes the currency mismatch of the firms it taxes.

Related literature. This paper connects the quantitative sovereign-default literature with firm dynamics. That literature builds on [Eaton and Gersovitz \(1981\)](#) and [Arellano \(2008\)](#), with long-term debt as in [Chatterjee and Eyigungor \(2012\)](#). A production-based strand adds firms to endogenize the government's income. In [Mendoza and Yue \(2012\)](#) default tightens firms' access to working capital and lowers production and trade, and in [Arellano et al. \(2026\)](#) sovereign risk weakens the banks that hold government debt, which raises firms' borrowing costs and lowers output, most for the firms with the largest financing needs. In [Song and Mihalache \(2026\)](#) firms also affect the sovereign, since they do not internalize that their investment moves its default risk, and [Arce \(2024\)](#) shows that private overborrowing raises sovereign risk when the government funds bailouts with risky debt. As in [Song and Mihalache \(2026\)](#) and [Wu \(2025\)](#), firms take aggregate dynamics as given, while the government's default incentive depends on the aggregate capital stock, in [Wu \(2025\)](#), as here, through the tax base.

A second literature studies how exchange rates interact with corporate balance sheets, going back to the "original sin" diagnosis of [Eichengreen and Hausmann \(1999\)](#). [Aguiar \(2005\)](#) shows that depreciations improve competitiveness for exporters but raise the debt burden of firms that borrow in foreign currency while earning at home. [Bleakley and Cowan \(2008\)](#) find that Latin American firms with more dollar debt did not invest less after depreciations, and [Kalemli-Özcan et al. \(2021\)](#) find that firms cut leverage more after depreciations in countries with more foreign-currency debt. [Ottonello \(2021\)](#) and [Basu](#)

[et al. \(2025\)](#) study optimal exchange-rate and financial policy in small open economy models in which a depreciation tightens an external borrowing constraint, and [Akinci and Queralto \(2024\)](#) micro-found such a constraint. In my model the firms' borrowing limit does not tighten in a depreciation. The depreciation lowers the net worth of mismatched firms, as in [Céspedes et al. \(2004\)](#), and because the limit does not rise to cover the loss, the firms invest less. Unlike these models, mine follows the loss through the tax base to the government's incentive to default.

On measurement, firm-level studies of foreign-currency borrowing and its hedging have covered one country or a few: [Salomao and Varela \(2022\)](#) for Hungary, [Alfaro et al. \(2021\)](#) for Chile, and [Kamil \(2012\)](#) for six Latin American countries. Aggregate measures of currency exposure build on a country's cross-border positions ([Lane and Shambaugh, 2010](#)) or on its non-government sector as a whole ([Chui et al., 2018](#)). I measure mismatch at the firm level, net of foreign assets, for 57 countries, including the foreign-currency debt that firms owe to domestic lenders.

[Della Corte et al. \(2022\)](#) show that higher sovereign CDS spreads go with a weaker currency. Closest to this paper are three studies that link the private sector's foreign-currency debt to sovereign risk. [Bernoth and Herwartz \(2021\)](#) show, in a structural VAR for sixteen emerging economies, that sovereign risk responds more to depreciations where the non-government sector's net foreign-currency position is more negative, measured as a country-level aggregate used to split the sample in two. [Du and Schreger \(2022\)](#) relate corporate foreign-currency debt to sovereign spreads. [Wu \(2025\)](#) finds that more corporate foreign-currency debt goes with a higher sovereign risk premium but not a higher default probability, and that tax revenue falls more in a depreciation where corporate dollar debt is higher. His model also taxes corporate profit net of exchange-rate gains and losses, and his foreign lenders are risk averse. Relative to these papers, I measure the amplification of sovereign risk in a depreciation with firm-level mismatch and quantify it in a sovereign default model. My foreign lenders are risk neutral, so the link runs through the default probability. It works through two mechanisms: the deduction of exchange-rate losses, which I document in tax codes and in the firms' tax bills, and lower investment. I also compare ending the deduction with limits on foreign-currency borrowing. [Wu \(2025\)](#) and this paper thus ask different questions about the same link and are complementary.

Outline. The paper is organized as follows. Section 2 describes the data and the empirical evidence, Section 3 develops the model, Section 4 calibrates it, Section 5 reports the counterfactuals, and Section 6 concludes.

2 Motivating Empirical Evidence

This section describes the novel firm-level data used to measure corporate currency mismatch, presents the paper’s main empirical finding, and then documents evidence on the channel behind it. The main finding is that, across emerging markets, the larger the currency mismatch of a country’s non-financial corporate sector, the more the country’s sovereign credit default swap (CDS) spread moves with the real exchange rate. This paper proposes that the channel is the tax base.

Sample. The primary data source is S&P Capital IQ Pro, which reports balance sheet and income statement data for listed non-financial corporations at quarterly frequency. The sample covers 41,822 firms from 57 countries between 2010Q1 and 2025Q4 and excludes government-owned firms.² Of the 57 countries, 30 are emerging markets and 27 are advanced economies according to the IMF’s World Economic Outlook classification at the end of the sample period. Appendix A.2 lists the countries and the number of firms in each.

Listed firms are a considerable part of the economy. Table 1 compares the listed firms in the dataset with the economy they operate in on three ratios: their aggregate revenue to gross output, their aggregate capital expenditure to gross fixed capital formation, and their aggregate foreign-currency debt to the government’s foreign-currency debt. Each entry is the median across countries of the country’s average ratio. Listed firms’ revenue amounts to 18 percent of gross output and their capital expenditure to 13 percent of gross fixed capital formation. Their foreign-currency debt is about as large as the government’s own in the median country. Shocks to these firms’ balance sheets are therefore large enough to matter for the economy as a whole.

There are two novelties in the dataset. The first is the Capital Structure module, which lists a firm’s debt instrument by instrument and which, to my knowledge, has not been used before to measure foreign-currency debt at this scale. Bruno and Shin (2023) use it to study Mexican firms. Here it covers the listed corporations of 57 countries.³ The second is the Geographic Segments module, which reports a firm’s assets and revenue by

²S&P Capital IQ reports consolidated statements, which include a firm’s subsidiaries. Some of these subsidiaries are listed and in the sample themselves, under 4 percent of the firms, and they are small: in the average country those whose parent is in the same country hold 1.8 percent of the assets used to measure corporate currency mismatch. Excluding them leaves the results essentially unchanged (Appendix B.4).

³Du and Schreger (2022) measure the currency composition of external debt, that is, debt owed to foreign investors, by sector for 14 emerging markets. The measure here covers all of a firm’s debt, including foreign-currency debt owed to domestic lenders.

Table 1: Listed non-financial corporations relative to the economy

	Median of country means
Revenue / gross output	17.6%
CapEx / gross fixed capital formation	12.6%
FC debt / government FC debt	100%

Notes: Each entry is the median across countries of the country's mean over 2010–2024 (to 2022 for gross output, where the TiVA tables end). Gross output is from the OECD inter-country input-output (TiVA) tables and gross fixed capital formation from S&P Capital IQ Pro. Each of the first two rows covers 53 countries. Government foreign-currency debt is general government debt times its foreign-currency share from [Arslanalp and Tsuda \(2012\)](#) and [Arslanalp and Tsuda \(2014\)](#), which cover 54 of the 57 countries. The third row covers the 48 countries whose government has foreign-currency debt. In the median emerging market the three ratios are 13.2, 8.8 and 54 percent.

location. As far as I know, this paper is the first to use it to measure firms' foreign assets and foreign revenue. Both modules had to be labeled by hand. An instrument without a reported repayment currency comes with only a short description, and a segment comes with only the name the firm gives it. I label every distinct description and segment name, country by country.

Foreign-currency debt data. In the Capital Structure data, most debt instruments carry a repayment currency reported by the provider. I label an instrument as local-currency (LC) debt if its repayment currency is legal tender in the firm's home country and as foreign-currency (FC) debt otherwise. When the repayment currency is missing, I classify the instrument from its description and/or the benchmark rate it pays. For instance, an instrument described as an overseas public debenture is foreign-currency debt for a Korean firm, while a loan priced at EURIBOR plus a margin is local-currency debt for a French firm. Instruments for which neither settles the currency are left unlabeled.⁴ Appendix A.3 describes the rules and reports coverage by country. Foreign-currency debt is almost entirely in hard currency. Table 2 reports its currency composition in two ways. First, as a share of the foreign-currency debt of all sample firms together: the US dollar accounts for 68 percent and the euro for 20 percent. Second, as the average across the 57 countries of each currency's share in a country's foreign-currency debt, which gives every country the same weight: on this measure the dollar accounts for 73 percent.

⁴In the data for the 57 sample countries, 208,085 instrument records lack a repayment currency and carry 44,548 distinct descriptions, and the rules label 100,558 of these records. In the estimation sample, the provider's currency covers 98.0 percent of debt by value, the rules add 0.7 percentage points, and 1.3 percent stays unlabeled and is excluded from the shares.

Foreign assets and export revenue data. I label each segment relative to the firm’s home country. For example, a segment located anywhere in Indonesia, say Jakarta, is local for an Indonesian firm, and a segment located in any other country is foreign. Local is defined by currency area rather than by country, so for a firm in the euro area, assets located and revenue earned in other euro-area countries count as local.

Firms name their segments as they choose, “Jakarta”, “North America” or “Rest of world”, so every distinct name has to be read and judged. I do this country by country: for each country I build a dictionary that assigns every name the firms of that country use to local or foreign.⁵

Two shares come out of this: the foreign share of a firm’s assets and the foreign share of its revenue, which I call the export share. Appendix A.3 describes in detail how both shares are built.

Defining currency mismatch. In the spirit of Goldstein and Turner (2004), Cowan et al. (2005) and Hardy (2023), I define the currency mismatch of a firm on its balance sheet as:

$$\text{Currency mismatch}_{i,c,t} = \frac{\text{Foreign-currency debt}_{i,c,t} - \text{Foreign assets}_{i,c,t}}{\text{Total assets}_{i,c,t}}$$

Currency mismatch of a firm is its foreign-currency debt in excess of its foreign assets, as a share of its total assets. It is positive for a firm whose foreign-currency debt exceeds its foreign assets and negative otherwise. Both terms are stocks, so the measure is comparable across firms like a leverage ratio.

Foreign-currency debt implies foreign-currency outflows, and Figure 2a shows that the foreign asset share implies foreign-currency inflows as well. Firms that earn more of their revenue abroad also hold more of their assets abroad. The same holds at the country level (Figure 2b): across country-quarters the two shares move together closely, and in the median country the export share exceeds the foreign share of assets by about 6 percentage points. This suggests that the currency mismatch defined on the balance sheet also reflects a currency mismatch in flows.

The measure has two limitations that come from the data. First, assets are labeled by location, not by currency. For example, dollar deposits that an Indonesian firm holds at

⁵Firms use about 9,400 distinct segment names. The same name has to be judged separately in each country, which makes 15,169 country–name pairs on the revenue side and 13,508 on the asset side. Under these dictionaries, 93 percent of segment revenue and 98 percent of segment assets, by value, end up labeled local or foreign.

Table 2: Currency composition of foreign-currency corporate debt

	Share of total value	Average country	25th–75th percentile
USD	67.5%	72.8%	63.6–92.9%
EUR	19.6%	14.0%	0.1–14.1%
GBP	3.7%	2.5%	0.0–2.4%
CNY	3.2%	1.5%	0.0–0.3%
JPY	1.0%	1.2%	0.0–1.4%
All other currencies	5.0%	8.0%	1.7–11.1%

Notes: The first column is each currency’s share of the foreign-currency debt of all sample firms together. For the other two, I compute each currency’s share of each country’s foreign-currency debt over 2010–2025. The second column averages these shares across the 57 countries, giving every country the same weight, and the third reports their 25th and 75th percentiles across countries. For sterling and the renminbi the average exceeds the 75th percentile because a few countries borrow heavily in them: half of Hong Kong’s foreign-currency debt is in renminbi, and sterling is above a tenth of foreign-currency debt in six countries.

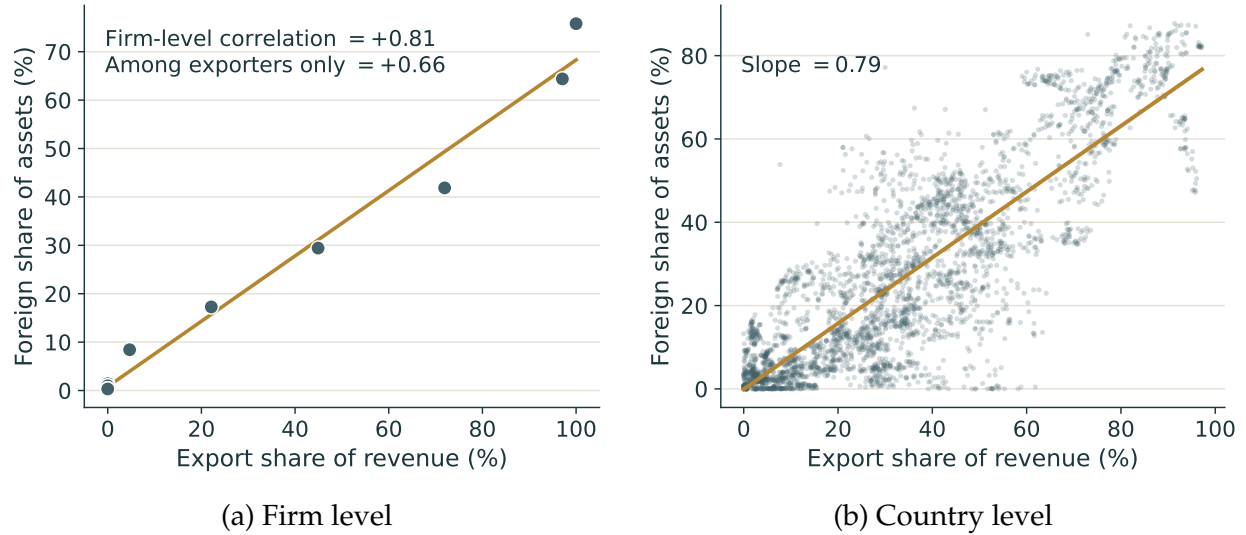


Figure 2: Export share of revenue and foreign share of assets

Notes: (a) Firm-quarters are sorted into 20 equal-sized bins by export share, and each dot is a bin’s average export share and average foreign share of assets. Most firm-quarters have no exports and almost no foreign assets, so 14 of the 20 bins lie on top of one another near (0, 0). The correlations are across firms, on each firm’s average shares (for exporters, over its quarters with exports), and the line is the least-squares fit through the bins. (b) Each dot is a country-quarter: the asset-weighted export share and foreign share of assets of the country’s eligible firms, 3,365 country-quarters in 57 countries. The line is the least-squares fit, slope 0.79.

a bank in New York count as foreign assets, but the same deposits at a bank in Jakarta count as local. Foreign-currency cash, deposits and receivables held at home are missed. The foreign asset share is therefore a proxy for the foreign-currency share of assets, which firm-level data rarely report.⁶ Second, the data contain no FX swaps or forwards, so financial hedges are not netted out. Where firm-level derivatives data exist, hedging is partial and concentrated: [Salomao and Varela \(2022\)](#) cite a survey in which only 4 percent of Hungarian small and medium-sized firms with foreign-currency debt used foreign-exchange derivatives, and report central bank data putting the figure at 6 percent in Peru. [Alfaro et al. \(2021\)](#), using the universe of Chilean derivative contracts, find that cross-currency swaps cover 65 percent of the foreign-currency debt of the firms that hedge but only 14 percent in aggregate, and that the firms that hedge are the largest exporters, importers and foreign-currency borrowers. Considering these data limitations, the currency mismatch measured in this paper is a proxy, not an exact accounting.

Summary statistics. Table 3 reports summary statistics for the firm-level measures. Most firms are purely domestic: 54 percent of the firm-quarters with a currency mismatch carry neither foreign-currency debt nor foreign assets, so their currency mismatch is exactly zero. Most firm-quarters carry no foreign-currency debt and earn no revenue abroad, which is why every median of the currency rows in Panel A is zero. Conditional on borrowing in foreign currency (Panel B), the magnitudes are substantial: about half of a foreign-currency borrower’s debt is in foreign currency, its foreign-currency debt amounts to 12 percent of its assets, and its export share is twice the unconditional mean. Foreign-currency borrowers are also the larger firms of their countries: the median borrower sits at the 73rd percentile of the size distribution of its country and quarter. They hold large foreign assets, however, so the mean currency mismatch is negative.

Country-level corporate currency mismatch. To measure the overall currency mismatch of a country’s corporate sector, I aggregate the firm-level measure to the country-quarter level as the asset-weighted average of currency mismatch across the country’s eligible firms:

⁶Studies that measure the foreign-currency composition of assets have had to hand-collect it from the notes to financial statements, for one country or a few: [Cowan et al. \(2005\)](#) for Chile and [Kamil \(2012\)](#) for six Latin American countries.

Table 3: Summary statistics of the firm-level measures (percent)

Measure	Mean	Median	S.D.	N
<i>Panel A: all firm-quarters</i>				
Total debt / assets	22.46	17.09	22.97	1,723,915
FC debt share	10.32	0.00	27.10	1,511,979
FC debt / assets	2.34	0.00	7.03	1,511,629
Export share	21.68	0.00	35.03	889,511
Currency mismatch	-15.86	0.00	29.99	1,056,312
<i>Panel B: foreign-currency borrowers (FC debt > 0)</i>				
FC debt share	51.58	46.53	38.68	286,888
FC debt / assets	12.35	7.97	11.70	286,888
Export share	44.38	36.39	41.41	171,615
Currency mismatch	-27.48	-15.74	37.53	198,691
Size percentile (within country-quarter)	65.29	72.73	28.55	286,888

Notes: All measures in percent, winsorized at the 2.5th and 97.5th percentiles. The sample is 41,822 non-financial corporations in 57 countries, 2010Q1–2025Q4. Total debt / assets uses every firm-quarter that reports total debt. The other rows use the firm-quarters in which at least half of the firm’s debt, by value, is labeled by currency. The export share also requires that the firm report its revenue by geographic segment, and currency mismatch that it report its assets by geographic segment. The size percentile is the firm’s percentile of total assets among sample firms in the same country and quarter.

$$\text{Corporate currency mismatch}_{c,t} = \frac{\sum_{j \in E_{c,t}} (\text{Foreign-currency debt}_{j,c,t} - \text{Foreign assets}_{j,c,t})}{\sum_{j \in E_{c,t}} \text{Total assets}_{j,c,t}}$$

where $E_{c,t}$ is the set of eligible firms. Not every firm reports its debt instruments and its geographic segments in enough detail for the labeling described above. A firm is eligible in a quarter if at least 75 percent of its debt and of its segment assets are labeled. Appendix A.4 describes this criterion, the coverage it gives and which country-quarters enter the analysis.

Figure 3 plots each country's average corporate currency mismatch over the sample period. Corporate currency mismatch is an emerging-market phenomenon: in every advanced economy, listed non-financial corporations hold more foreign assets than foreign-currency debt on average, so the corporate currency mismatch is negative. Among emerging markets there is heterogeneity: Argentina, Indonesia, Russia and Turkey have high currency mismatch on average, while Chile, Malaysia, Mexico and South Africa are net holders of foreign assets. The rest of this section therefore focuses on the 30 emerging markets. Appendix B.1 reports every result that follows for the pooled sample of 57 countries.

Corporate currency mismatch and sovereign risk. The main empirical finding of the paper is that the sovereign's default risk responds more to the real exchange rate in countries where corporate currency mismatch is higher. I measure sovereign risk with the five-year sovereign credit default swap (CDS) spread from S&P Capital IQ Pro.⁷ Daily quotes of the CDS spread are averaged within each quarter. Across the 30 emerging markets, the median of the countries' average spreads over the sample is 1.72 percentage points. The exchange rate is the real effective exchange rate (REER) from Bruegel (Darvas, 2021).⁸ The real depreciation rate of country c in quarter t is

$$s_{c,t} = -\Delta \log \text{REER}_{c,t},$$

⁷A CDS insures against a government default: the buyer pays the spread as an annual premium and is compensated for the loss on the government's bonds if it defaults. I use it rather than a bond spread because a bond spread also reflects the bond's liquidity and, for local-currency bonds, currency risk, neither of which is default risk.

⁸The REER is a CPI-based index against 120 trading partners, available monthly and averaged within the quarter.

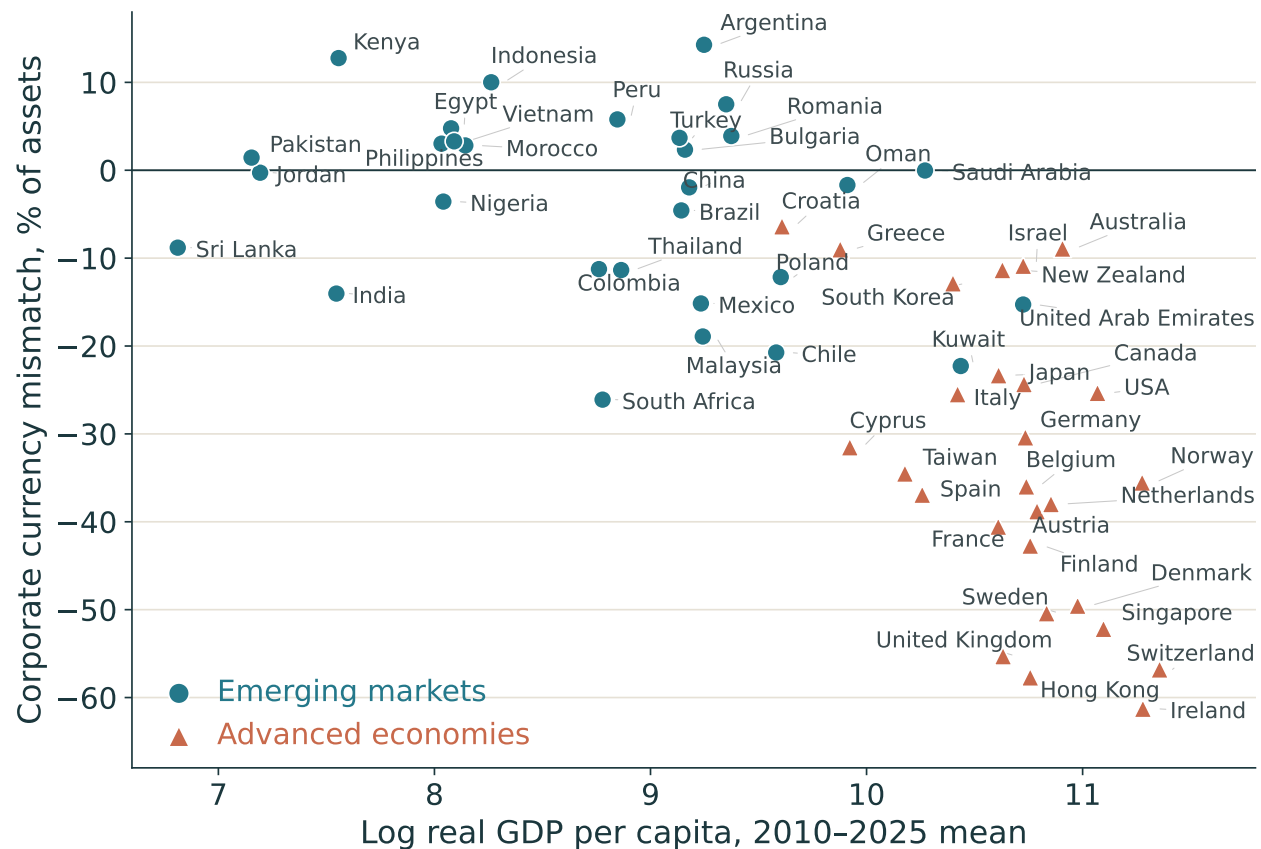


Figure 3: Corporate currency mismatch by country, 2010–2025

Notes: Each marker is a country's average corporate currency mismatch over its quarters that pass the coverage rule of Appendix A.4, against its mean log real GDP per capita over 2010–2025 (S&P Capital IQ Pro). Circles are emerging markets and triangles advanced economies.

so that $s_{c,t} > 0$ is a real depreciation and $s_{c,t} < 0$ a real appreciation. For country c in quarter t , I estimate:

$$\begin{aligned} \text{CDS}_{c,t} = & \beta_0 + \beta_1 \text{Corporate currency mismatch}_{c,t-1} \\ & + \beta_2 \left(\text{Corporate currency mismatch}_{c,t-1} \times s_{c,t} \right) \\ & + \beta_3 s_{c,t} + \beta_4' X_{c,t-1} + \alpha_c + \alpha_t + \varepsilon_{c,t}, \end{aligned}$$

where $X_{c,t-1}$ contains controls for lagged inflation, real GDP growth, the level of the REER and government debt to GDP, α_c is a country fixed effect, and α_t is a quarter fixed effect that absorbs global conditions such as US interest rates and investors' risk appetite. β_3 is the response of the spread to the exchange rate in a country whose corporate sector has no currency mismatch, and β_2 is how much more the spread responds where the mismatch is higher. Corporate mismatch enters with a one-quarter lag. Standard errors are clustered by country.

Table 4: Corporate currency mismatch and sovereign CDS spreads, emerging markets

	Sovereign CDS spread (pp)
Corporate currency mismatch $_{c,t-1} \times s_{c,t}$ (β_2)	+15.63** (7.53)
Corporate currency mismatch $_{c,t-1}$ (β_1)	−0.06 (0.68)
$s_{c,t}$ (β_3)	+3.48*** (0.87)
Controls (lagged)	Yes
Country FE, Quarter FE	Yes
Observations	1,542
Countries	30
R ²	0.84

Notes: The 30 emerging markets. The dependent variable is the quarterly average five-year sovereign CDS spread in percentage points. $s_{c,t} = -\Delta \log \text{REER}_{c,t}$ is the quarterly real depreciation rate. Currency mismatch and $s_{c,t}$ are fractions (0.1 is 10 percent). Controls, all lagged one quarter: inflation, real GDP growth, the level of the REER, and government debt to GDP (external government debt where it is reported, Appendix A.1). Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 4 reports the estimates on the 30 emerging markets. The spread rises with a depreciation even where corporate mismatch is zero: $\beta_3 = 3.48$, so a 10 percent depreciation goes with a spread 0.35 percentage points higher. The interaction is $\beta_2 = 15.63$, significant at the 5 percent level: in the same 10 percent depreciation, a country whose corporate currency mismatch is 10 percentage points of assets higher sees its spread rise by a further 0.16 percentage points, about 9 percent of the median spread. Where mismatch is higher, the spread rises more when the currency depreciates. Appendix B reports robustness checks.

The channel: the tax base. Why does a depreciation raise the spread more where firms are more mismatched? The paragraphs below document this channel in four steps. A depreciation lowers the profits and the investment of mismatched firms. The corporate income tax, the tax on those profits, raises a large part of tax revenue in emerging markets and is their most volatile tax. In most emerging markets the tax code lets firms deduct the exchange-rate loss in the year it is booked, and the deduction lowers their tax bill. And when aggregate corporate income tax revenue falls relative to GDP, the sovereign spread tends to rise the following year.

Currency mismatch, firm profitability and investment. The first link is at the firm: the larger a firm's currency mismatch, the more its profitability and investment move with the real exchange rate. For firm i in country c , with the depreciation rate $s_{c,t}$ defined above, I estimate:

$$y_{i,c,t} = \beta_0 + \beta_1 \text{Currency mismatch}_{i,c,t-1} + \beta_2 \left(\text{Currency mismatch}_{i,c,t-1} \times s_{c,t} \right) + \beta_3' Z_{i,c,t-1} + \alpha_i + \alpha_{c,t} + \varepsilon_{i,c,t},$$

where $y_{i,c,t}$ is the return on assets (ROA), net income over lagged total assets, a loss indicator equal to 100 when net income is negative, or investment. Investment responds with a lag, so for it $y_{i,c,t}$ is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, and $s_{c,t}$ is replaced by the real depreciation summed over the same four quarters. $Z_{i,c,t-1}$ contains controls for lagged log revenue and leverage, α_i is a firm fixed effect, and $\alpha_{c,t}$ is a country-by-quarter fixed effect.⁹ The coefficient of interest is β_2 : how much more the outcome of a firm with a larger currency mismatch moves with the exchange rate than that of its compatriots in the same quarter. Mismatch enters with a

⁹The country-by-quarter fixed effect absorbs everything common to the firms of a country in a quarter, including the exchange rate itself, so $s_{c,t}$ does not enter separately.

Table 5: Currency mismatch, firm profitability and investment, emerging markets

	ROA	Loss indicator	Investment
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	−5.13** (2.44)	+50.5** (25.6)	−19.3*** (6.4)
Currency mismatch $_{i,c,t-1}$ (β_1)	+0.42 (0.27)	−7.6** (3.3)	−1.1 (2.2)
Controls (lagged log revenue, leverage)	Yes	Yes	Yes
Firm FE, Country $\times$ quarter FE	Yes	Yes	Yes
Observations	267,933	267,933	179,539
Firms	8,368	8,368	6,106
Countries	30	30	30
R ²	0.38	0.36	0.45

Notes: The 30 emerging markets. ROA is net income over lagged total assets, in percent. The loss indicator equals 100 when quarterly net income is negative. $s_{c,t} = -\Delta \log REER_{c,t}$ is the quarterly real depreciation rate. Currency mismatch and $s_{c,t}$ are fractions (0.1 is 10 percent). Investment is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, in percent, and in its column $s_{c,t}$ is the real depreciation summed over the same four quarters. Currency mismatch, ROA and investment are winsorized at the 2.5 and 97.5 percentiles. Firms with fewer than eight quarters of observations are dropped. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

one-quarter lag. Standard errors are clustered by country.

Table 5 reports the estimates. The median quarterly ROA in the emerging markets is 0.77 percent. For ROA the interaction is −5.13 and significant at the 5 percent level: in a 10 percent real depreciation, a firm whose currency mismatch is 10 percentage points of assets larger loses about 0.051 percentage points of quarterly ROA relative to a firm in the same country and quarter, about 7 percent of the median. For the loss indicator the interaction is +50.5, significant at the 5 percent level: the same firm is 0.5 percentage points more likely to report a loss in that quarter.¹⁰ For investment the interaction is −19.3, significant at the 1 percent level: over the next four quarters, the same firm invests 0.19 percent of its capital less, about 1.6 percent of the median investment rate. Appendix B reports robustness checks.

The corporate income tax. The corporate income tax, the tax on these profits, raises a large part of tax revenue in emerging markets. Figure 4(a) shows the corporate income tax as a share of total tax revenue in the emerging markets, from the OECD’s Global Revenue

¹⁰For ROA and the loss indicator, the level coefficient β_1 has the opposite sign: within a firm, a larger currency mismatch in a quarter in which the real exchange rate does not move goes with slightly higher profitability and a lower probability of a loss. The two coefficients offset each other at a real depreciation of about 8 percent within a quarter (15 percent for the loss indicator).

Statistics. In the median emerging market it raised 10 percent of tax revenue in 1995 and 17 percent in 2024. In Indonesia, the calibration country of Section 4, it raises about a third of tax revenue. The corporate income tax is also the most volatile tax (Figure 4(b)). The standard deviation of the yearly change in its ratio to GDP, relative to that ratio, is 0.15 in emerging markets, against 0.07 to 0.11 for the other taxes.

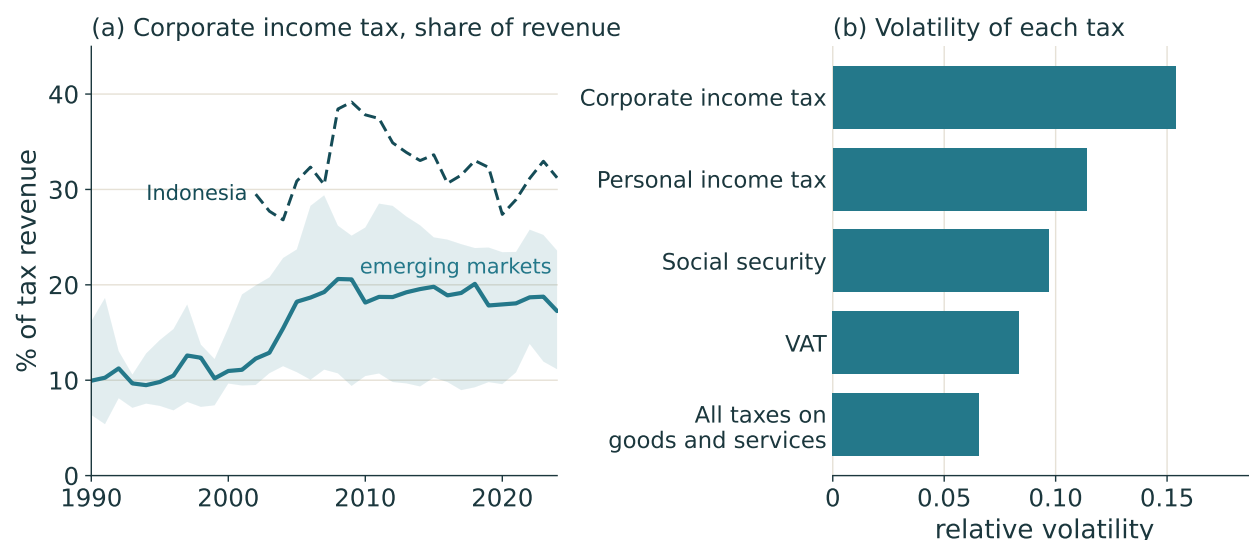


Figure 4: The corporate income tax in tax revenue

Notes: OECD Global Revenue Statistics, general government, the emerging markets with data. (a) The corporate income tax as a percent of total tax revenue. The line is the median across the emerging markets with data in each year, the shaded area its interquartile range, and the dashed line is Indonesia. (b) Relative volatility is the standard deviation of the yearly change in the tax's ratio to GDP divided by its mean ratio, for each country with at least 15 years of data. The bars are the medians across the emerging markets. All taxes on goods and services include VAT.

The tax treatment of exchange-rate losses. When the currency depreciates, a firm with foreign-currency debt books an exchange-rate loss. At the end of each year the firm values its foreign-currency debt at the year-end exchange rate, and the increase in the local-currency value of this debt is recorded as a loss. Tax codes differ in when this loss reduces taxable profit. In some countries the loss is deducted in the year it is booked, before any of the debt is repaid. In others it is deducted on settlement, only in the year the firm repays the debt and only on the amount repaid.¹¹ In a third group of countries, the loss on long-term debt is never deducted.

¹¹Take a two-year loan of 100 dollars at 10 pesos per dollar, 1,000 pesos, repaid at the end of the second year. The dollar goes to 20 pesos at the end of the first year and to 15 at the end of the second, so the firm repays 1,500 pesos. Deducted as booked, the firm deducts a loss of 1,000 pesos in the first year, when its debt is revalued to 2,000 pesos, and reports a gain of 500 in the second, when the debt falls to 1,500 and is repaid. Deducted on settlement, nothing is deducted in the first year and 500 pesos in the second. The total is the same, 500 pesos, but when the loss is deducted as booked, the treasury shares it in the year of the

Table 6: The corporate-tax treatment of exchange-rate losses on debt, emerging markets

Deducted in the year it is booked	On settlement	Not deductible
Argentina, Bulgaria, Chile, China, Colombia (to 2016), Egypt*, India (from 2016), Indonesia, Mexico, Morocco, Peru, Romania, Russia (to 2022), South Africa, Thailand, Turkey, Vietnam (from 2011)	Brazil [†] , Colombia (from 2017), Kenya, Nigeria, Oman, Philippines, Poland [†] , Russia (from 2023), Sri Lanka	Malaysia

Notes: The rule a listed non-financial firm faces on the exchange-rate loss on its long-term foreign-currency debt, from the tax statutes and the practitioner guides (Online Appendix OA.1). Countries whose rule changed within 2010–2025 are listed with the years. India is not classified before fiscal 2016–17. Vietnam’s 2010 is coded as on settlement. [†] Brazil and Poland: the firm may elect to deduct the loss in the year it is booked instead of waiting for settlement. * The statute does not settle the timing. Taxable income starts from accounting profit, and the country is coded as deducting the loss in the year it is booked. Not listed: Saudi Arabia and Kuwait, which levy no corporate income tax on their domestic listed firms, the United Arab Emirates, which levied none before mid-2023, and Jordan and Pakistan, whose rule could not be established.

Few emerging markets follow the third rule. In Malaysia the loss on long-term debt is a capital loss, which falls outside the tax base, Kuwait and Saudi Arabia levy no corporate income tax on their domestic listed firms, and the United Arab Emirates levied none before mid-2023. The other emerging markets follow the first two rules, most of them the first (Table 6). Of the 25 emerging markets that tax corporate profit and whose rule I could establish, counting Colombia and Russia under the rule that held for most of 2010–2025, 16 deduct the loss in the year it is booked, Indonesia among them, and eight on settlement. In two of these eight, Brazil and Poland, the firm may elect to deduct the loss as booked instead. The 16 countries hold 67 percent of the emerging markets’ listed-firm foreign-currency debt. Online Appendix OA.1 documents the classification of all 57 countries with its sources.

The timing of the deduction matters for public finances. When the loss is deducted as booked, the treasury shares the firms’ exchange-rate losses in the year of the depreciation. When it is deducted on settlement, the treasury shares them only as the debt is repaid. Governments treat this timing as a policy lever in a currency crash, and there are four notable examples. In August 1997, as the rupiah began to collapse, Indonesia’s finance ministry allowed exchange-rate losses to be deducted only when realized, and in November it restored the deduction as booked but let firms spread the year’s losses over up to five years. Brazil kept the losses of its January 1999 devaluation deductible but moved exchange-rate variations to deduction on settlement from 2000, which is still its default

depreciation.

rule. Argentina's emergency law of January 2002, which ended the peso's convertibility, limited the deduction of the devaluation loss on existing dollar debt to a fifth a year over five years. More recently, after the peso lost 40 percent of its dollar value between mid-2014 and the end of 2015, Colombia's tax reform of December 2016 made exchange-rate gains and losses count for tax only on settlement, from 2017.¹² Each change spread the deduction of a depreciation's losses over later years. All four changes came in or right after a currency crash, suggesting their importance for public finances.

The firms' tax bill. Whether the deduction moves revenue can be measured at the firm. I link the firms to Compustat Global and North America, which report, for each firm and fiscal year, the exchange-rate result the firm books and its current tax expense, the tax it owes for that year.¹³ Two regressions follow the loss from the exchange rate to the tax bill. Both are annual, with t a fiscal year, because Compustat reports these lines once a year. The first asks whether firms with foreign-currency debt book an exchange-rate loss when the currency depreciates, and whether they do so alike under both rules:

$$\begin{aligned} R_{i,c,t} = & \beta_0 + \beta_1 (D_{i,c,t-1} \times s_{c,t} \times B_{c,t}) \\ & + \beta_2 (D_{i,c,t-1} \times s_{c,t} \times (1 - B_{c,t})) \\ & + \beta_3' Z_{i,c,t-1} + \alpha_i + \alpha_{c,t} + \varepsilon_{i,c,t}, \end{aligned}$$

where $R_{i,c,t}$ is the booked exchange-rate result, $D_{i,c,t-1}$ is foreign-currency debt over assets at the start of the fiscal year, $s_{c,t}$ is here the real depreciation over the fiscal year, and $B_{c,t}$ equals one where the law deducts the loss in the year it is booked. A negative $R_{i,c,t}$ is an exchange-rate loss. $Z_{i,c,t-1}$ contains controls for the level of the debt ratio, log revenue and leverage at the start of the fiscal year, and α_i and $\alpha_{c,t}$ are firm and country-by-year fixed effects.

The second regression asks whether a firm that books a larger exchange-rate loss owes less tax in the same year. This should happen only in countries that deduct the loss in the year it is booked, so the regression estimates the effect separately for the two groups of

¹²Indonesia: Finance Minister decrees 449/KMK.04/1997 of 26 August 1997 and 597/KMK.04/1997 of 21 November 1997. Brazil: Law 9.816 of 23 August 1999, for the losses of the 1999 devaluation, and Provisional Measure 1.858-10 of 26 October 1999, Art. 30, for deduction on settlement from 2000, now Provisional Measure 2.158-35 of 2001, Art. 30. Argentina: Law 25.561 of 6 January 2002, Art. 17, and Decree 2568 of 11 December 2002. Colombia: Law 1819 of 29 December 2016, Art. 376, which repealed Art. 32-1 of the Tax Statute, and Art. 288 of the Tax Statute, added by the same law.

¹³The firms are linked by ISIN, SEDOL and CUSIP. Of the emerging-market firms, 91 percent link (84 percent in the full sample), and total assets agree within 5 percent for 98 percent of the linked firm-years. Appendix B.6 describes the sample and the robustness checks.

Table 7: The firms' tax bill and the tax rule, emerging markets

	Deducted as booked	On settlement or never	Difference
<i>A. Booked exchange-rate result $R_{i,c,t}$ (first regression)</i>			
$D_{i,c,t-1} \times s_{c,t}$	-0.170*** (0.032)	-0.199*** (0.029)	
Firm-years	114,703		
<i>B. Tax on the booked result (second regression)</i>			
Current tax	+0.122*** (0.028)	+0.048*** (0.016)	+0.074** (0.032)
Book tax expense (placebo)	+0.194*** (0.046)	+0.193*** (0.037)	+0.001 (0.059)
Firm-years	156,479		

Notes: Firm-fiscal years 2010–2024 of the Capital IQ firms linked to Compustat in the 25 emerging markets with an established rule. Panel A is the first regression in the text and Panel B the second. The Compustat lines are over the previous year's total assets and winsorized at the 1st and 99th percentiles, and foreign-currency debt over assets and leverage at the 2.5th and 97.5th. The difference is the first column minus the second. Panel B's firm-years are those of the current-tax regression. Firm and country-by-fiscal-year fixed effects. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

countries:

$$\begin{aligned}
\text{Current tax}_{i,c,t} = & \beta_0 + \beta_1 (R_{i,c,t} \times B_{c,t}) + \beta_2 (R_{i,c,t} \times (1 - B_{c,t})) \\
& + \beta_3 (W_{i,c,t} \times B_{c,t}) + \beta_4 (W_{i,c,t} \times (1 - B_{c,t})) \\
& + \alpha_i + \alpha_{c,t} + \varepsilon_{i,c,t},
\end{aligned}$$

where $W_{i,c,t}$ is pretax income excluding the exchange-rate result. Current tax, $R_{i,c,t}$ and $W_{i,c,t}$ are over the previous year's total assets. The control for $W_{i,c,t}$ compares firms with the same other profits, so that a large loss does not stand in for a bad year.

Table 7 reports both regressions. Firms with foreign-currency debt book the loss under both rules alike: the booked result falls by 0.17 to 0.20 for each unit of debt times depreciation in both groups. Where the loss is deducted as booked, current tax falls by 0.122 for each unit of booked loss, against 0.048 where it is deducted on settlement or never, and the difference is significant at the 5 percent level. Where the loss is deducted on settlement, part of the debt is repaid within the year, and some firms may choose to deduct the loss as booked. Book tax expense, the tax line of the income statement, is a placebo. Accounting standards record the tax value of a booked loss at once under both rules, as

a deferred tax asset where the deduction comes later, so book tax expense should not differ between the two groups, and the difference is not significant. Appendix B reports robustness checks.

Tax revenue and the sovereign spread. The last link is in the aggregate: when corporate income tax revenue falls, the sovereign spread rises. I regress the log change in the sovereign CDS spread from year t to year $t + 1$ on the log change in tax revenue over GDP from $t - 1$ to t , with country and year fixed effects and controls for real growth, inflation, the depreciation and the appreciation against the dollar, and the changes in government debt and in the current account over GDP. Table 8 reports the estimates for the emerging markets. On the country-years with both corporate and other tax revenue, a 10 percent fall in corporate tax revenue relative to GDP goes with a spread 1.8 percent higher the following year, significant at the 5 percent level. A fall in the other taxes goes with a rise of the same size, estimated less precisely because the other taxes move half as much from year to year. Appendix B reports robustness checks.

Summary. Four facts carry over to the model. First, corporate currency mismatch is an emerging-market phenomenon, since in advanced economies firms are net holders of foreign assets. Second, across emerging markets, sovereign CDS spreads move more with the exchange rate where the corporate sector's currency mismatch is larger. Third, the profitability and investment of firms with a larger currency mismatch move more with the real exchange rate. Fourth, the corporate income tax raises a large part of tax revenue in emerging markets and is their most volatile tax, a firm's current tax falls with its exchange-rate loss where the loss is deducted as booked, and a fall in aggregate corporate income tax revenue goes with a higher sovereign spread the following year. These facts motivate the small open economy model of Section 3, calibrated to an emerging market with high corporate currency mismatch.

Table 8: Tax revenue and the sovereign CDS spread, emerging markets

	(1)	(2)	(3)
$\Delta \log(\text{CIT}/\text{GDP})_t$	−0.184** (0.087)		−0.182** (0.088)
$\Delta \log(\text{other taxes}/\text{GDP})_t$		−0.180 (0.206)	−0.170 (0.215)
$\Delta \text{ current account} / \text{GDP}_t$	−0.010** (0.005)	−0.009* (0.005)	−0.011** (0.005)
Wild-cluster bootstrap p, corporate income tax	0.033		0.033
Wild-cluster bootstrap p, other taxes		0.411	0.452
Macro controls	Yes	Yes	Yes
Country and year fixed effects	Yes	Yes	Yes
Observations	351	351	351
Countries	29	29	29

Notes: The 29 emerging markets with tax data, on the 351 country-years with both corporate and other tax revenue. The dependent variable is the log change of the yearly average five-year sovereign CDS spread from year t to year $t + 1$. The tax terms are the log changes of corporate income tax revenue and of all other tax revenue relative to GDP from $t - 1$ to t . Controls, dated t : real GDP growth, log inflation, the depreciation and the appreciation of the local currency against the US dollar, and the changes in government debt and in the current account relative to GDP, in percentage points. Years 2008 to 2024 with inflation below 40 percent. Tax revenue: OECD Global Revenue Statistics, else the UNU-WIDER Government Revenue Dataset, else the IMF World Revenue Longitudinal Data. Country and year fixed effects. Standard errors clustered by country in parentheses. The bootstrap p-values are from a wild-cluster bootstrap with the null imposed. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3 Model

This section builds a small open economy with two goods, a local good and a foreign good. Firms produce with capital and labor, sell a share x of their output in the foreign good and hold a share m of their capital abroad, and borrow in both goods from two segmented pools of financiers. Firms pay an output tax and a net income tax to a government that borrows in the foreign good and cannot commit to repay, in the tradition of [Eaton and Gersovitz \(1981\)](#).

A real depreciation, a rise in the price of the foreign good in terms of the local good, reaches sovereign risk through two mismatched balance sheets, the government's and the firms'. The government's debt is in the foreign good, but only the share x of the revenue it taxes is earned in that good. Thus, a depreciation would increase the debt burden of the government relatively more than its tax revenue. Secondly, firms would lose if they enter a depreciation episode with foreign-good debt larger than their foreign assets and export revenues. A part of this loss shrinks the government's budget through tax deductions from taxable income. The rest of the firms' loss would lower the firms' net worth. The loss combined with a limited borrowing capacity would lead to a loss in investment, which lowers the government's tax base for the next period.

Environment. Time is discrete, $t = 0, 1, 2, \dots$. There are two goods. The *local good* is consumed by the economy's domestic agents, the owners and the workers. The *foreign good* is consumed and lent by the international lenders and the financiers who stand between them and the firms. The star superscript marks the foreign good. The price of the local good is normalized to one, and the real exchange rate s_t is the relative price of the foreign good with respect to the local good. A rise in s_t is a real depreciation.

There is a continuum of competitive *brokers* who convert the local good and the foreign good into each other at the rate s_t , i.e. they use s_t units of the local good to produce one unit of the foreign good and vice versa. Every local-to-foreign or foreign-to-local conversion goes through these brokers. Their conversion technology s_t is exogenous.

Two exogenous shocks drive the economy, the real exchange rate s_t and productivity z_t . Both follow AR(1) processes in logs,

$$\log s_{t+1} = \rho_s \log s_t + \sigma_s \varepsilon_{t+1}^s, \quad \varepsilon_{t+1}^s \sim \mathcal{N}(0, 1), \quad (1)$$

$$\log z_{t+1} = \rho_z \log z_t + \sigma_z \varepsilon_{t+1}^z, \quad \varepsilon_{t+1}^z \sim \mathcal{N}(0, 1), \quad (2)$$

with independent innovations.¹⁴

A unit mass of identical firms produces one output with capital and labor,

$$y_t = z_t k_t^\alpha \ell_t^{1-\alpha}.$$

Part of each firm's business is abroad. A share m of its capital is located there, and a share x of its output is sold there, to buyers who pay in the foreign good. The rest of its output is sold at home for the local good. One unit of output therefore brings

$$e(s) = (1 - x) + x s \quad (3)$$

local goods, one per unit sold at home and s per unit sold abroad, and the firm's revenue is $e(s_t) y_t$.

Capital is split by location in the same way: the share m abroad is worth s_t local goods per unit and the rest one, so a unit of capital is priced at

$$p_I(s) = (1 - m) + m s \quad (4)$$

local goods, whether the firm builds a new unit or sells an installed one. Capital depreciates at the rate δ_K . Workers supply labor with the preferences of [Greenwood et al. \(1988\)](#), described below. The government taxes revenue at the rate τ_y and the firms' net income at the rate τ_π .

Lending runs through three groups. Risk-neutral, deep-pocketed *international lenders* lend the foreign good. Their discount factor is $\beta^* \equiv 1/(1 + r^*)$, where r^* is the risk-free rate in foreign good. The government borrows from these lenders directly. Firms borrow through two segmented pools of *financiers*, pool F and pool L, who stand between the firms and the international lenders, pool F lending to firms in the foreign good and pool L in the local good, both funded in the foreign good at r^* . Figure 5 draws the chain.

Agents. The economy is populated by seven types of agents:

- **Firms:** a unit mass of identical price takers. Each produces with capital and labor, sells the share x of its output abroad, pays the output and net income taxes to the

¹⁴The data support this assumption. In a first-order VAR of quarterly cycles of the two series for Indonesia, the calibration country (Section 4), past productivity does not help forecast the exchange rate, and the past exchange rate does not help forecast productivity. The cross-lag coefficients are not statistically different from zero. The correlation of the two innovations is -0.08 . The median correlation is -0.06 across the emerging markets of the sample and -0.03 across all 57 countries (Appendix A.5).

government, borrows from the two pools of financiers, and pays dividends d_t to its owners.

- **Owners:** have CRRA preferences over the consumption of the local good, with discount factor β_{owner} and risk aversion γ_{owner} , and consume the dividends.¹⁵
- **Workers:** have the preferences of [Greenwood et al. \(1988\)](#), CRRA over consumption of the local good net of the disutility of labor, with discount factor β_{worker} and risk aversion γ_{worker} . They supply labor, consume labor income plus government transfers, and hold no assets.
- **Government:** benevolent toward workers, receives the output and net income taxes from the firms, borrows long term in the foreign good from the international lenders, rebates the proceeds to workers, and has limited commitment on repaying its debt.
- **Financiers:** two segmented pools funded in the foreign good by the international lenders, each a unit mass of small financiers. Pool F holds the firms' foreign-good debt and pool L their local-good debt.
- **International lenders:** risk neutral and deep pocketed. They value the foreign good, fund both pools of financiers, hold the government's debt, and discount the future at $\beta^* = 1/(1 + r^*)$.
- **Brokers:** a competitive continuum, converting the two goods to each other at the rate s_t .

Timing. Figure 6 shows the timing within a period.

Within each period t :

1. Firms enter with capital k_t and with debt due this period, b_t in the local good and b_t^* in the foreign good (face values). The government enters with its bond stock $B_{g,t}^*$.
2. The shocks (s_t, z_t) are realized.
3. Firms hire labor and produce $y_t = z_t k_t^\alpha \ell_t^{1-\alpha}$. They earn the revenue $e(s_t) y_t$, pay wages, and pay the output tax $\tau_y e(s_t) y_t$ and the net income tax $\tau_\pi \max\{0, \pi_t\}$, where taxable income π_t is defined in (6). The two taxes make up the government's revenue R_t .

¹⁵Owners' risk aversion gives the firm a motive to smooth dividends, which firms do in the data ([Lintner, 1956](#); [Leary and Michaely, 2011](#)).

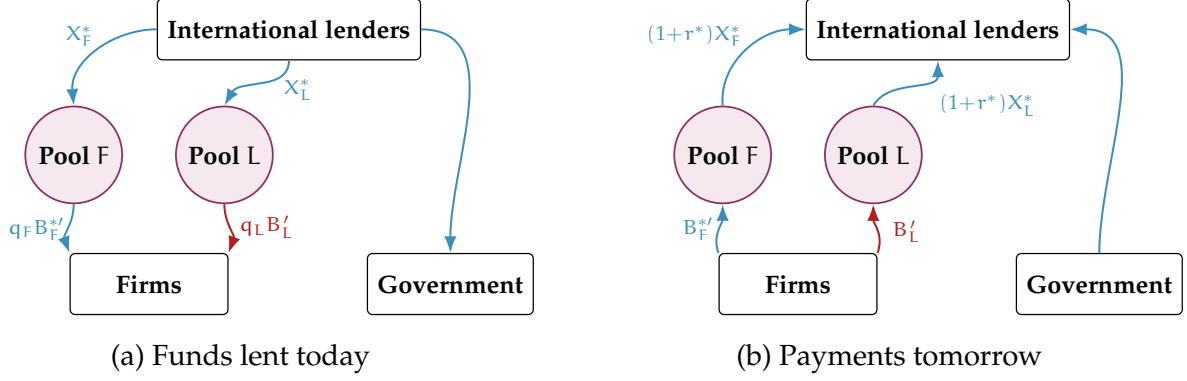


Figure 5: Who lends to whom. Blue arrows carry the foreign good, red arrows the local good. Every claim is ultimately held by the same risk-neutral international lenders. The government reaches them directly, the firms only through the two segmented pools of financiers. Pool F lends $X_F^* = q_F B_F^{*'}$ foreign goods against $B_F^{*'}$ units of foreign-good face. Pool L borrows X_L^* foreign goods, converts them at s , and lends $sX_L^* = q_L B_L^{'}$ local goods against $B_L^{'}$ units of local-good face. Tomorrow the firms repay the face, and pool L collects local goods and converts them at tomorrow's rate. Thus, while pool L carries the exchange-rate risk, pool F does not. The unlabeled arrows between the government and the international lenders are its long-term, defaultable bond, described under *Government*.

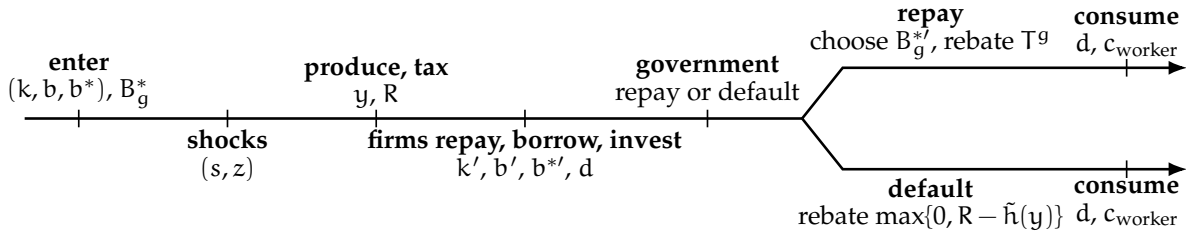


Figure 6: Timing within a period.

4. Firms repay their maturing debt and choose next-period capital k_{t+1} , new borrowing (b_{t+1}, b_{t+1}^*) from the two pools and the dividend d_t , subject to the collateral constraint.
5. The government decides whether to repay or default on $B_{g,t}^*$. If it repays, it chooses next period's debt $B_{g,t+1}^*$ and the transfer T_t^g . If it defaults, it is excluded from borrowing and rebates its tax revenue less a deadweight loss.
6. Owners consume d_t and workers consume $c_{\text{worker},t} = w_t \ell_t + T_t^g$.

Firms. A firm enters the period with capital k , local-good debt b and foreign-good debt b^* ,¹⁶ and observes (s, z) . The aggregate state is $\mathcal{S} = (K, B_L, B_F^*, s^-, s, z)$, where K is the firms' aggregate capital, B_L and B_F^* are their aggregate debts in the two goods, and s^- is the exchange rate at which those debts were issued. Given the wage $w = W(\mathcal{S})$, the two prices $q_F = Q_F(\mathcal{S})$ (in foreign goods) and $q_L = Q_L(\mathcal{S})$ (in local goods), and the law of motion of the aggregate state, a firm chooses labor ℓ , next-period capital k' , the new debt b' and b^* (face values due next period), and the dividend d :

$$V(k, b, b^*; \mathcal{S}) = \max_{\ell, k', b', b^*, d} \left\{ u_{\text{owner}}(d) + \beta_{\text{owner}} \mathbb{E}[V(k', b', b^*; \mathcal{S}') \mid \mathcal{S}] \right\} \quad (5)$$

subject to the budget constraint and dividend non-negativity

$$0 \leq d \leq (1 - \tau_\pi^+) \left[\underbrace{(1 - \tau_y) e(s) z k^\alpha \ell^{1-\alpha} - w \ell - \delta_K p_I(s) k - \underbrace{((1 - q_L^-) b + s^-(1 - q_F^-) b^*)}_{\text{interest}} - \underbrace{(s - s^-) b^*}_{\text{exchange-rate loss}}}_{\pi: \text{taxable income}} \right] \\ - \underbrace{p_I(s) (k' - k)}_{\text{net investment}} - \underbrace{(q_L^- b + q_F^- s^- b^*)}_{\text{principal repayment}} + \underbrace{(q_L b' + q_F s b^{*'})}_{\text{new borrowing}} \quad (6)$$

where $e(s)$ and $p_I(s)$ are the revenue factor (3) and the price of capital (4), a superscript minus marks last period's value, the prices and exchange rate at which the maturing debt was issued, and τ_π^+ is the net income tax rate the firm faces,

$$\tau_\pi^+ = \begin{cases} \tau_\pi & \text{if } \pi \geq 0, \\ 0 & \text{if } \pi < 0, \end{cases} \quad (7)$$

so a loss ($\pi < 0$) pays no net income tax. The firm is also subject to the collateral constraint

$$q_L b' + q_F s b^{*'} \leq \theta p_I(s) k'. \quad (8)$$

In the budget constraint (6), the dividend is after-tax income, less net investment at today's price of capital, less the principal of the maturing debt, plus the proceeds of new borrowing. Taxable income π is after-tax revenue net of wages, of depreciation at today's price of capital, of the interest on both debts and of the exchange-rate loss on the foreign-good debt. The face b^* raised $q_F^- s^- b^*$ local goods when it was issued at the exchange rate s^- and is repaid at s , so its interest is $s^-(1 - q_F^-) b^*$ and its exchange-rate loss $(s - s^-) b^*$.¹⁷

¹⁶Local-good debt is the model's counterpart of local-currency debt in the data, and foreign-good debt of foreign-currency debt.

¹⁷Deducting the exchange-rate loss in the period it is booked is the rule in Indonesia, the calibration

The dividend cannot be negative, so the firm cannot issue equity. Nor can it hold financial assets, so $b' \geq 0$ and $b^* \geq 0$. The collateral constraint (8) limits the funds raised in both goods together to the value of a fraction θ of next-period capital, at today's price.¹⁸ At the limit, each local good of the firm's own funds finances capital worth $1/(1 - \theta)$ local goods.

Let

$$\eta \equiv \frac{q_F s b^{*'}}{q_F s b^{*'} + q_L b'} \quad (9)$$

be the foreign-good share of the firm's new borrowing. With one-period debt, the firm's inherited debt enters its problem only through its net worth after repayment and tax,

$$n = (1 - \tau_\pi^+) \pi + p_I(s) k - (q_L^- b + q_F^- s^- b^*), \quad (10)$$

which is after-tax income plus the capital stock at today's price, less the principal of the maturing debt, so that the budget constraint reads $0 \leq d \leq n - p_I(s) k' + q_L b' + q_F s b^{*}$. The firm's problem can then be written as a consumption-saving problem for its owners together with a portfolio choice of η (Appendix C.1).

Financiers. Two segmented pools of financiers lend to the firms. Each pool is a unit mass of small, identical, risk-neutral, one-period financiers who borrow the foreign good from the international lenders at r^* and pass their profits or losses abroad. Pool F lends to the firms in the foreign good and pool L in the local good, and a financier in one pool cannot lend in the other's good. The pools are built à la [Gabaix and Maggiori \(2015\)](#), adapted to a small open economy with an exogenous real exchange rate.

A financier in pool $j \in \{F, L\}$ who intermediates x_j^* foreign goods of funds earns $\Omega_j x_j^*$ in present value, where Ω_j is the pool's expected excess return, in foreign goods, over the funding cost r^* , per unit of funds intermediated. After she has taken her position, she can divert a fraction $\Gamma_j x_j^*$ of the funds, $\Gamma_j (x_j^*)^2$ in all, so her creditors lend to her only if her

country, and in most emerging markets of the sample (Section 2). The firms' debt matures in one period, so deducting the loss as booked and deducting it on settlement give the same taxable income here. Losses are not carried forward.

¹⁸The limit is an incentive-compatibility constraint under limited enforcement, with the timing of [Bianchi and Mendoza \(2018\)](#) and [Arce \(2024\)](#). The firm can refuse to repay at the end of the period, after the loans are made and the capital is installed and before next period's shocks. Its lenders can then seize only the fraction θ of the capital, worth $p_I(s)$ per unit outside the firm, the price at which capital trades. Default has no other consequence. The firm keeps the rest of its capital and is not excluded from borrowing. As in [Kiyotaki and Moore \(1997\)](#), the firm can therefore settle any debt worth more than $\theta p_I(s) k'$ by offering its lenders $\theta p_I(s) k'$, which leaves them as well off as seizing. Lenders anticipate this and lend at most $\theta p_I(s) k'$, valued at today's prices.

profit covers what she could divert, $\Omega_j x_j^* \geq \Gamma_j (x_j^*)^2$. This is her incentive-compatibility constraint. Her profit is linear in x_j^* and the constraint is quadratic, so she lends up to the limit $x_j^* = \Omega_j / \Gamma_j$ whenever $\Omega_j > 0$, and so does the unit mass of financiers in her pool, which gives $X_j^* = \Omega_j / \Gamma_j$. A pool lends more the higher its expected excess return, and $1/\Gamma_j$ is its capacity, the funds it supplies per unit of excess return.

Let $1 + r_F$ and $1 + r_L$ be the gross interest rates the firms pay, each in the good it borrows, so that $q_F = 1/(1 + r_F)$ and $q_L = 1/(1 + r_L)$. Each foreign good that pool F lends returns $1 + r_F$ foreign goods and costs $1 + r^*$ to fund, so

$$1 + \Omega_F = \frac{1 + r_F}{1 + r^*}. \quad (11)$$

Each foreign good that pool L lends becomes s local goods, which return $s(1 + r_L)$ local goods next period, worth $s(1 + r_L)/s'$ foreign goods, so

$$1 + \Omega_L = \frac{(1 + r_L) \mathcal{E}(s)}{1 + r^*}, \quad \mathcal{E}(s) \equiv \mathbb{E}[s/s' | s]. \quad (12)$$

Pool L is funded in the foreign good and repaid in the local good, so it bears the exchange-rate risk on the firms' local-good debt. After a depreciation the exchange rate is expected to revert, $\mathcal{E}(s)$ rises, and local-good credit becomes cheaper.

In equilibrium each pool lends exactly the funds the firms borrow from it (Figure 5), so its premium is

$$\Omega_F = \Gamma_F X_F^*, \quad \Omega_L = \Gamma_L X_L^*. \quad (13)$$

Solving (11)–(13), the prices at which the pools lend are

$$Q_F(B_F^{*'}) = \frac{2\beta^*}{1 + \sqrt{1 + 4\Gamma_F \beta^* B_F^{*'}}}, \quad Q_L(B_L'; s) = \frac{2\beta^* \mathcal{E}(s)}{1 + \sqrt{1 + 4\Gamma_L \beta^* \mathcal{E}(s) B_L'/s}}. \quad (14)$$

At zero issuance both prices are frictionless, $Q_F(0) = \beta^*$ and $Q_L(0; s) = \beta^* \mathcal{E}(s)$, and each falls as the pool's book grows.

Workers. Workers own no capital and hold no financial assets. Each period they supply labor ℓ and consume their labor income plus the government's transfer, $c_{\text{worker}} = w\ell + T^9$. They can neither save nor borrow. Any borrowing on their behalf is done by the government. Their period utility is

$$u_{\text{worker}}(c_{\text{worker}} - \chi \ell^\omega / \omega), \quad u_{\text{worker}}(x) = x^{1-\gamma_{\text{worker}}} / (1 - \gamma_{\text{worker}}),$$

the preferences of [Greenwood et al. \(1988\)](#), and their discount factor is β_{worker} . Labor supply has no wealth effect and depends only on the wage,

$$w = \chi \ell^{\omega-1}, \quad (15)$$

with Frisch elasticity $1/(\omega - 1)$. Firm optimality equates the wage to the after-tax marginal product of labor,

$$w = (1 - \tau_y)(1 - \alpha) e(s) z k^\alpha \ell^{-\alpha}, \quad (16)$$

and the market clears at

$$\ell(k, z, s) = \left[\frac{(1 - \tau_y)(1 - \alpha) e(s) z k^\alpha}{\chi} \right]^{\frac{1}{\omega-1+\alpha}}, \quad w \ell = (1 - \tau_y)(1 - \alpha) e(s) y, \quad (17)$$

so labor and output respond to capital, to productivity and, through the foreign share of sales, to the exchange rate. The constant χ only fixes the unit in which labor is measured, and it is set so that $\ell = 1$ at the ergodic mean of capital and productivity and at $s = 1$.

Government. The government is benevolent toward workers. It collects the tax revenue $R = \tau_y e(s) y + \tau_\pi \max\{0, \pi\}$, borrows from the international lenders in the foreign good, and rebates the proceeds to workers as a lump-sum transfer T^g . It cannot commit to repay. Its state is its debt stock B_g^* together with the aggregate state $\mathcal{S}$.

Government debt is a single long-term bond denominated in the foreign good, as in [Hatchondo and Martinez \(2009\)](#) and [Chatterjee and Eyigungor \(2012\)](#). Each period a fraction δ_B of the outstanding stock matures and the rest is carried over, with no coupon. A unit of the bond pays one foreign good when it matures, so the debt service in local goods is $\delta_B B_g^*$ and rises with a depreciation. The default decision is on the entire debt stock.

Each period, after the firms have made their choices, the government decides whether to repay or default:

$$V^G(B_g^*; \mathcal{S}) = \max\{V^R(B_g^*; \mathcal{S}), V^D(\mathcal{S})\}. \quad (18)$$

Under repayment it chooses next period's debt $B_g^{*'}$, facing the bond price schedule $q_F^g(B_g^{*'}; \mathcal{S})$ set by the international lenders below, which depends on how much it issues:

$$V^R(B_g^*; \mathcal{S}) = \max_{B_g^{*'}} u_{\text{worker}}(w \ell + T^g - \chi \ell^\omega / \omega) + \beta_{\text{worker}} \mathbb{E}[V^G(B_g^{*'}; \mathcal{S}') | \mathcal{S}], \quad (19)$$

subject to the budget constraint

$$T^g \leq \underbrace{R}_{\text{tax revenue}} + \underbrace{(B_g^{*'} - (1 - \delta_B) B_g^*) s q_F^g(B_g^{*'}; S)}_{\text{proceeds from new issuance}} - \underbrace{\delta_B B_g^* s}_{\text{debt service}}, \quad (20)$$

where the proceeds are the foreign goods raised, converted at s . Under default the government is excluded from borrowing¹⁹ and regains access with probability λ each period, re-entering with no debt:

$$V^D(S) = u_{\text{worker}}(w \ell + T_{\text{def}}^g - \chi \ell^\omega / \omega) + \beta_{\text{worker}} \mathbb{E}[\lambda V^R(0; S') + (1 - \lambda) V^D(S') \mid S], \quad (21)$$

where the transfer under default is

$$T_{\text{def}}^g = \max\{0, R - \tilde{h}(y)\}, \quad \tilde{h}(y) = \kappa y^2 / \bar{y}, \quad (22)$$

with y physical output and $\bar{y}$ its mean. In default the government transfers what it collects less a deadweight loss $\tilde{h}(y)$, which rises with the square of output relative to its mean, so it is small when output is low and grows convexly with output.

The international lenders price the bond off next period's default probability $p(B_g^{*'}; S')$, the probability that $V^D(S')$ exceeds $V^R(B_g^{*'}; S')$. A unit of the bond bought today pays, if the government repays next period, the maturing fraction δ_B plus the market value of the $1 - \delta_B$ units that survive, and nothing under default. Risk-neutral lenders discounting at r^* break even:

$$q_F^g(B_g^{*'}; S) = \frac{1}{1 + r^*} \mathbb{E}\left[(1 - p(B_g^{*'}; S'))(\delta_B + (1 - \delta_B) q_F^g(B_g^{*''}; S')) \mid S\right], \quad (23)$$

where $B_g^{*''}$ is the government's debt policy at next period's state. The sovereign spread is the yield on this bond over the risk-free rate r^* (Appendix C.3).

The cost of default. The default cost in (22) differs from the literature in where it falls. In quantitative sovereign-default models with an exogenous endowment, the cost is a loss of output during exclusion, an asymmetric cap on income in [Arellano \(2008\)](#) and a convex function of output in [Chatterjee and Eyigungor \(2012\)](#). When output is produced rather than endowed, the cost is modeled as a loss of productive efficiency. In [Mendoza and Yue \(2012\)](#), default cuts firms' working-capital financing of imported inputs, which are

¹⁹Exclusion is a simplification. [Cetin \(2026\)](#) shows, with disbursement data for 66 default episodes, that emerging-market sovereigns keep borrowing from private external creditors while in default, at about a third of the flow outside default.

replaced by inferior domestic substitutes, so measured productivity falls. In [Sosa-Padilla \(2018\)](#), default impairs the banks that hold the government's bonds, and the resulting credit crunch lowers output. Here the deadweight loss $\tilde{h}(y)$ is charged against the tax revenue the government rebates to workers. The sovereign's default leaves output, wages and the firms' cash flows untouched and falls only on the transfer T^g . The functional form is the quadratic case of the cost in [Chatterjee and Eyigungor \(2012\)](#), small in bad states and rising with output. Its one parameter, κ , is calibrated in Section 4.

Recursive competitive equilibrium. A *symmetric recursive competitive equilibrium* consists of a law of motion for the aggregate state $\mathcal{S} = (K, B_L, B_F^*, s^-, s, z)$, price functions Q_F and Q_L , a wage function W and a sovereign bond price q_F^g , together with a firm value function V with policies $\ell(\cdot)$, $k'(\cdot)$, $b'(\cdot)$, $b^*(\cdot)$ and $d(\cdot)$, and government value functions V^R, V^D, V^G with policies $B_g^{*'}(\cdot)$, $\text{default}(\cdot)$ and $T^g(\cdot)$, such that:

1. **Firm optimality.** Given W, Q_F, Q_L and the law of motion, V and the firm's policies solve (5)–(8).
2. **Consistency.** The aggregate firm agrees with the individual firm. The individual policies, evaluated at the aggregate state, give the aggregate quantities,

$$K' = k'(K, B_L, B_F^*; \mathcal{S}), \quad B_L' = b'(K, B_L, B_F^*; \mathcal{S}), \quad B_F^{*'} = b^{*'}(K, B_L, B_F^*; \mathcal{S}).$$

3. **Financier market clearing.** Each pool lends what the firms borrow from it, $X_F^* = q_F B_F^{*'}$ and $X_L^* = q_L B_L'/s$, so that $q_F = Q_F(B_F^{*'})$ and $q_L = Q_L(B_L'; s)$ as in (14).
4. **Labor market clearing and wages.** Labor and the wage satisfy (15)–(17) at $k = K$, so $W(\mathcal{S}) = \chi \ell(K, z, s)^{\omega-1}$.
5. **Government optimality.** Given the bond price schedule and the firms' policies, V^R, V^D, V^G and the government's policies solve (18)–(22).
6. **Sovereign bond price.** The international lenders break even, (23).
7. **Resource constraint, in local goods.** Under repayment,

$$\begin{aligned} c_{\text{worker}} + d + p_I(s)[k' - (1 - \delta_K)k] &= e(s) z k^\alpha \ell^{1-\alpha} + \underbrace{q_L b' + q_F s b^{*'} - b - s b^*}_{\text{firms' net borrowing}} \\ &\quad + \underbrace{s q_F^g (B_g^{*'} - (1 - \delta_B) B_g^*) - \delta_B s B_g^*}_{\text{government's net borrowing}}. \end{aligned} \tag{24}$$

Consumption plus investment expenditure equals revenue in local goods plus the firms' and the government's net borrowing. Under default the government's net borrowing is zero, and the deadweight loss, $\tilde{h}(y)$ or all of R if R is smaller, is subtracted from the right side.

8. **Law of motion and rational expectations.** The aggregate state evolves as $\mathcal{S}' = (K', B_L', B_F^*, s, s', z')$, with (K', B_L', B_F^*) from consistency and (s', z') from (1)–(2). The government's debt follows its own policy, $B_g^*(B_g^*, \mathcal{S})$.

The foreign-good share of debt. The firm's first-order conditions for its two kinds of debt are

$$\begin{aligned} u'_{\text{owner}}(d) q_L &= \beta_{\text{owner}} \mathbb{E} [u'_{\text{owner}}(d') (1 - \tau_{\pi}^{+'} (1 - q_L))] + \mu q_L, \\ u'_{\text{owner}}(d) q_F &= \beta_{\text{owner}} \mathbb{E} \left[u'_{\text{owner}}(d') \left(\frac{s'}{s} - \tau_{\pi}^{+'} \left(\frac{s'}{s} - q_F \right) \right) \right] + \mu q_F, \end{aligned}$$

where $\mu \geq 0$ is the multiplier on the collateral constraint (8) (Appendix C.1). Here $\tau_{\pi}^{+'}$ is tomorrow's value of τ_{π}^+ in (7). In profitable states, the tax lowers the cost of each debt by τ_{π} times its deductible part, the interest on both and the exchange-rate loss on the foreign-good debt. Per unit of funds, a local-good loan costs $1 + (1 - \tau_{\pi})r_L$ and a foreign-good loan $1 + (1 - \tau_{\pi})[(1 + r_F)s'/s - 1]$. The government bears the fraction τ_{π} of the firms' exchange-rate losses in those states. In both conditions the left-hand side shows the marginal value of what one more unit of debt raises today. The right-hand side is the expected cost of repaying that unit of debt tomorrow plus the collateral it uses, scaled by the shadow value of the collateral constraint. Dividing both conditions by their prices q_j and subtracting the equations from each other removes the μ part. With $\tilde{u}' \equiv (1 - \tau_{\pi}^{+'}) u'_{\text{owner}}(d')$, the owners' marginal utility tomorrow net of the tax shield,

$$(1 + r_F) \mathbb{E} \left[\tilde{u}' \frac{s'}{s} \mid \mathcal{S} \right] = (1 + r_L) \mathbb{E} [\tilde{u}' \mid \mathcal{S}]. \quad (25)$$

Each side is the expected after-tax repayment of one local good raised today, in local goods and weighted by marginal utility. If the firm is profitable in every state tomorrow, $\tilde{u}'$ is $(1 - \tau_{\pi})u'_{\text{owner}}(d')$ and the condition is the one without the tax, because interest and the exchange-rate loss are deducted alike. The tax changes the currency choice only through states in which the firm has a loss.

Dividing (25) by $\mathbb{E}[\tilde{u}' | \mathcal{S}]$ and separating the covariance gives

$$1 + r_L = (1 + r_F) \mathbb{E}\left[\frac{s'}{s} \mid \mathcal{S}\right] + (1 + r_F) \frac{\text{Cov}(\tilde{u}', s'/s \mid \mathcal{S})}{\mathbb{E}[\tilde{u}' \mid \mathcal{S}]}. \quad (26)$$

In local goods, a unit borrowed in the local good costs $1 + r_L$ tomorrow, and a unit borrowed in the foreign good is expected to cost $(1 + r_F) \mathbb{E}[s' | s]/s$. Uncovered interest parity would make the two equal, and the last term is the gap between them. It is the price the owners put on the exchange-rate risk of foreign-good debt. This price is positive when their after-tax marginal utility tomorrow is high in the states where the currency depreciates most.

To see how the pools' capacities set the share, write (26) in the premia of (11) and (12) and drop products of small terms:

$$\Omega_L \approx \Omega_F + \sigma^2 + \frac{\text{Cov}(\tilde{u}', s'/s \mid \mathcal{S})}{\mathbb{E}[\tilde{u}' \mid \mathcal{S}]}, \quad (27)$$

where $\sigma^2 = \sigma_s^2$ is the variance of the one-period change in $\log s$ given today's s . The local premium exceeds the foreign premium by a Jensen term, present even with risk-neutral owners, and by the failure of uncovered interest parity.

The covariance depends on the firm's own exposure, and to a first approximation it is linear in η , equal to $\Pi_0 + \tilde{\rho} \eta$. Even a firm with no foreign-good debt faces some exchange-rate risk, because tomorrow's exchange rate moves the prices at which it borrows tomorrow, and Π_0 is the price of that risk. The slope $\tilde{\rho}$ is the rise in the risk price per unit of η , since more foreign-good debt makes tomorrow's net worth move more with the exchange rate. With $X^* \equiv X_F^* + X_L^*$ the firms' total funds in foreign goods, pool F lends the share η of them and pool L the rest, so (13) gives $\Omega_F = \Gamma_F X^* \eta$ and $\Omega_L = \Gamma_L X^* (1 - \eta)$. Substituting Ω_F and Ω_L into (27) and solving for the share,

$$\eta^* \approx \frac{\Gamma_L X^* - \sigma^2 - \Pi_0}{(\Gamma_L + \Gamma_F) X^* + \tilde{\rho}}. \quad (28)$$

When the Jensen and risk terms are small relative to the premia, η^* is close to $\Gamma_L/(\Gamma_L + \Gamma_F)$, so the relative size of Γ_L and Γ_F mainly shapes the foreign-good share of the firms' borrowing. Appendix C.2 gives the derivation.

Transmission mechanism. Two balance sheets in this economy carry a currency mismatch, and an unexpected depreciation reaches the sovereign spread through both (Figure 7).

The government's own balance sheet is mismatched. Its debt is entirely in the foreign good, while its revenue is a tax on the firms' revenue and net income, of which only the share x earned abroad is in the foreign good. As long as $x < 1$ the government is short the foreign good. A depreciation raises the local-good cost of this period's payment, $\delta_B B_g^* s$, and, because s is persistent, of the debt that remains. It raises the local-good value of revenue by less. This is why the spread responds to a depreciation even in an economy whose firms borrow only in the local good.

The firms' balance sheet is mismatched too. Their foreign-good debt b^* is a short position, and the share m of their capital located abroad and the share x of their sales made abroad are long positions. A depreciation raises the local-good cost of the debt by $b^* \Delta s$, and the local-good value of the capital abroad and of the foreign sales by $m k \Delta s$ and $x y \Delta s$. What the firms lose is their net position. Its balance-sheet part, the foreign-good debt net of the capital abroad, is the model's counterpart of the currency mismatch of Section 2. Taxes split this loss between the owners and the government. In a profitable state the firm deducts the loss on its debt, $b^* \Delta s$, so the treasury bears $\tau_\pi b^* \Delta s$ and the owners $(1 - \tau_\pi) b^* \Delta s$. The output tax and the net income tax apply to the higher local-good value of the foreign sales, $x y \Delta s$, but not to the revaluation of the capital abroad, $m k \Delta s$. In the period of the shock, revenue falls by $\tau_\pi b^* \Delta s$ less the taxes on $x y \Delta s$. To smooth the consumption of the workers, if the government tries to compensate this fall in tax revenue with new borrowing, its debt and correspondingly the spread it faces would rise.

The owners' share of the loss affects the government's budget next period through the investment channel. The borrowing limit $\theta p_I(s) k'$ rises by the share m of capital abroad, while the debt burden rises with the share η . If $\eta > m$, the firm cannot compensate for the loss through higher borrowing, as the borrowing limit does not increase at the pace of the debt burden. This net worth loss therefore has to decrease dividend payments or investment or both. Risk-averse owners do not cut the dividends by the full amount, and investment falls.²⁰ Next period's output (and therefore the output tax) and wages are then lower than in an economy without the depreciation. A smaller tax base tomorrow lowers the repayment probability, which makes the spread rise today.

²⁰With risk-neutral owners the foreign-good share of new borrowing η would still be interior, since the pools pin it, but the capital condition would fix k' independently of net worth whenever the dividend is positive, and the dividend would absorb the whole loss.

Three forces work against this, two of them coming from the expected reversal of the exchange rate. New borrowing is cheaper in both goods: pool L's price q_L rises with $\mathcal{E}(s)$, and a foreign good borrowed now raises $s q_F$ local goods against an expected repayment of $\mathbb{E}[s' | s]$, below s .²¹ And the gain on the foreign-good debt the firms issue at the high rate is taxable when the rate comes back, so the government expects more net income tax next period. Since the bond is priced on next period's default probability, this expected revenue lowers the spread today. Hours also rise a little on impact, with the local-good value of the foreign sales. The spread rises when the heavier debt burden and the lost revenue outweigh these forces.

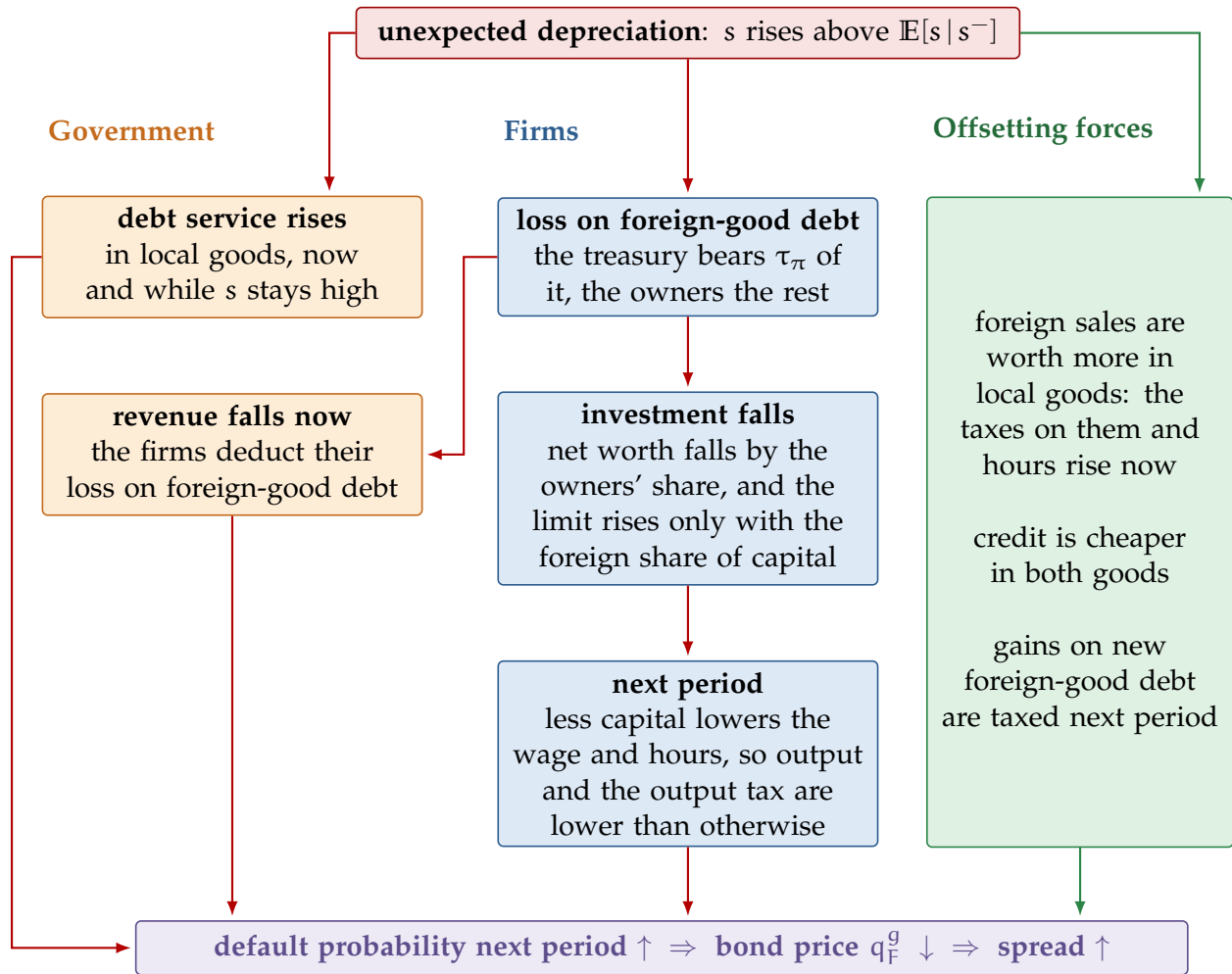


Figure 7: Transmission from an unexpected depreciation to the sovereign spread, through the government's own mismatch (left) and the firms' (middle). Red arrows push the spread up, and green arrows push it down.

²¹Persistence and mean reversion are not in conflict here. With s above its unconditional mean, $\mathbb{E}[s' | s]$ lies between that mean and today's s . Being above the mean keeps the remaining debt costly to carry, and being below today's s makes new borrowing cheaper.

Numerical solution. The firms' problem does not depend on the government's choices: the tax rates are fixed, the cost of default falls on the revenue the government rebates rather than on output, owners and workers are separate agents, and the government's bonds are held abroad. The model is therefore solved in two blocks, the firms' policies first and the government's decisions given them. Online Appendix OA.2 describes the solution.

4 Calibration

The model is calibrated at an annual frequency to Indonesia. Indonesia suits the model for three reasons. It is a large emerging market, the fourth most populous country in the world and the largest economy of Southeast Asia. Its listed firms hold few assets abroad, 3 percent of total assets, against foreign-currency debt of 13 percent, so they are among the most mismatched of the emerging markets in the sample, which makes Indonesia an illustrative case. And its tax code, like the model, deducts exchange-rate losses and taxes exchange-rate gains in the year they are booked. Table 9 lists the parameters.

Parameters set outside the model. The risk aversion of owners and of workers is set to 2, the standard value in quantitative sovereign-default models (Arellano, 2008; Chatterjee and Eyigungor, 2012). The capital share is 0.35, close to the values used in emerging-market business-cycle models (Aguilar and Gopinath, 2007; García-Cicco et al., 2010), and the depreciation rate of capital is 0.05 a year, close to the values used to measure capital stocks across developing countries (Caselli, 2005; Gourinchas and Jeanne, 2013). The labor-supply curvature $\omega = 1.455$ is the value of Mendoza (1991), used since in small open economy models (Uribe and Yue, 2006; Mendoza and Yue, 2012), and gives a Frisch elasticity of $1/(\omega - 1) = 2.2$. The constant χ only fixes the unit in which labor is measured. It is set so that labor equals one at the ergodic mean of capital and productivity and at $s = 1$.

The foreign share of the firms' capital, $m = 0.033$, is the eligible firms' foreign assets over assets (Section 2). The foreign share of revenue is tied to it. The export share exceeds the foreign share of assets by what the domestic plants export: about 5 percentage points for Indonesia's eligible firms and about 6 in the median of the 57 countries (Section 2). The calibration fixes this margin at 0.05, so $x \equiv m + 0.05 = 0.083$, against 0.080 in the data, and keeps the margin at 0.05 in every experiment of Section 5 that changes m : firms that hold more of their assets abroad also sell more abroad, as Section 2 shows.

The real exchange rate process is estimated on the annual real effective exchange rate of Darvas (2021) over 1999–2025. With the small-sample correction of Kendall (1954), its persistence is $\rho_s = 0.90$ and its innovation standard deviation $\sigma_s = 0.045$.²² Productivity is proxied by real GDP, the series on which the output process of sovereign-default models is estimated (Arellano, 2008; Chatterjee and Eyigungor, 2012): annual real GDP from 2000 to 2025 with a log-linear trend removed gives $\rho_z = 0.916$ and $\sigma_z = 0.016$. The innovations

²²The least-squares persistence is 0.77 in 27 observations, biased toward zero in so short a sample.

Table 9: Calibration

Parameter	Value	Target	Data or source	Model
<i>Set outside the model</i>				
$\gamma_{\text{owner}}, \gamma_{\text{worker}}$	2, 2	risk aversion	standard	
α	0.35	capital share	close to Aguiar and Gopinath (2007)	
δ_K	0.05	depreciation of capital	close to Caselli (2005)	
ω	1.455	labor curvature, Frisch elasticity 2.2	Mendoza (1991)	
χ	1.083	labor equal to one at the ergodic mean	normalization	
ρ_s, σ_s	0.90, 0.045	real exchange rate process	real effective exchange rate 1999–2025, Darvas (2021)	
ρ_z, σ_z	0.916, 0.016	productivity process	real GDP, 2000–2025, trend removed	
m	0.033	foreign share of the firms' capital	foreign assets / assets, eligible firms (Section 2)	
κ	0.083	foreign share of revenue, $m + 0.05$	foreign revenue / revenue, eligible firms, 0.080 (Section 2)	
τ_y	0.08	output tax, other tax revenue / GDP	OECD Global Revenue Statistics	
τ_π	0.22	net income tax, corporate rate	Tax Foundation (2025)	
r^*	0.77%	world real rate	Cleveland Fed, 1990–2025	
λ	0.208	re-entry, mean default episode 4.8 years	Asonuma and Trebesch (2016)	
δ_B	0.078	bond maturity, 12.9 years	Dealogic	
<i>Firm side</i>				
θ	0.286	debt / assets, mean	29.1%	29.1%
β_{owner}	0.950	debt / assets, s.d.	1.96 pp	1.89 pp
Γ_L	0.035	foreign-currency share of debt	45.3%	45.3%
Γ_F	0.039	dollar bond spread at issue	2.70 pp	2.71 pp
<i>Government side</i>				
β_{worker}	0.935	sovereign spread, mean	1.63 pp	1.63 pp
κ	0.0267	foreign-currency public debt / GDP	12.1%	12.1%

Notes: Firm moments: listed non-financial Indonesian firms, 2010–2025 (S&P Capital IQ). Dollar bond spread: investment-grade non-financial issues over the maturity-matched Treasury yield (Dealogic). Sovereign spread: ten-year dollar bond over the ten-year Treasury yield, monthly (Bloomberg). Foreign-currency public debt: IMF WEO debt times the foreign-currency share of [Arslanalp and Tsuda \(2014\)](#). pp: percentage points.

of the two processes are almost uncorrelated in the data (Appendix A.5).

The net income tax rate $\tau_\pi = 0.22$ is the statutory corporate income tax rate (Tax Foundation, 2025). The output tax rate $\tau_y = 0.08$ stands for every other tax and is set so that tax revenue resembles Indonesia's. In the data, tax revenue is 11.8 percent of GDP and the corporate income tax raises 33 percent of it (OECD). In the model, the government collects 11.1 percent of output, and the net income tax raises 28 percent of it (Table 11). As in Indonesian law, the net income tax falls on operating profit net of depreciation, interest and exchange-rate losses, and a loss pays no tax.

The world rate $r^* = 0.77$ percent is the average ex-ante one-year US real rate of the Federal Reserve Bank of Cleveland over 1990–2025. The re-entry probability $\lambda = 0.208$ is the inverse of the mean length of a default episode, 4.8 years, in the database of Asonuma and Trebesch (2016). The maturity parameter $\delta_B = 0.078$ is the inverse of the face-value-weighted average maturity at issue of the bonds the Indonesian government has issued since 2010, 12.9 years (Dealogic).

Firm side. The firm block has four parameters, the collateral limit θ , the owners' discount factor β_{owner} , and Γ_L and Γ_F , the inverses of the two pools' capacities, calibrated jointly to four moments. With one-period debt, the foreign-good share of new borrowing η is also the foreign-currency share of the debt stock, so its counterpart is the firms' aggregate foreign-currency debt over their aggregate debt, 45.3 percent. Leverage is the face value of debt over the value of capital, $(b' + s b^{*'})/(p_I(s) k')$, whose counterpart is total debt over total assets, 29.1 percent, with a standard deviation of 1.96 pp. The premium Ω_F that pool F earns is the spread at issue of investment-grade dollar bonds of non-financial Indonesian firms over the Treasury yield of the same maturity, 2.70 pp (Dealogic). The restriction to investment grade keeps the expected default loss, which the model's firm never imposes on its lenders, small relative to the spread.

The four parameters are calibrated jointly, but each is informative mainly about one moment. θ moves leverage, because firms borrow close to the limit. β_{owner} moves the volatility of leverage: the more patient the owners, the more they smooth dividends and let borrowing absorb the shocks. Γ_F moves the dollar premium through $\Omega_F = \Gamma_F X_F^*$, and Γ_L the foreign-currency share through $\eta^* \approx \Gamma_L/(\Gamma_L + \Gamma_F)$ of (28).

Government side. The government block calibrates β_{worker} ²³ and the default-cost parameter κ jointly to two moments. The spread's counterpart is the yield of Indonesia's

²³The government is benevolent toward workers, so the discount factor in its problem is the workers'.

Table 10: Untargeted moments, Indonesia and the model

Moment	Data	Model
corr(change in the spread, depreciation)	0.63	0.53
corr(spread, log s)	0.69	0.53
autocorrelation of the spread	0.60	0.44
sovereign spread, s.d. (pp)	0.58	0.58
corr(spread, investment)	-0.34	-0.39
corr(spread, foreign-currency share of debt)	0.31	0.26
investment / assets, mean	0.063	0.051
investment / assets, s.d.	0.015	0.017
autocorrelation of debt / assets	0.57	0.48
autocorrelation of the foreign-currency share	0.93	0.67
foreign-currency share of debt, s.d. (pp)	11.3	0.4
s.d. of consumption / s.d. of output	1.01	1.01
corr(consumption, output)	0.89	0.98
dividends / assets	0.027	0.037

Notes: Data: Indonesia. Firms 2010–2025 (eligible set, ratios of sums). The spread rows use the sovereign CDS spread, 2009–2025, except the s.d., which uses the ten-year dollar bond over the ten-year Treasury yield, monthly, 2010–2025, the series the calibration targets. The bond series has no data for 2018–2023, so the correlations use the CDS. National accounts 2000–2024. Model: means over simulated windows as long as the data sample. The s.d. of the spread and of the foreign-currency share are moments of the full simulated path. Correlations and the two consumption rows are of HP(100)-filtered series, the other rows of the annual series in levels.

ten-year dollar bond over the ten-year Treasury yield, monthly over 2010–2025, 1.63 pp on average (Bloomberg).²⁴ The debt’s counterpart is foreign-currency public debt over GDP, 12.1 percent: general-government debt of 31.2 percent of GDP (IMF) times the 38.8 percent of it denominated in foreign currency (Arslanalp and Tsuda, 2014).²⁵ β_{worker} is informative mainly about the level of the spread, since a less patient government borrows more and defaults more often, and κ about the debt the government carries at that spread, since a larger cost of default makes a given debt safer.

Procedure. The six internal parameters are chosen by the simulated method of moments, in the two blocks of Section 3. The firms’ problem does not depend on the govern-

²⁴The ten-year series has no quotes for 2018–2023, so the average covers 2010–2017 and 2024–2025.

²⁵The level covers general government, while the currency split covers only central-government securities.

ment's choices, so the firm block comes first,

$$\hat{\Theta}_{\text{firm}} = \arg \min_{\Theta_{\text{firm}}} \sum_{j \in \mathcal{F}} \left(\frac{M_j(\Theta_{\text{firm}}) - \hat{M}_j}{\hat{M}_j} \right)^2, \quad \Theta_{\text{firm}} = (\theta, \beta_{\text{owner}}, \Gamma_L, \Gamma_F), \quad (29)$$

and the government block follows, given the firms' policies,

$$\hat{\Theta}_{\text{gov}} = \arg \min_{\Theta_{\text{gov}}} \sum_{j \in \mathcal{G}} \left(\frac{M_j(\hat{\Theta}_{\text{firm}}, \Theta_{\text{gov}}) - \hat{M}_j}{\hat{M}_j} \right)^2, \quad \Theta_{\text{gov}} = (\beta_{\text{worker}}, \kappa). \quad (30)$$

Here $\mathcal{F}$ holds the four firm moments and $\mathcal{G}$ the two government moments of Table 9, $\hat{M}_j$ is a data moment and M_j its model counterpart (Online Appendix OA.2).

Fit. Table 9 compares the targeted moments in the data and the model. Five of the six targets are matched to within 1 percent, and the volatility of leverage to within 4 percent. With the foreign share of capital set to the data's and the foreign-currency share and leverage targeted, the firms' currency mismatch follows: 9.9 percent of assets against 10.0 in the data. Table 10 compares untargeted moments in the data and the model. The model reproduces the volatility of the spread, the volatility of the investment rate and the volatility of consumption relative to output. It gets the sign and about the size of the spread's comovement with the exchange rate, with investment and with the foreign-currency share. It misses the volatility of the firms' foreign-currency share, 0.4 pp against 11.3 in the data, because the two pools' capacities are constant and the share moves only with the exchange rate. It also understates the persistence of the spread, of leverage and of the foreign-currency share, and the mean investment rate, and overstates dividends relative to assets. It overstates the correlation of consumption with output.

Indonesia among large emerging markets. Table 11 puts Indonesia next to seven other large emerging markets: Brazil, Chile, Colombia, India, Mexico, the Philippines and Turkey. Every moment is computed for every country in the same way as for Indonesia. In the moments the calibration targets, Indonesia is close to the median of the group. Its spread is 1.63 pp against a median of 1.59. Its foreign-currency public debt is 12 percent of GDP against 10. The same holds for its firms. Their leverage is 29 percent against 33. Their foreign-currency debt share is 45 percent against 49. Their dollar bonds are issued at 2.70 pp over Treasuries against 2.81. Indonesia differs on the asset side and on the tax side. Its firms hold 3 percent of their assets abroad, the least of the eight. Their corporate currency mismatch, 10 percent of assets, is the highest. The corporate income tax raises a

third of Indonesia's tax revenue, against a fifth in the median country of the group.

A second economy: Brazil. Indonesia stands out in its firms' mismatch, its low tax revenue and the weight of its corporate income tax, and all three enter the model's fiscal channel directly. To see whether the results depend on them, I also calibrate the model to Brazil, which differs from Indonesia in all three: its firms hold more assets abroad than foreign-currency debt, a mismatch of -4.6 percent of assets against $+10.0$, and the corporate income tax raises 10 percent of its revenue, against a third in Indonesia, and its tax revenue is 32 percent of GDP, against 12. The calibration follows the same procedure, with Brazil's own moments: a net income tax of 0.34 and an output tax of 0.28 by the same mapping, a foreign share of capital of 0.131 and of revenue of 0.181, an exchange-rate process twice as volatile as Indonesia's,²⁶ and the six internal parameters fitted to Brazil's leverage and its volatility, the foreign-currency share of debt, the dollar premium, the spread and the foreign-currency public debt (Appendix C.4 reports the parameters, the fit and its misses). Exchange-rate losses are deductible in both countries: Indonesia deducts them as booked, and Brazil deducts them on settlement by default but lets a firm elect to deduct them as booked.

²⁶Brazil's persistence is the least-squares estimate. The small-sample correction used for Indonesia would give it a unit root.

Table 11: Indonesia among large emerging markets, 2010–2025

	Model	Indonesia	Brazil	Chile	Colombia	India	Mexico	Philippines	Turkey	Median
<i>Firms</i>										
Foreign-currency share of debt	0.453	0.453	0.259	0.494	0.537	0.136	0.576	0.257	0.621	0.494
Foreign-currency debt / assets	0.132	0.133	0.085	0.148	0.180	0.043	0.192	0.084	0.158	0.148
Foreign assets / assets	0.033	0.033	0.131	0.356	0.299	0.183	0.349	0.054	0.121	0.183
Corporate currency mismatch	0.099	0.100	−0.046	−0.207	−0.119	−0.140	−0.157	0.030	0.037	−0.119
Debt / assets	0.291	0.291	0.330	0.299	0.336	0.318	0.327	0.331	0.256	0.327
s.d. of the annual series	0.019	0.020	0.027	0.023	0.076	0.025	0.032	0.028	0.053	0.028
Investment / assets	0.050	0.063	0.042	0.038	0.041	0.024	0.046	0.048	0.040	0.041
Dollar bond spread at issue (pp)	2.71	2.70	3.00	2.33	3.47	2.11	2.81	2.34	3.57	2.81
<i>Sovereign</i>										
Public debt / GDP (%)	12.1	31.2	76.7	24.3	49.8	73.9	50.4	46.1	31.8	49.8
Foreign-currency share of public debt	1.00	0.39	0.05	0.23	0.33	0.05	0.19	0.29	0.41	0.23
Foreign-currency public debt / GDP (%)	12.1	12.1	4.1	5.5	16.5	3.9	9.7	13.5	12.9	9.7
Spread, 10-year dollar bond (pp)	1.63	1.63	1.86	0.61	1.90	–	1.31	1.13	2.42	1.59
s.d. (pp)	0.58	0.58	0.88	0.16	0.69	–	0.34	0.38	0.57	0.47
CDS spread (pp)	–	1.32	1.93	0.77	1.58	0.99	1.21	0.94	3.06	1.21
s.d. (pp)	–	0.48	0.72	0.24	0.56	0.28	0.26	0.37	1.44	0.37
Maturity of bond issuance (years)	12.9	12.9	15.6	14.3	18.6	10.9	15.2	15.6	6.4	15.2
Tax revenue / GDP (%)	11.1	11.8	31.7	20.8	19.5	–	15.0	16.6	24.1	20.1
corporate income tax, % of tax revenue	28.2	32.8	10.0	22.4	25.4	–	19.4	22.4	8.5	20.9
<i>Shocks and taxes</i>										
Real exchange rate: persistence	0.90	0.90*	0.87	0.66	0.84	0.91	0.84	0.95	0.94	0.87
standard deviation	0.10	0.10*	0.20	0.06	0.14	0.13	0.13	0.15	0.23	0.14
Output: persistence	0.92	0.92	0.89	0.82	0.76	0.68	0.46	0.62	0.40	0.68
innovation s.d.	0.016	0.016	0.027	0.031	0.031	0.028	0.028	0.031	0.035	0.031
Corporate income tax rate, 2025 (%)	22	22	34	27	35	30	30	25	25	30
Exchange-rate losses deductible	booked	booked	settled [†]	booked	settled [‡]	booked	booked	settled	booked	–

Notes: Model: the calibrated economy. Median: the seven countries other than Indonesia. Firm rows: listed non-financial firms, 2010–2025 (S&P Capital IQ). Dollar bond spread: investment-grade non-financial issues over the maturity-matched Treasury yield (Dealogic). Public debt: IMF WEO, with its foreign-currency share from [Arslanalp and Tsuda \(2014\)](#). Spread: ten-year dollar bond over the ten-year Treasury yield (five-year for Chile). Maturity: face-value-weighted maturity at issue of the government's bonds issued since 2010 (Dealogic). Tax revenue and the corporate income tax's share of it: OECD Global Revenue Statistics, all levels of government, social security contributions included, means of 2010–2023 (India is not in the database). Real exchange rate: least-squares persistence and standard deviation of the annual log real effective rate, 1999–2025, except Indonesia's*. Output: AR(1) of log-linearly detrended real GDP, 2000–2025. Tax rate: [Tax Foundation \(2025\)](#). Exchange-rate losses deductible when booked (booked) or only when the debt is settled (settled): the sources of Table OA.1 in the online appendix. * The values used in the calibration: the persistence corrected for small-sample bias ([Kendall, 1954](#)) and the standard deviation it implies, against 0.77 and 0.12 by least squares. The correction would push the persistence of four of the other seven countries to one or above, so their columns are least squares, and Brazil's calibration uses its least-squares persistence. [†] Firms may elect to deduct the loss as booked. [‡] Deducted as booked through 2016.

5 Counterfactuals

This section uses the calibrated model. I first run the paper’s regression on simulated economies whose firms differ in their balance sheets. I then measure how much the firms’ foreign-currency debt adds to the spread’s response to a depreciation and where the extra response comes from, compare Indonesia with Brazil, and ask how policy can lower that response.

Economies that differ in their firms’ balance sheets. To run the regressions of Section 2 on simulated data, I solve the model for economies that differ only in their firms’ foreign-currency debt and foreign assets. The firms’ foreign-currency debt is set mainly by how the financiers’ capacity is split between the two pools, $\eta^* \approx \Gamma_L/(\Gamma_L + \Gamma_F)$ in (28), where pool j supplies $1/\Gamma_j$ units of funds per unit of excess return. At the calibrated values pool F holds 47 percent of the capacity and the firms raise 45 percent of their funds in the foreign good. I move capacity from one pool to the other and keep the total, $C \equiv 1/\Gamma_F + 1/\Gamma_L$, at its calibrated value.²⁷ The firms’ foreign assets are set by the share of their capital located abroad, m , and with it the share of their sales made abroad, $x = m + 0.05$. Every other parameter keeps its calibrated value. The financiers’ capacity is the same in every economy, but the firms choose how much to borrow, so credit and capital are not held fixed. Across these economies, foreign-currency debt runs from 0 to 23 percent of assets, foreign assets from 0 to 18 percent, and mismatch from -18 to $+19$ percent.

Model-simulated regression results. Table 12 runs the regressions of Table 4 on panels simulated from these economies and sets each coefficient next to its data counterpart. The Brazilian economies are built the same way around Brazil’s calibration. These coefficients are untargeted moments. In the regression of Table 4 the interaction of mismatch with the depreciation is 8.9 for Indonesia and 6.0 for Brazil, against 15.6 in the emerging markets’ data, with a standard error of 7.5, and the coefficient on the depreciation 3.2 and 2.5 against 3.5. Split into its two sides, the model’s foreign-currency debt raises the spread’s response by 10.3 per unit in Indonesia and 4.3 in Brazil, and foreign assets lower it by 6.8 and 7.2, against 15.7 (11.6) and -16.7 (7.5) in the data. Indonesia’s interaction and debt term lie within one standard error of the data’s, and the other coefficients within one and a half. Appendix C.5 compares depreciations and appreciations in the data and the model.

²⁷Closing the foreign pool without moving its capacity to the local pool, which is what a ban on foreign-currency borrowing does, would also shrink the firms’ credit, by 16 percent, and their capital, by 11 percent.

Table 12: Model-simulated regression results

	Data	Model, Indonesia	Model, Brazil
Mismatch _{c,t-1} × s _{c,t}	+15.63** (7.53)	+8.92	+6.01
s _{c,t}	+3.48*** (0.87)	+3.24	+2.55
FC debt / assets _{c,t-1} × s _{c,t}	+15.73 (11.60)	+10.30	+4.29
Foreign assets / assets _{c,t-1} × s _{c,t}	-16.67** (7.54)	-6.77	-7.16

Notes: The dependent variable is the sovereign spread in percentage points. Mismatch is corporate currency mismatch. Data: Table 4, the 30 emerging markets, with standard errors clustered by country in parentheses. The split rows are the same regression with mismatch's two sides entered separately. Model: the same regressions on panels simulated from economies that differ in how the financiers' capacity is split between the two pools and in the share of their capital located abroad, every other parameter at the country's calibrated value. The model's mismatch is foreign-good debt net of the capital abroad, over capital, as in Section 2. The model's depreciation is annual and the data's quarterly. ***p < 0.01, **p < 0.05, *p < 0.1.

The spread's response to a depreciation. To measure what the firms' foreign-currency debt adds to the spread's response, I compare the calibrated Indonesian economy, the Indonesian baseline, with the same economy in which the local pool holds the whole capacity, so that the firms borrow only in the local good and keep their foreign assets and sales. I call it the $\eta = 0$ economy. In the long run the two economies have nearly the same spread, debt and default rate (Table 13, Panel C). They differ in how the spread responds to the exchange rate. Because the model is nonlinear, the response to a shock depends on the state of the economy when the shock hits. I use the generalized impulse response of [Koop et al. \(1996\)](#), the expected path of a variable after the shock minus its expected path without it, averaged over the economy's ergodic distribution (Online Appendix OA.2 gives the details). The shock is a one-standard-deviation depreciation, and I report every response per 10 percent of depreciation.

Figure 8 shows the spread's response. In the Indonesian baseline the spread rises by 0.46 percentage points on impact. In the $\eta = 0$ economy it rises by 0.26, because the government's own debt is in the foreign good. The government's debt is long term and the exchange rate is persistent, so the depreciation raises the local-good cost of servicing the whole stock for several years, and the default probability priced into the bond rises. I call the difference between the two impact responses $\mathcal{A}$. It is 0.20 percentage points, with a standard error of 0.007, almost half of the spread's response. The gap narrows as the exchange rate returns toward its mean and is close to zero after eight years.

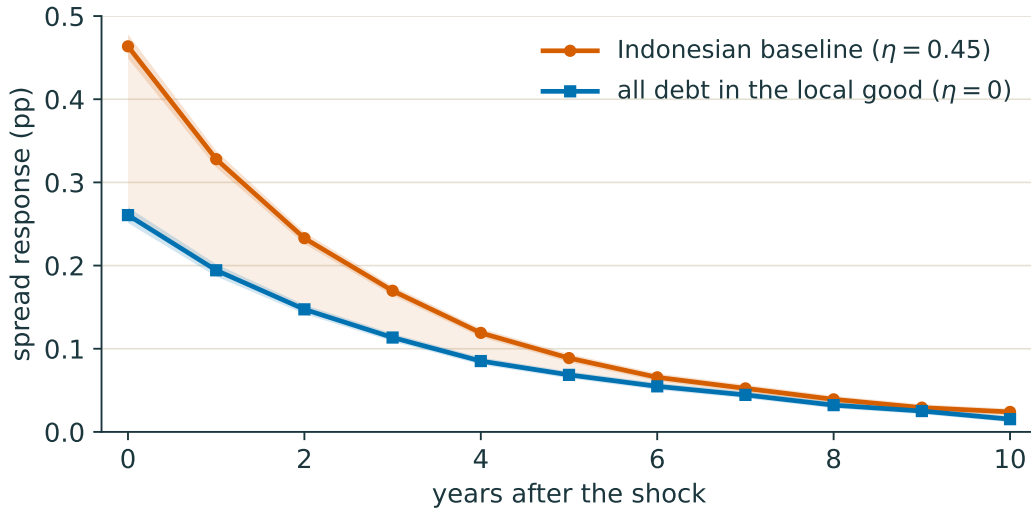


Figure 8: The spread's response, per 10 percent depreciation

Notes: Generalized impulse responses of the sovereign spread, in percentage points, for the Indonesian baseline ($\eta = 0.45$) and the economy whose financiers have the same capacity but lend only in the local good ($\eta = 0$). The shaded area is the gap between the two responses, which equals $\mathcal{A}$ on impact. The bands show 95 percent confidence intervals.

Sources of the extra response. Panel A of Table 13 compares the impact responses of the two economies. In the Indonesian baseline a depreciation lowers the firms' net worth by 0.80 percent, their new capital by 0.58 percent and tax revenue by 6.0 percent on impact. Dividends barely move (+0.08 percent), and physical output the next year is 0.23 percent higher. In the $\eta = 0$ economy the same foreign sales raise net worth by 0.61 percent, revenue by 2.0 percent and capital by 0.65 percent on impact.

Revenue falls in the baseline because the deduction of the firms' exchange-rate loss costs more than the output tax and the net income tax gain on the higher local-good value of their foreign sales. With dividends nearly flat, the owners take the loss through lower investment. Output still rises, as the exchange rate is persistent and the foreign sales keep hours high, which outweighs the lower capital. In the $\eta = 0$ economy capital rises since local-good credit becomes cheaper when the exchange rate is expected to come back.

The net income tax, elastic hours and the borrowing limit pass the firms' loss on to the government. Under the net income tax the exchange-rate loss is deducted from taxable income, and revenue falls in the year of the shock. Lower capital lowers the wage, and with elastic hours, the workers supply fewer hours ℓ , which would lower next year's output even more. The borrowing limit $\theta p_1(s)k'$ rises with the shock only through the small share m of capital abroad, and the firms cannot borrow to make up for the net worth they lose, so they invest less. To measure what each contributes, I switch the features off,

Table 13: Sources of the extra response

<i>A. Impact responses, per 10 percent depreciation</i>		
	Indonesian baseline	$\eta = 0$ economy
Net worth n (%)	−0.80	+0.61
Capital k' (%)	−0.58	+0.65
Dividends d (%)	+0.08	+1.12
Tax revenue R (%)	−5.99	+1.99
Output y , next year (%)	+0.23	+1.02
Spread (pp)	+0.46	+0.26
<i>B. Shapley split of $\mathcal{A}$</i>		
	pp	Share
Net income tax	0.087	44%
Elastic hours	0.062	31%
Borrowing limit	0.049	25%
<i>C. Long-run moments</i>		
	Indonesian baseline	$\eta = 0$ economy
Firms' mismatch (% of assets)	+9.9	−3.3
Foreign-good share of borrowing, η	0.45	0
Mean spread (pp)	1.64	1.65
Standard deviation of the spread (pp)	0.58	0.56
Government debt / output (%)	12.1	12.3
Default rate (% of years)	1.08	1.05

Notes: Panel A: generalized impulse responses on impact, in percent of the no-shock path, except output one year after the shock and the spread in percentage points. Panel B: Shapley values, the average contribution of each feature over the six orders of switching the features off. They split the difference between $\mathcal{A}$ in the Indonesian baseline, 0.204 percentage points, and $\mathcal{A}$ with all three features switched off, 0.006. Appendix C.6 reports the eight economies behind them and how each feature is switched off. Panel C: long-run means of each economy. Mismatch is foreign-good debt net of the capital abroad, over capital.

alone and together, and in each of the eight resulting economies I compute $\mathcal{A}$ against the $\eta = 0$ economy with the same features (Appendix C.6 reports them and how each feature is switched off). The net income tax is replaced by an output tax that raises the same revenue, hours are fixed, and the borrowing limit is raised until it never binds, with steeper premia that keep leverage at the baseline's. With all three features off, $\mathcal{A}$ falls from 0.204 to 0.006 percentage points. Panel B splits the difference of 0.198 by Shapley values, the average contribution of each feature over every order of switching them off. The net income tax accounts for 44 percent, elastic hours for 31 percent, and the borrowing limit for 25 percent.

Brazil. As for Indonesia, every response is per 10 percent of depreciation. In Brazil the spread rises by 0.23 percentage points, against 0.46 in Indonesia. Brazilian firms hold more assets abroad than foreign-currency debt, so the depreciation raises their net worth, by 1.5 percent on impact, and their capital, by 0.4 percent, while Indonesia's fall. Their foreign-currency debt still adds 0.08 percentage points to the spread's response, against 0.20 in Indonesia, mainly because its exchange-rate loss is deducted from taxable income whatever the firms hold abroad (Appendix C.4).

Table 14 gives the Brazilian economy Indonesia's corporate mismatch: its firms' foreign-asset share is set to Indonesia's 0.033, and with it the foreign share of revenue to 0.083, and, at the same total financier capacity, the split of that capacity between the two pools is set so that the firms' mismatch comes close to Indonesia's, 9.3 against 9.9 percent of assets, with every other parameter Brazilian.²⁸ The sovereign then responds more like Indonesia's: the response per 10 percent rises from 0.23 to 0.37 percentage points, and the part from foreign-currency debt from 0.08 to 0.13. Mismatch decides whether a depreciation is contractionary for the firms (Table 14): capital falls on impact in Indonesia, by 0.6 percent, and in Brazil with Indonesia's corporate mismatch, by 0.4 percent, but rises in Brazil with its own balance sheet, by 0.4 percent. The firms' balance sheet thus accounts for most of the gap between the two countries' responses, and Brazil's other parameters for the rest.

Inefficiency. The firms' borrowing is inefficient in two ways. First, each firm takes the pools' premia as given, but a pool's premium rises with its lending, $\Omega_j = \Gamma_j X_j^*$, so each firm's borrowing raises the premium that every other firm pays. The premia are rents

²⁸The foreign-currency share of debt that gives this mismatch is lower than Indonesia's, 0.39 against 0.45, because the two economies have different leverages: Brazilian firms borrow more against their capital, so a smaller foreign-currency share of a larger debt leaves nearly the same net position.

Table 14: Brazil with Indonesia's corporate mismatch

Per 10 percent of depreciation	Brazil	Brazil with Indonesia's corporate mismatch	Indonesia
Spread response on impact (pp)	0.23	0.37	0.46
From foreign-currency debt, $\mathcal{A}$ (pp)	0.08	0.13	0.20
Capital on impact (%)	+0.4	−0.4	−0.6
Firms' mismatch (% of assets)	−4.5	+9.3	+9.9
Foreign-currency share of debt	0.26	0.39	0.45

Notes: The first three rows are generalized impulse responses, per 10 percent depreciation, and the last two are long-run means. The middle column is the Brazilian economy with its firms' foreign-asset share set to Indonesia's, the foreign share of revenue moving with it, and, at the same total financier capacity, the split between the two pools set so that the firms' mismatch comes close to Indonesia's. Every other parameter is at Brazil's calibrated value, so its sovereign's parameters are not re-targeted.

paid to foreign financiers, 2.4 percent of output in the Indonesian baseline. A firm pays $\Gamma_j X_j^*$ per unit of funds while the country pays $2\Gamma_j X_j^*$ at the margin, so firms borrow more than is efficient from both pools. This distortion has nothing to do with the currency of the debt. Second, firms ignore that their foreign-currency debt moves public revenue and the government's default risk, an externality that [Wu \(2025\)](#) also studies. In the calibrated economy this second externality is small. Even with a 10 percent depreciation (more than twice the standard deviation of a year's change in the exchange rate), the firms' foreign-currency debt adds only 0.20 percentage points to the spread. The government also adapts to its riskier revenue: compared with the $\eta = 0$ economy it carries less debt, 12.1 against 12.3 percent of output (Table 13, Panel C). How much of the firms' exchange-rate gains and losses on foreign-currency debt reaches the budget is set by the tax code.²⁹ With the deduction, the government bears the share τ_π of a profitable firm's exchange-rate loss. In a 10 percent depreciation its transfer to workers falls by 4.1 percent, while the owners keep their dividend.

Three policies. I consider three policies. I measure each group's welfare by a consumption equivalent: the constant level of consumption whose discounted utility equals the group's expected lifetime utility, averaged over the economy's ergodic distribution. For workers, consumption is net of the disutility of labor. Changes are in percent of the In-

²⁹Both kinds of debt expose the firm to the exchange rate. With foreign-good debt, the amount the firm repays in local goods moves with the exchange rate. With local-good debt, the repayment is fixed, but the price at which the firm borrows, q_L , moves with the expected exchange rate, and pool L bears the risk on repayment. Only the gain or loss on foreign-good debt enters taxable income. The cost of local-good debt is deducted as interest.

Indonesian baseline's level.

The first policy ends the deduction of exchange-rate losses on foreign-good debt and the taxation of exchange-rate gains. To nest it with the law, I rewrite the firm's taxable income and budget constraint with $\zeta \in [0, 1]$, the share of the exchange-rate result that enters taxable income:

$$\pi_\zeta = \text{revenue after the output tax} - \text{wages} - \text{capital depreciation} - \text{interest} - \zeta (s - s^-) b^*,$$

$$d \leq (1 - \tau_\pi^+) \pi_\zeta - (1 - \zeta) (s - s^-) b^* \\ - \text{net investment} - \text{principal repayment} + \text{new borrowing}.$$

Here τ_π^+ depends on the sign of π_ζ . Under Indonesian law $\zeta = 1$, which gives (6). At $\zeta = 0$ the exchange-rate result is neither deducted nor taxed, and only interest is deductible. For any ζ the firm pays the whole loss $(s - s^-) b^*$, and $\zeta (s - s^-) b^*$ of it enters taxable income.

The second policy is a tax τ_F on each unit of foreign-good funds the firm raises. The new borrowing in (6) becomes

$$q_L b' + (1 - \tau_F) q_F s b^{*'},$$

and the government adds $\tau_F q_F s b^{*'}$ to its revenue. The firm cannot deduct this tax, and the borrowing limit applies to the funds before tax.

The third policy is a cap on the foreign-good share of new borrowing,

$$\eta = \frac{q_F s b^{*'}}{q_F s b^{*'} + q_L b'} \leq \eta_{\text{cap}}.$$

With a cap of zero, firms cannot borrow in the foreign good at all.³⁰

Table 15 and Figure 9 report the results. Without the deduction of exchange-rate losses, revenue does not fall in the year of a depreciation, and the spread's response drops from 0.46 to 0.31 percentage points. Average capital stays the same. Firm owners gain 0.26 percent, and workers' welfare does not change.

The tax and the cap lower the spread's response but cost welfare. They restrict the firms' access to foreign-good credit. Firms move to the local pool, whose premium rises, so total

³⁰In all three policies the output tax and the net income tax stay at their Indonesian rates. The paper does not look for optimal tax rates and does not solve a Ramsey problem. It takes the output tax rate and the corporate income tax rate as they are in the data.

Table 15: Three policies in Indonesia

	Setting	Spread			Welfare (%)	
		response (pp)	η	Capital (%)	Workers	Owners
Indonesian baseline		0.46	0.45			
All debt in the local good	$\eta = 0$	0.26	0	+0.6		
Ending the deduction of exchange-rate losses	$\zeta = 0$	0.31	0.45	+0.0	+0.00 (0.01)	+0.26 (0.01)
Tax on foreign-good borrowing	$\tau_F = 1\%$	0.40	0.32	-3.5	-1.15 (0.00)	-3.10 (0.00)
	$\tau_F = 2\%$	0.32	0.18	-6.8	-3.19 (0.01)	-5.92 (0.01)
	$\tau_F = 4\%$	0.23	0.00	-10.9	-6.94 (0.01)	-9.15 (0.01)
Cap on the foreign-good share	$\eta_{cap} = 40\%$	0.44	0.40	-0.3	-0.17 (0.00)	-0.26 (0.00)
	$\eta_{cap} = 20\%$	0.35	0.20	-4.2	-2.74 (0.00)	-3.83 (0.00)
	$\eta_{cap} = 0$	0.23	0	-10.9	-6.98 (0.01)	-9.19 (0.01)

Notes: Spread response: the spread's response on impact to a 10 percent depreciation. η : mean foreign-good share of new borrowing. Capital: mean capital, percent change from the Indonesian baseline. Welfare: consumption equivalents of the long-run distributions, percent change from the same baseline. Every parameter not named in a row keeps its calibrated value. Standard errors of the welfare changes, which measure simulation noise only, in parentheses. For $\zeta = 0$ the welfare changes are realized lifetime consumption equivalents.

credit and capital fall. A 1 percent tax lowers the response to 0.40 percentage points and capital by 3.5 percent, and a 40 percent cap lowers the response to 0.44 and capital by 0.3 percent, at welfare losses of 0.2 to 3.1 percent. A 4 percent tax or a ban brings the response down to 0.23 percentage points, close to the $\eta = 0$ economy, but cuts credit by 16 percent, capital by 11 percent and welfare by 7 to 9 percent.

Ending the deduction. Panel A of Table 16 reports how the economy's long-run averages change. Under the law, exchange-rate gains on foreign-good debt are taxed and losses are deducted alike, so the tax favors neither currency. Without the deduction, the cost of foreign-good borrowing shifts by the net income tax rate times the expected change in the exchange rate. After a depreciation the local currency is expected to appreciate, the expected gain is no longer taxed, and foreign-good borrowing becomes cheaper. After an appreciation the expected loss is no longer deducted, and it becomes more expensive. On average the two effects offset. The foreign-good share of borrowing moves only from 45.3 to 44.8 percent, while its standard deviation rises from 0.4 to 3.7 percentage points (Panel A). Under the law the government borrows less when a depreciation is expected, because its revenue would fall with the currency. Without the deduction it no longer needs to. So on average it borrows more, 12.3 percent of output against 12.1. Its average spread rises slightly.

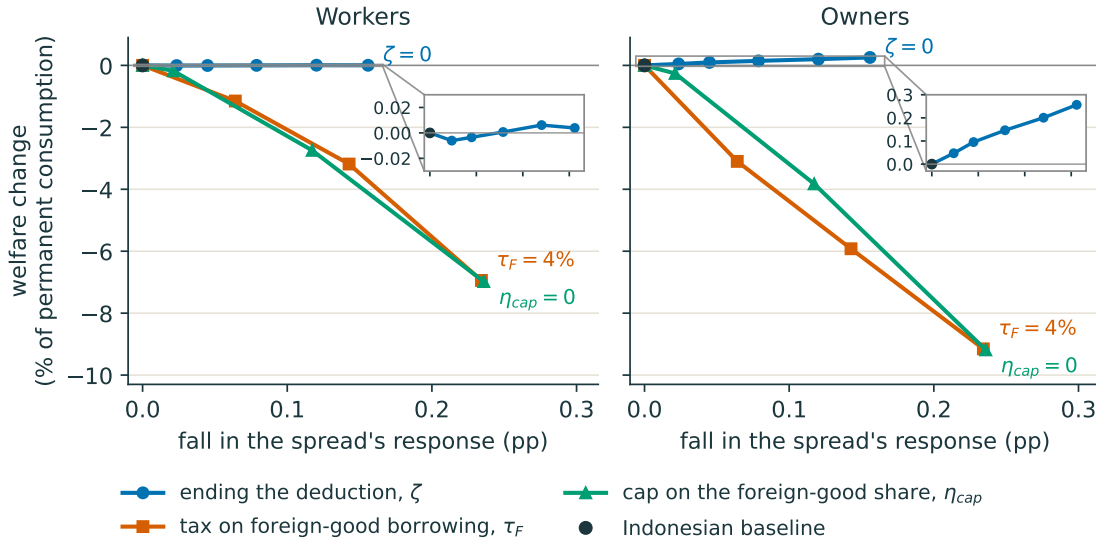


Figure 9: Three policies in Indonesia: the fall in the spread's response and welfare

Notes: Left panel workers, right panel owners. Horizontal axis: the fall in the spread's response on impact to a 10 percent depreciation, relative to the Indonesian baseline, in percentage points. Vertical axis: welfare, in percent of the baseline's consumption equivalent. The markers are $\zeta = 0.8, 0.6, 0.4, 0.2$ and 0 , $\tau_F = 1, 2$ and 4 percent, and $\eta_{cap} = 40, 20$ and 0 percent. The dot is the Indonesian baseline. The insets zoom in on the lines for ending the deduction.

Panel B splits the owners' welfare change into two steps, the firms' old choices under the new law and their new choices. Owners gain 0.26 percent in total. At the old choices they lose 0.22 percent, mainly because the treasury no longer shares the exchange-rate gains and losses on the firms' foreign-good debt and their dividends swing more. Their new choices give them 0.48 percent. The firms borrow 0.6 percent less at the same capital and pay lower premia, and their timing of foreign-good borrowing earns gains that are no longer taxed. On average capital, output and wages do not move, and dividends rise by 0.26 percent (Panel A).

Workers' welfare does not change. Panel C splits it into three steps that offset. Their wages do not move. At the firms' old choices the government's transfer to them rises and no longer falls in depreciations, because the treasury no longer shares the firms' exchange-rate result, which is a small loss on average.³¹ The firms' new choices add little, because the lower premia raise taxable income by about as much as the untaxed gains lower it. And the government borrows more, which in the long run lowers the transfer by about as much as the first two steps raise it.

³¹The exchange rate is lognormal, so a rise of a given log size raises the local cost of the debt by more than an equally likely fall lowers it.

Table 16: Ending the deduction of exchange-rate losses in three steps

	Indonesia	Brazil
<i>A. The long run without the deduction</i>		
Capital (%)	+0.01	−0.22
Wages (%)	+0.01	−0.15
Firms' debt per unit of capital (%)	−0.6	−0.5
Foreign-good share of borrowing, s.d. (pp)	0.4 → 3.7	1.7 → 11.2
Premia the firms pay (% of dividends)	−0.17	+0.35
Dividends (%)	+0.26	+0.21
Tax revenue (%)	+0.06	−0.30
Government debt (pp of output)	+0.20	+0.09
Transfer to workers (%)	−0.03	−0.31
<i>B. Owners</i>		
1. Same choices, new tax law	−0.22	−0.54
2. The firms' new choices	+0.48	+0.82
Total	+0.26	+0.28
<i>C. Workers</i>		
1. Same choices, new tax law	+0.035	+0.021
2. The firms' new choices	+0.017	−0.197
3. The government's borrowing and default	−0.049	−0.020
Total	+0.004	−0.195

Notes: Panel A: long-run averages without the deduction, in percent change from each country's baseline, except the premia the firms pay (change in percent of dividends), the standard deviation of the foreign-good share of new borrowing (percentage points, in the baseline and without the deduction) and government debt (change in percentage points of output). Panels B and C: welfare change from ending the deduction ($\zeta = 0$), in percent of the realized lifetime consumption equivalent. Step 1 keeps every choice of each country's baseline and applies the new tax law, with the change in revenue passed to the workers in the period it is collected. Step 2 lets the firms choose again, with revenue still passed through. Step 3 is the rest, the government's borrowing and default response. Owners' welfare depends only on the firms, so it has no third step.

Why Brazil's workers lose. In Brazil, ending the deduction lowers the response by about 0.05 percentage points per 10 percent of depreciation, at a welfare change of -0.20 percent for workers and $+0.28$ for owners (Appendix C.4 reports Brazil's decomposition and its three policies). Brazil's net income tax rate is higher, 0.34 against 0.22, so each untaxed gain costs its budget more. There the firms' new choices in step 2 cost workers 0.20 percent, against a gain of 0.02 percent in step 1. Before the government's response, the tax rates alone reverse the result: with Brazil's tax rates, Indonesia's workers would lose from ending the deduction, and with Indonesia's, Brazil's would gain.³² Figure 10 moves Indonesia's two tax rates step by step toward Brazil's: step 1 stays about the same, and the cost of step 2 grows. Other differences between the two countries change the size of the result but not its sign, except that Indonesia's financing parameters would also reverse Brazil's (Appendix C.7).

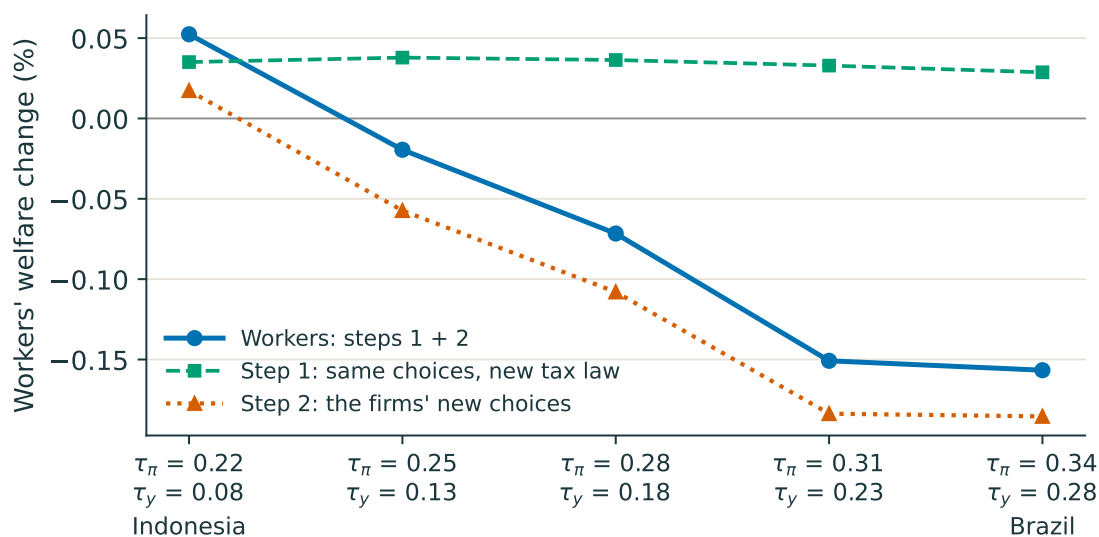


Figure 10: Ending the deduction: Indonesian workers' welfare at higher tax rates

Notes: Indonesia's economy with both tax rates moved a quarter, a half and three quarters of the way to Brazil's. Welfare change in percent of the realized lifetime consumption equivalent, with the change in revenue passed to the workers in the period it is collected, as in steps 1 and 2 of Table 16, so the government's response, step 3, is left out.

³²With the government's borrowing held fixed, as in steps 1 and 2 of Table 16, Indonesian workers gain 0.05 percent at Indonesia's tax rates and would lose 0.16 percent at Brazil's, and Brazilian workers lose 0.18 percent and would gain 0.26 percent at Indonesia's (Table 37).

6 Conclusion

This paper documents how corporate currency mismatch amplifies the response of sovereign risk to the exchange rate. Using a novel dataset I construct, which measures the currency mismatch of listed firms in 57 countries, I show that mismatch is concentrated in emerging markets and that, across emerging markets, sovereign spreads rise more in a depreciation where the corporate sector is more mismatched. The channel this paper proposes is the tax channel. At the firm level, mismatched firms earn less and invest less after a depreciation, and where tax law deducts exchange-rate losses in the year they are booked, firms with foreign-currency debt owe less tax. A sovereign default model built around these facts and calibrated to Indonesia produces an amplification within one standard error of the one found in the data. In the model, this channel works in two ways. In the year of a depreciation, mismatched firms deduct their exchange-rate losses from taxable income, so tax revenue falls. In the following years they invest less, so they produce and earn less and the tax base is smaller than it would be without mismatch. The firms' foreign-currency debt accounts for almost half of the spread's response, and 44 percent of that part comes from the corporate income tax. In Brazil, whose firms hold more assets abroad than foreign-currency debt, the spread responds less, and most of the gap closes when Brazil is given Indonesia's corporate mismatch.

Excluding exchange-rate gains and losses from taxable income lowers the spread's response to a depreciation. Firm owners gain. Capital and wages barely move, so workers are affected mainly through tax revenue: they are unaffected in Indonesia and lose 0.20 percent in Brazil, whose tax rates are higher. Firms borrow more in foreign currency when they expect an exchange-rate gain, which is no longer taxed, and the higher the tax rates, the more revenue this costs. Caps and taxes on foreign-currency borrowing also lower the response, but at a welfare loss, because firms lose credit and capital.

Further work is still needed. Foreign-currency debt is concentrated in large firms, so a model with heterogeneous firms could speak to reallocation between exposed and unexposed firms and to policies that depend on firm size. Firm debt in the model matures in one period, and under every tax rule the loss is then deducted in the year it is booked. With long-term debt, deduction on settlement would come later. A model with such debt could measure what that delay is worth.

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A Data

This appendix documents the data behind Section 2 and the calibration of Section 4.

A.1 Data sources

Table 17 lists the data. The firm-level data are from S&P Capital IQ Pro, except the booked exchange-rate result and the tax lines of Table 7 and Appendix B.6, which are from Compustat. S&P Capital IQ Pro provides three modules for each firm. The first is the financial statements. The second is the Capital Structure module, which lists a firm's debt instrument by instrument with the amount outstanding, the repayment currency and a short description. The third is the Geographic Segments module, which reports assets and revenue by location as stated in the firm's filings. The financial statements are placed in calendar quarters. The other two modules are reported less often than the balance sheet. For each quarter I take the shares from the nearest report within four quarters and the balance-sheet levels from the quarter itself.

I use the five-year sovereign CDS spread, averaged over the days of each quarter. For Russia and Sri Lanka I take the provider's running-spread series, as its main series is quoted as an upfront payment. Quarterly averages above 1,000 basis points are dropped, and the series is winsorized at the 1st and 99th percentiles.

The calibration of Section 4 uses the further sources in the last block of Table 17. Dealogic supplies two sets of bond issues. The first is the dollar bonds of non-financial firms, with their yield, maturity and credit rating at issue. The spread of the investment-grade issues over the Treasury yield of the same maturity is the dollar bond spread to which Γ_F is matched. The second is the bonds issued by central governments, with their face value, maturity and currency, and their face-value-weighted maturity gives δ_B . The sovereign spread is the yield on the ten-year point of each government's dollar yield curve, five-year for Chile, less the Treasury yield of the same maturity.

A.2 Sample

The sample consists of the listed non-financial corporations of 57 countries.³³ Firms owned by a government are excluded. A firm counts as government-owned when its

³³These are the countries with at least 35 listed non-financial corporations, except four. Tunisia has too few firms with labeled debt and segments, Luxembourg has no sovereign CDS series in the data, the Cayman Islands, an offshore financial center, have no macroeconomic data, and Jamaica has too few eligible firms.

Table 17: Data sources

Variable	Source	Frequency
<i>Firms</i>		
Balance sheet and income statement	S&P Capital IQ Pro	Quarterly
Debt instruments and their currency	S&P Capital IQ Pro, Capital Structure	At filing
Assets and revenue by location	S&P Capital IQ Pro, Geographic Segments	At filing
<i>Exchange rates and sovereign risk</i>		
Real effective exchange rate	Bruegel (Darvas, 2021)	Monthly
Exchange rate against the US dollar	S&P Capital IQ Pro	Quarterly
Five-year sovereign CDS spread	S&P Capital IQ Pro; Investing.com (United States before September 2014)	Daily
Broad dollar index	Federal Reserve Board, via FRED	Daily
<i>Macroeconomic data</i>		
Inflation, real GDP and its growth	S&P Capital IQ Pro	Quarterly
Real GDP per capita	S&P Capital IQ Pro	Quarterly
Gross fixed capital formation	S&P Capital IQ Pro	Quarterly
Gross output	OECD Trade in Value Added	Annual
Government debt to GDP	World Bank QEDS; Global Macro Database (Müller et al., 2025)	Annual
Government FC debt share	Arslanalp and Tsuda (2012, 2014)	Annual
Trade openness	Global Macro Database	Annual
Current account to GDP	Global Macro Database	Annual
Tax revenue by tax	OECD Global Revenue Statistics; UNU-WIDER Government Revenue Dataset (UNU-WIDER, 2023); IMF World Revenue Longitudinal Data	Annual
Exchange rate against the US dollar, GDP and inflation, 1981–2024	World Bank World Development Indicators	Annual
Emerging and advanced economies	IMF World Economic Outlook	–
<i>Calibration (Section 4)</i>		
Corporate dollar bonds at issue	Dealogic	At issue
Government bonds at issue	Dealogic	At issue
Sovereign dollar yield curve	Bloomberg	Monthly
US Treasury yields	Federal Reserve Board, via FRED	Daily
Ex-ante US real interest rate	Cleveland Fed, via FRED	Monthly
Government debt and revenue	IMF World Economic Outlook	Annual
Sovereign defaults	Asonuma and Trebesch (2016)	By episode
National accounts, Indonesia	World Bank World Development Indicators	Annual
Tax rates	Tax Foundation	Annual
Tax treatment of exchange-rate losses on debt	Tax statutes, tax-authority circulars and practitioner guides (Online Appendix OA.1)	–
Firms’ booked exchange-rate result, current tax, taxes paid, book tax	Compustat Global and North America, linked to Capital IQ by ISIN, SEDOL and CUSIP	Annual

Notes: The real effective exchange rate is CPI-based, against 120 trading partners. Government debt to GDP is government external debt from the World Bank’s Quarterly External Debt Statistics (QEDS) for the countries that report it for at least five years, and general government debt from the Global Macro Database otherwise. Trade openness is exports plus imports over GDP. The broad dollar index is the Federal Reserve Board’s nominal broad dollar index. Country groups follow the World Economic Outlook at the end of the sample. For the calibration, the Treasury yields are the 1-, 5- and 10-year constant-maturity series and the real rate the one-year one. The corporate income tax rates of Table 9 and Table 11 are from the Tax Foundation’s *Corporate Tax Rates around the World* ([Tax Foundation, 2025](#)).

name or its parent's name identifies a government owner in the provider's firm list. Emerging markets and advanced economies follow the IMF's World Economic Outlook classification at the end of the sample period, so Croatia, which joined the euro area and the advanced group in 2023, counts as advanced, and Bulgaria, which adopted the euro only in January 2026, after the sample ends, as an emerging market. This gives 30 emerging markets and 27 advanced economies.

Table 18 shows how the sample is built, from all listed companies in the 57 countries to the firm regression sample. Table 19 shows the unbalanced panel. Firms enter and leave it, and not every firm reports in every quarter, so the number of firm-quarters differs from firm to firm. For each country, the table reports the number of firms and of firm-quarters, the two labeling coverage shares, and the number of quarters in the sovereign regression.

Table 18: Sample construction

	Firms	Firm-quarters
Listed companies in the 57 countries	49,124	
Non-financial corporations with data in 2010Q1–2025Q4	43,378	2,015,167
Not government-owned	42,702	1,977,865
With positive total assets (the sample)	41,822	1,725,221
Firm regression sample, all 57 countries (Table 23, column 1)	22,682	815,478

Notes: Firm-quarters from 2010Q1 to 2025Q4. The firm regression sample also requires that at least half of a firm's debt and of its segment assets be labeled, that the lagged regressors be available, and that the firm have at least eight quarters. The sovereign regression uses 2,812 country-quarters, 1,542 of them in the emerging markets of Table 4 (Appendix A.4).

Table 19: Firms, labeling coverage and CDS quarters by country

Country	Firms	Firm-quarters	Debt labeled (%)	Assets by location (%)	CDS quarters
<i>Emerging markets (30)</i>					
China	5,939	236,482	91	42	63
India	4,629	96,412	88	72	41
Malaysia	1,110	52,074	92	83	55
Indonesia	817	31,647	88	77	63
Thailand	809	37,846	91	72	63
Vietnam	623	20,703	73	81	63
Poland	550	26,760	92	49	63
Turkey	504	20,580	92	41	37
Pakistan	358	19,334	91	70	55

Table 19, continued

Country	Firms	Firm- quarters	Debt labeled (%)	Assets by location (%)	CDS quarters
Saudi Arabia	310	9,758	91	76	35
Brazil	293	14,795	97	67	63
Romania	239	9,583	73	44	63
Philippines	228	12,059	89	80	63
Sri Lanka	206	11,827	97	71	38
South Africa	171	9,157	94	57	63
Egypt	152	7,352	88	75	60
Russia	137	6,178	90	75	47
Chile	123	7,401	94	74	63
Mexico	117	6,110	95	73	59
Bulgaria	102	4,497	84	63	63
United Arab Emirates	100	3,285	96	63	25
Nigeria	90	4,163	88	76	21
Jordan	89	4,782	79	72	63
Peru	79	4,475	91	71	63
Kuwait	73	4,235	85	74	34
Argentina	64	3,680	91	57	28
Oman	63	3,310	95	52	56
Morocco	59	3,028	90	69	62
Colombia	47	2,329	96	64	51
Kenya	38	1,733	82	61	19
<i>Total</i>	<i>18,119</i>	<i>675,575</i>	<i>90</i>	<i>60</i>	<i>1,542</i>
<i>Advanced economies (27)</i>					
USA	4,677	181,562	90	80	63
Japan	3,465	164,581	91	90	46
Canada	2,637	114,899	63	86	55
South Korea	2,300	92,163	80	41	63
Taiwan	2,086	108,594	93	83	13
Australia	1,523	69,395	74	75	46
Hong Kong	1,335	61,872	93	90	63
United Kingdom	869	40,842	85	73	46
Sweden	770	31,242	85	66	46
Singapore	591	26,118	95	87	28
Israel	541	23,849	91	66	63

Table 19, continued

Country	Firms	Firm- quarters	Debt labeled (%)	Assets by location (%)	CDS quarters
Germany	501	23,529	93	69	46
France	499	24,934	96	49	46
Italy	339	12,284	95	37	46
Spain	212	8,314	96	66	46
Switzerland	209	10,555	94	69	46
Norway	187	7,766	93	56	46
Finland	160	6,967	97	71	46
Greece	142	7,534	97	49	42
Denmark	127	5,840	92	74	46
Belgium	107	5,369	96	62	42
Netherlands	102	4,853	95	71	46
New Zealand	100	5,214	91	72	46
Ireland	70	3,652	86	84	46
Cyprus	55	2,523	94	75	46
Austria	50	2,753	95	78	46
Croatia	49	2,442	97	28	56
<i>Total</i>	23,703	1,049,646	86	76	1,270
<i>All 57 countries</i>	41,822	1,725,221	88	70	2,812

Notes to Table 19: Firms and firm-quarters with positive total assets, 2010Q1–2025Q4. *Debt labeled* is the share of the country’s firm-quarters in which at least half of the firm’s debt, by value, is labeled by currency. *Assets by location* is the share with a foreign share of assets, that is, with geographic segment assets reported and labeled. *CDS quarters* is the number of the country’s observations in the sovereign regression on all 57 countries (Table 22), of which the emerging markets form Table 4. The CDS series ends in 2019Q4 for Sri Lanka, before its default, and in 2021Q4 for Russia, before sanctions stopped trading. For 19 of the 27 advanced economies it starts in 2014Q3. Missing quarters are filled with a contract in another currency for Singapore and, before September 2014, with quotes from Investing.com for the United States.

A.3 Labeling debt by currency and segments by location

Debt. Most instruments in the Capital Structure module carry a repayment currency reported by the provider. An instrument is local-currency debt if its repayment currency is legal tender in the firm’s home country and foreign-currency debt otherwise. I count pre-euro national currencies as euros and record redenominated currencies under their current code. When the repayment currency of the instrument is missing, I classify the

instrument's repayment currency by using its description. The description can state the location or type of the instrument that can imply the repayment currency, e.g. "overseas", "offshore". It can also state its denomination, e.g. "basket of currencies", "denominated in X". The benchmark interest rate of the instrument can also imply the repayment currency, e.g. LIBOR or SOFR for the US dollar, EURIBOR for the euro, TIE for the Mexican peso, JIBOR for the Indonesian rupiah and so on. If none of these applies, the instrument stays unlabeled. Table 19 shows, for each country, the share of firm-quarters in which at least half of debt by value is labeled.

Geographic segments. There is no standardized record for reporting the geographic segments in the firms' reports. Firms report the locations of their segments on their own, which varies from firm to firm. Sometimes a firm reports a very specific location for its segment, e.g. "Istanbul", and sometimes a very vague location, e.g. "Latin America". For each country, I read every distinct segment name reported by every firm in the country and assign these unique segment names to local, foreign or a regional aggregate with respect to that country. A regional aggregate such as "Latin America" counts as foreign for a Turkish company, but for a Latin American firm (say an Argentinian firm) it is undetermined. In that case, if the firm also reports its home country's location (e.g. "Argentina" or "Buenos Aires") as a different segment, I interpret the regional aggregate "Latin America" as the other Latin American countries and label it as foreign. Otherwise I leave it unlabeled. The same methodology is used for determining the location of both the assets and the revenues. The foreign share of assets is the value of the foreign segments divided by the value of all labeled segments. Table 19 reports, country by country, the share of firm-quarters with a foreign share of assets.

A.4 Country-level aggregation

A firm is eligible in a quarter if at least 75 percent of its debt and of its segment assets, by value, are labeled. A country-quarter is used only if its eligible firms hold at least 25 percent of the assets of all of the country's listed non-financial corporations in that quarter, eligible or not. I set the threshold low, at 25 percent, to keep as many countries as possible. Under higher thresholds the estimates change little but lose precision (Appendix B.2).

The export-share aggregate of Figure 2b applies the same two rules with a 50 percent labeling threshold for segment revenue. Each aggregate enters the regressions with a one-quarter lag, taken only across consecutive quarters.

The sovereign regression uses the 2,812 country-quarters in 57 countries that also have

a CDS spread and the lagged controls, 1,542 of them in emerging markets and 1,270 in advanced economies. Table 19 gives the count by country. Figure 3 plots each country's average over its usable quarters, for countries with at least 12 such quarters whose median quarter has more than ten eligible firms, and all 57 countries pass.

A.5 The shock-correlation restriction

Tables 20 and 21 check the assumption that the innovations to the exchange rate and to productivity are independent. Both use quarterly data for 2000–2025, the Hodrick–Prescott cycles of seasonally adjusted log real GDP, the productivity proxy, and of the log real effective exchange rate, for each of the 57 sample countries. They report Indonesia, Brazil and the medians across countries. For Indonesia the correlation of the two innovations is -0.08 . It is the same whether I fit the series one at a time or jointly in a first-order VAR. In the VAR, neither series helps forecast the other. When I estimate the correlation the same way for all 57 sample countries, the median across the 57 countries is -0.03 . The median across the 30 emerging markets is -0.06 . Each cross-lag is significant at the 5 percent level in only 14 percent of the 57 countries. In Brazil, the second calibrated economy, depreciations tend to come with weak output.

Table 20: Correlation of productivity and exchange-rate innovations

	corr(innov.)	corr(cycle)
Indonesia	-0.08	-0.05
Brazil	-0.31	-0.37
Median, 30 emerging markets	-0.06	-0.08
Median, 27 advanced economies	$+0.02$	$+0.07$
Median, all 57 countries	-0.03	-0.05

Notes: Quarterly data, 2000–2025. Cycles from the Hodrick–Prescott filter ($\lambda = 1600$) of seasonally adjusted log real GDP and of the log real effective exchange rate. A rise in the exchange rate is a depreciation. corr(innov.) is the correlation between the residuals of the two AR(1) regressions, corr(cycle) is the correlation between the two cycles. Each country has 73 to 104 quarters. The medians are across the countries of each group.

Table 21: Jointly estimated VAR(1) of the exchange-rate and productivity cycles

	$s_{t-1} \rightarrow s_t$	$z_{t-1} \rightarrow s_t$	$s_{t-1} \rightarrow z_t$	$z_{t-1} \rightarrow z_t$	$\text{corr}(u^s, u^z)$
Indonesia	0.68	+0.02	+0.02	0.18	−0.08
Brazil	0.78	+0.27	−0.03	0.51	−0.31
Median, 30 emerging markets	0.77	−0.02	+0.01	0.48	−0.06
Median, 27 advanced economies	0.75	+0.03	+0.03	0.54	+0.02
Median, all 57 countries	0.75	+0.01	+0.01	0.51	−0.03
<i>Share of countries with a cross-lag significant at 5 percent</i>					
30 emerging markets		20%	13%		
27 advanced economies		7%	15%		
All 57 countries		14%	14%		

Notes: A first-order VAR of the two cycles of Table 20, on the same samples. Each column is the coefficient of one lagged cycle in one equation, and $\text{corr}(u^s, u^z)$ is the correlation of the two residuals. For Indonesia and Brazil neither cross-lag is significant at the 10 percent level (Granger block F tests). The medians are across the countries of each group, coefficient by coefficient, and the bottom rows give the share of countries whose Granger test rejects at 5 percent.

B Empirical robustness

B.1 Results for the pooled sample

This appendix reports the results of Section 2 for all 57 countries and for the 27 advanced economies, next to the 30 emerging markets of the main text.

Sovereign CDS spreads. Table 22 reports the sovereign regression of Table 4 and its split into depreciations and appreciations for each group. On all 57 countries the interaction is +9.71, significant at the 5 percent level, and $\beta_3 = 3.60$. A 10 percent depreciation goes with a spread 0.36 percentage points higher where mismatch is zero and a further 0.10 percentage points higher where mismatch is 10 percentage points of assets higher, about 11 percent of the median spread of 0.88 percentage points across the 57 countries. In the advanced economies, where corporate currency mismatch is negative in every country, the interaction is +6.94 and not significant. On the depreciation side it is +18.77 on all 57 countries, significant at the 1 percent level, and +18.07 in the advanced economies, not significant.

Firm profitability and investment. Table 23 reports the firm regressions of Table 5 for each group. On all 57 countries the interaction is -3.35 for ROA, significant at the 5 percent level, and +61.0 for the loss indicator, significant at the 1 percent level. With the median quarterly ROA of 0.69 percent on all 57 countries, a 10 percent real depreciation lowers the quarterly ROA of a firm whose currency mismatch is 10 percentage points of assets larger by about 0.034 percentage points, about 5 percent of the median, and raises its probability of a loss by 0.6 percentage points. In the advanced economies the interaction is -2.96 for ROA, significant at the 10 percent level, and +63.4 for the loss indicator, significant at the 1 percent level. For investment the interaction is -10.2 on all 57 countries, significant at the 5 percent level, and -6.7 in the advanced economies, not significant.

The firms' tax bill. Table 24 reports the two regressions of Table 7 for each group. On the 52 countries with an established rule, the booked result falls by 0.14 to 0.17 for each unit of debt times depreciation under both rules, and current tax falls by 0.095 for each unit of booked loss where the loss is deducted as booked, against 0.036 where it is deducted on settlement or never, a difference significant at the 10 percent level. In the advanced economies current tax moves with the booked loss alike under both rules, 0.022 against 0.034.

Table 22: Corporate currency mismatch and sovereign CDS spreads: emerging markets and advanced economies

	All countries (1)	Emerging (2)	Advanced (3)
<i>Panel A. Symmetric response</i>			
Corp. currency mismatch $_{c,t-1} \times s_{c,t}$	+9.71** (4.32)	+15.63** (7.53)	+6.94 (6.36)
Corp. currency mismatch $_{c,t-1}$	−0.13 (0.59)	−0.06 (0.68)	−0.62 (1.31)
$s_{c,t}$	+3.60*** (0.93)	+3.48*** (0.87)	+1.82 (1.83)
Observations	2,812	1,542	1,270
Countries	57	30	27
<i>Panel B. Depreciation and appreciation sides</i>			
Corp. currency mismatch $_{c,t-1} \times \text{dep}_{c,t}$	+18.77*** (6.69)	+22.40** (10.89)	+18.07 (12.70)
Corp. currency mismatch $_{c,t-1} \times \text{app}_{c,t}$	+4.81 (9.03)	−3.60 (15.98)	+4.44 (5.01)
Corp. currency mismatch $_{c,t-1}$	−0.37 (0.61)	−0.27 (0.75)	−0.75 (1.36)
$\text{dep}_{c,t}$	+6.08*** (1.15)	+5.43*** (1.06)	+5.99 (4.03)
$\text{app}_{c,t}$	+0.92 (2.09)	+0.16 (2.08)	+2.58 (2.01)
Observations	2,812	1,542	1,270
Countries	57	30	27

Notes: Panel A is the regression of Table 4 and Panel B its split into depreciations and appreciations on each group of countries, with $\text{dep}_{c,t} = \max(0, s_{c,t})$ and $\text{app}_{c,t} = \max(0, -s_{c,t})$. Column (2) is the sample of the main text. The dependent variable is the quarterly average five-year sovereign CDS spread in percentage points. Country and quarter fixed effects. Controls, all lagged one quarter: inflation, real GDP growth, the level of the REER and government debt to GDP. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 23: Currency mismatch, firm profitability and investment by country group

	All countries (1)	Emerging (2)	Advanced (3)
<i>Panel A. ROA</i>			
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	−3.35** (1.40)	−5.13** (2.44)	−2.96* (1.67)
Currency mismatch $_{i,c,t-1}$ (β_1)	+0.33* (0.18)	+0.42 (0.27)	+0.40** (0.20)
Observations	815,478	267,933	547,545
Firms	22,682	8,368	14,314
Countries	57	30	27
<i>Panel B. Loss indicator</i>			
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	+61.0*** (15.3)	+50.5** (25.6)	+63.4*** (17.2)
Currency mismatch $_{i,c,t-1}$ (β_1)	−4.1** (1.8)	−7.6** (3.3)	−3.2* (1.9)
Observations	815,478	267,933	547,545
Firms	22,682	8,368	14,314
Countries	57	30	27
<i>Panel C. Investment</i>			
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	−10.2** (5.1)	−19.3*** (6.4)	−6.7 (6.3)
Currency mismatch $_{i,c,t-1}$ (β_1)	+4.2*** (1.6)	−1.1 (2.2)	+5.2*** (1.7)
Observations	481,626	179,539	302,087
Firms	15,305	6,106	9,199
Countries	57	30	27

Notes: Each column repeats Table 5 on the stated group, with firm and country-by-quarter fixed effects and lagged log revenue and leverage as controls. Column (2) is the sample of the main text. ROA is in percent, and the loss indicator equals 100 when quarterly net income is negative. Investment is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, in percent, with $s_{c,t}$ summed over the same four quarters. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 24: The firms' tax bill and the tax rule by country group

	Deducted as booked	On settlement or never	Difference	Firm-years
<i>A. Booked exchange-rate result on foreign-currency debt / assets $\times$ real depreciation</i>				
All countries	−0.140*** (0.030)	−0.168*** (0.037)		250,756
Emerging markets	−0.170*** (0.032)	−0.199*** (0.029)		114,703
Advanced economies	−0.013 (0.018)	−0.120** (0.058)		136,053
<i>B. Current tax expense on the booked exchange-rate result</i>				
All countries	+0.095*** (0.025)	+0.036* (0.018)	+0.059* (0.031)	326,509
Emerging markets	+0.122*** (0.028)	+0.048*** (0.016)	+0.074** (0.032)	156,479
Advanced economies	+0.022 (0.015)	+0.034 (0.021)	−0.012 (0.026)	170,030
<i>C. Income taxes paid on the booked exchange-rate result</i>				
All countries	+0.070** (0.035)	+0.014 (0.016)	+0.056 (0.038)	232,281
Emerging markets	+0.086** (0.042)	+0.029 (0.022)	+0.057 (0.047)	136,185
Advanced economies	+0.007 (0.030)	+0.010 (0.020)	−0.003 (0.035)	96,096
<i>D. Book tax expense (placebo) on the booked exchange-rate result</i>				
All countries	+0.154*** (0.036)	+0.081*** (0.028)	+0.072 (0.045)	335,845
Emerging markets	+0.194*** (0.046)	+0.193*** (0.037)	+0.001 (0.059)	157,876
Advanced economies	+0.058*** (0.010)	+0.062** (0.029)	−0.004 (0.031)	177,969

Notes: Firm-fiscal years, 2010 to 2024, linked Capital IQ and Compustat firms in the countries with an established rule: 52 in all, 25 emerging markets and 27 advanced economies. Panel A is Panel A of Table 7, and Panels B to D are the second regression of Table 7, one tax line each, with the difference between the rules. Firm and country-by-fiscal-year fixed effects. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

The corporate income tax and the tax rule. Figure 11 repeats Figure 4 for both groups. The corporate income tax's share of tax revenue has risen in both. In the median advanced economy it raised 8 percent of tax revenue in 1995 and 10 percent in 2024, and in the median emerging market 10 percent in 1995 and 17 percent in 2024. Table 25 repeats Table 6 for all 57 countries. Of the 52 countries that tax corporate profit and whose rule could be established, counting Colombia, Italy and Russia under the rule that held for most of 2010–2025, 30 deduct the exchange-rate loss on foreign-currency debt in the year it is booked, 16 of the 25 emerging markets and 14 of the 27 advanced economies.

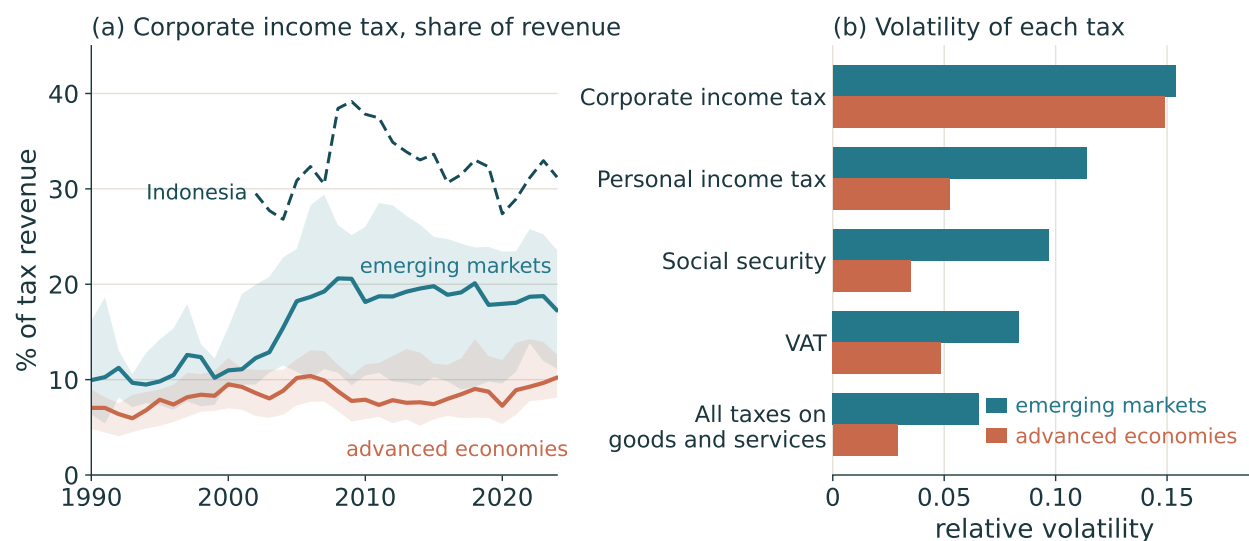


Figure 11: The corporate income tax in tax revenue, by country group

Notes: OECD Global Revenue Statistics, general government, the sample countries with data. (a) The corporate income tax as a percent of total tax revenue. The lines are the medians across the countries of each group with data in each year, the shaded areas their interquartile ranges, and the dashed line is Indonesia. (b) Relative volatility is the standard deviation of the yearly change in the tax's ratio to GDP divided by its mean ratio, for each country with at least 15 years of data. The bars are the medians across countries. All taxes on goods and services include VAT.

B.2 Robustness: sovereign CDS spreads

Depreciations and appreciations. The regression of Table 4 treats a depreciation and an appreciation of the same size symmetrically. To see whether the spread responds to both, I split the exchange rate change into its two sides, $\text{dep}_{c,t} = \max(0, s_{c,t})$ and $\text{app}_{c,t} = \max(0, -s_{c,t})$, and let each enter on its own and interacted with corporate cur-

Table 25: The corporate-tax treatment of exchange-rate losses on debt, all 57 countries

Deducted in the year it is booked	On settlement	Not deductible
Argentina, Austria, Belgium, Bulgaria, Chile, China, Colombia (to 2016), Croatia*, Egypt*, Finland, France, India (from 2016), Indonesia, Ireland, Israel, Italy (from 2024), Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Romania, Russia (to 2022), South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, Vietnam (from 2011)	Australia [†] , Brazil [†] , Canada, Colombia (from 2017), Denmark [†] , Germany, Greece, Italy (to 2023), Japan [†] , Kenya, Nigeria, Oman, Philippines, Poland [†] , Russia (from 2023), South Korea [†] , Sri Lanka, Taiwan, USA	Cyprus, Hong Kong, Malaysia, Singapore

Notes: The rule a listed non-financial firm faces on the exchange-rate loss on its long-term foreign-currency debt, from the tax statutes and the practitioner guides (Online Appendix OA.1). Emerging markets are in teal and advanced economies in terracotta. Countries whose rule changed within 2010–2025 are listed with the years. India is not classified before fiscal 2016–17. Vietnam’s 2010 is coded as on settlement. Greece is coded on settlement in every year, the rule of its 2014 Income Tax Code. [†] Australia, Brazil, Denmark, Japan, Poland and South Korea: the firm may elect to deduct the loss in the year it is booked instead of waiting for settlement. * The statute does not settle the timing. Taxable income starts from accounting profit, and the country is coded as deducting the loss in the year it is booked. Canada deducts half the loss on settlement against capital gains only, and Germany deducts a loss before settlement only for a “lasting” rise. Not listed: Saudi Arabia and Kuwait, which levy no corporate income tax on their domestic listed firms, the United Arab Emirates, which levied none before mid-2023, and Jordan and Pakistan, whose rule could not be established.

rency mismatch:

$$\begin{aligned}
\text{CDS}_{c,t} = & \beta_0 + \beta_1 \text{Corporate currency mismatch}_{c,t-1} \\
& + \beta_2^d \left(\text{Corporate currency mismatch}_{c,t-1} \times \text{dep}_{c,t} \right) \\
& + \beta_2^a \left(\text{Corporate currency mismatch}_{c,t-1} \times \text{app}_{c,t} \right) \\
& + \beta_3^d \text{dep}_{c,t} + \beta_3^a \text{app}_{c,t} + \beta_4' X_{c,t-1} + \alpha_c + \alpha_t + \varepsilon_{c,t}.
\end{aligned}$$

Column (2) of Table 26 reports the estimates, next to the symmetric regression in column (1). The interaction is on the depreciation side, $\beta_2^d = 22.4$, significant at the 5 percent level, while $\beta_2^a = -3.6$ is small and insignificant. The same holds for the exchange rate on its own. The spread rises in a depreciation, $\beta_3^d = 5.43$, and does not fall in an appreciation, $\beta_3^a = 0.16$ and insignificant. Countries with more corporate currency mismatch thus see sovereign risk rise more when the currency depreciates. The estimate for appreciations is too imprecise to say whether an appreciation of the same size lowers it again.

Additional controls. Table 27 adds three controls to the regression of Table 4, one at a time and then together. Trade openness (exports plus imports over GDP, lagged one

Table 26: Corporate currency mismatch and sovereign CDS spreads: depreciations and appreciations

	Sovereign CDS spread (pp)	
	(1)	(2)
Corporate currency mismatch $_{c,t-1} \times s_{c,t}$ (β_2)	+15.63** (7.53)	
Corporate currency mismatch $_{c,t-1} \times \text{dep}_{c,t}$ (β_2^d)		+22.40** (10.89)
Corporate currency mismatch $_{c,t-1} \times \text{app}_{c,t}$ (β_2^a)		-3.60 (15.98)
Corporate currency mismatch $_{c,t-1}$ (β_1)	-0.06 (0.68)	-0.27 (0.75)
$s_{c,t}$ (β_3)	+3.48*** (0.87)	
$\text{dep}_{c,t}$ (β_3^d)		+5.43*** (1.06)
$\text{app}_{c,t}$ (β_3^a)		+0.16 (2.08)
Controls (lagged)	Yes	Yes
Country FE, Quarter FE	Yes	Yes
Observations	1,542	1,542
Countries	30	30
R ²	0.84	0.84

Notes: The 30 emerging markets. Column (1) is the regression of Table 4. Column (2) splits $s_{c,t}$ into $\text{dep}_{c,t} = \max(0, s_{c,t})$ and $\text{app}_{c,t} = \max(0, -s_{c,t})$. The dependent variable is the quarterly average five-year sovereign CDS spread in percentage points. Controls, all lagged one quarter: inflation, real GDP growth, the level of the REER, and government debt to GDP. Country and quarter fixed effects. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

year) and the government's own foreign-currency debt share (an annual series, lagged one quarter) enter on their own and interacted with the exchange rate, because corporate currency mismatch might otherwise pick up the economy's trade exposure or the government's own currency mismatch. The broad dollar index enters as its quarterly log change interacted with corporate currency mismatch, because the quarter fixed effects absorb its level and its change. Next to each estimate, the table reports the baseline re-estimated on the same observations, since the government's foreign-currency debt share is missing for some country-quarters. The interaction of corporate currency mismatch with the real exchange rate stays between +15.6 and +17.1 in every row. With the government's share it is significant at the 10 percent level, and with all three controls together it keeps its size, +17.05, but is not significant. None of the added interactions is significant.

Eligibility thresholds. Table 28 raises the two thresholds of Appendix A.4. Panel A requires the eligible firms to hold at least 35 or 50 percent of the country's listed non-financial assets, instead of 25 percent. Panel B requires at least 80 or 90 percent of a firm's debt and segment assets to be labeled, instead of 75 percent. The interaction changes little, staying between +15.6 and +16.8 in every row. The higher coverage thresholds remove 9 and 28 percent of the country-quarters, and the estimates lose precision: at 35 percent the interaction is significant at the 10 percent level, and at 50 percent only its depreciation side is significant, at the 5 percent level. Raising the labeling threshold leaves the estimates essentially unchanged.

B.3 Robustness: firm profitability and investment

Table 29 re-estimates Table 5 on the firm-quarters in which at least 75 percent of debt and of segment assets are labeled, instead of the baseline's 50 percent. The interaction moves by less than a twentieth of a standard error, to -5.04 for ROA and $+49.7$ for the loss indicator, which is then significant at the 10 percent level. The level coefficient keeps its sign, positive for ROA and negative for the loss indicator. For investment the interaction is -19.6 (6.5), against -19.3 (6.4) in the baseline.

B.4 Listed parents and listed subsidiaries

S&P Capital IQ reports each firm's consolidated statements, which include the assets, debt and income of the firms it controls. Some of these subsidiaries are listed and are in the sample themselves. I identify them from the ultimate parent that Capital IQ reports for each firm: a firm is a listed subsidiary when its ultimate parent is another firm in the

Table 27: Corporate currency mismatch and sovereign CDS spreads: additional controls

Added control	Mismatch $\times s_{c,t}$		Added interaction	Obs.
	With control	Without		
None (baseline)	+15.63** (7.53)			1,542
Trade openness	+16.76** (8.01)	+15.63** (7.53)	+0.91 (2.55)	1,542
Government FC debt share	+16.23* (9.45)	+15.71** (7.51)	-0.01 (0.06)	1,535
Broad dollar index	+15.62** (7.55)	+15.63** (7.53)	+0.25 (6.83)	1,542
All three	+17.05 (10.71)	+15.71** (7.51)		1,535

Notes: The 30 emerging markets. The regression of Table 4 with the stated control added. “With control” is the interaction of corporate currency mismatch with $s_{c,t}$, and “Without” re-estimates the baseline on the observations of that row. “Added interaction” is trade openness $\times s_{c,t}$, the government’s foreign-currency debt share (in percent) $\times s_{c,t}$, or corporate currency mismatch $\times \Delta \log$ broad dollar index. Country and quarter fixed effects and the controls of Table 4. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 28: Corporate currency mismatch and sovereign CDS spreads: eligibility thresholds

	Mismatch $\times s_{c,t}$	Mismatch $\times \text{dep}_{c,t}$	Obs.
<i>Panel A. Share of listed non-financial assets held by eligible firms</i>			
At least 25 percent (baseline)	+15.63** (7.53)	+22.40** (10.89)	1,542
At least 35 percent	+16.82* (9.30)	+16.63 (11.15)	1,406
At least 50 percent	+15.93 (11.02)	+19.17** (9.64)	1,112
<i>Panel B. Share of a firm’s debt and of its segment assets that is labeled</i>			
At least 75 percent (baseline)	+15.63** (7.53)	+22.40** (10.89)	1,542
At least 80 percent	+15.76** (7.71)	+22.53** (11.07)	1,540
At least 90 percent	+16.13** (7.53)	+20.29* (11.22)	1,520

Notes: The 30 emerging markets. The first column re-estimates column (1) of Table 26 and the second the depreciation side of its column (2), with corporate currency mismatch rebuilt under the stated threshold and the other threshold at its baseline. Standard errors clustered by country in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 29: Currency mismatch, firm profitability and investment: robustness

	Baseline (1)	$\geq 75\%$ labeled (2)
<i>Panel A. ROA</i>		
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	-5.13** (2.44)	-5.04** (2.48)
Currency mismatch $_{i,c,t-1}$ (β_1)	+0.42 (0.27)	+0.40 (0.27)
Observations	267,933	265,946
Firms	8,368	8,334
Countries	30	30
<i>Panel B. Loss indicator</i>		
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	+50.5** (25.6)	+49.7* (26.7)
Currency mismatch $_{i,c,t-1}$ (β_1)	-7.6** (3.3)	-8.1** (3.4)
Observations	267,933	265,946
Firms	8,368	8,334
Countries	30	30
<i>Panel C. Investment</i>		
Currency mismatch $_{i,c,t-1} \times s_{c,t}$ (β_2)	-19.3*** (6.4)	-19.6*** (6.5)
Currency mismatch $_{i,c,t-1}$ (β_1)	-1.1 (2.2)	-1.7 (2.0)
Observations	179,539	178,192
Firms	6,106	6,083
Countries	30	30

Notes: The 30 emerging markets. Column (1) is Table 5. Column (2) keeps the firm-quarters in which at least 75 percent of debt and of segment assets, by value, are labeled (baseline: 50 percent). Firm and country-by-quarter fixed effects and lagged log revenue and leverage as controls. ROA is in percent, and the loss indicator equals 100 when quarterly net income is negative. Investment is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, in percent, with $s_{c,t}$ summed over the same four quarters. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

sample. This gives 1,562 listed subsidiaries, under 4 percent of the firms, 1,085 of them with the parent in the same country. In the average country, these 1,085 hold 1.8 percent of the assets used to measure corporate currency mismatch, and in the median country 0.7 percent.

Table 30 re-estimates the main regressions with these subsidiaries excluded. In Panel A, the second row excludes a listed subsidiary in the quarters in which its listed parent, in the same country, is also in the data, which leaves the interaction close to the baseline, +15.16 against +15.63. Panel B excludes the listed subsidiaries whose parent is in the same country from the firm regressions of Table 5. The ROA and loss estimates move by a tenth of a standard error or less and are significant at the 10 percent level. For investment the interaction is -20.4 (7.1), against -19.3 (6.4) in the baseline.

Table 30: Listed parents and listed subsidiaries

<i>Panel A. Sovereign CDS spreads</i>			
	Mismatch $\times s_{c,t}$	Mismatch $\times dep_{c,t}$	Obs.
Baseline	+15.63** (7.53)	+22.40** (10.89)	1,542
Listed subsidiaries excluded	+15.16** (7.49)	+22.31** (10.77)	1,546
<i>Panel B. Firm profitability and investment</i>			
	ROA	Loss indicator	Investment
Baseline	-5.13^{**} (2.44)	$+50.5^{**}$ (25.6)	-19.3^{***} (6.4)
Listed subsidiaries excluded	-5.03^* (2.72)	$+47.8^*$ (27.8)	-20.4^{***} (7.1)
Observations, baseline	267,933	267,933	179,539
Observations, subsidiaries excluded	256,139	256,139	171,589

Notes: The 30 emerging markets. Panel A repeats columns (1) and (2) of Table 26, the second shown on the depreciation side, with corporate currency mismatch rebuilt as stated. *Listed subsidiaries excluded* removes a listed subsidiary in the quarters in which its listed parent, in the same country, is also in the data. The dependent variable is the quarterly average five-year sovereign CDS spread in percentage points. Panel B repeats Table 5 without the listed subsidiaries whose parent is in the same country, in every quarter. ROA is in percent, and the loss indicator equals 100 when quarterly net income is negative. Investment is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, in percent, with $s_{c,t}$ summed over the same four quarters. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B.5 Nominal exchange rate against the US dollar

The exchange rate in Section 2 is the real effective rate, a trade-weighted basket. Because foreign-currency debt is mostly dollar debt (Table 2), the bilateral rate against the dollar

is the other natural shock. Table 31 repeats the four regressions with $s_{c,t}^{\$} = \Delta \log e_{c,t}$, where $e_{c,t}$ is the quarterly average of local currency per US dollar, so that $s_{c,t}^{\$} > 0$ is again a depreciation. The same controls are used, except that the real effective exchange rate control is replaced with the nominal exchange rate.

The symmetric interaction stays positive and significant. The coefficients of the split differ from Table 26. The interaction is about as large on the appreciation side as on the depreciation side, and both are significant. The spread rises when the currency appreciates against the dollar, +4.15, significant at the 1 percent level, and rises more where mismatch is higher. With the real effective rate neither appreciation coefficient is significant (Table 26). The firm-level result is not robust. The interactions keep their signs but lose significance: -2.23 (1.77) for ROA, $+21.0$ (15.4) for the loss indicator and -2.1 (6.5) for investment.

B.6 The firms' tax bill

This appendix describes the sample of the firm-level tax test of Table 7 and reports its robustness.

The firm-level sample. The unit is the firm-fiscal year, 2010 to 2024. Besides the booked exchange-rate result and current tax expense, Compustat reports the income taxes the firm paid and its book tax expense. Foreign-currency debt over assets, log revenue and leverage are measured at the start of the fiscal year or, if the firm did not report that quarter, at its latest balance sheet in the three quarters before. They need only the firm's debt to be labeled by currency, at least half of it by value. Every regression has firm fixed effects and country-by-fiscal-year fixed effects, so the depreciation itself, and everything else common to a country's firms in a year, is absorbed, and every slope is identified from differences across firms within a country-year. Standard errors are clustered by country. Netting foreign assets out of the debt dilutes the revalued position, because the foreign operations are revalued through the translation reserve in equity (the last row of Table 32 shows the consequence). The fall in current tax per unit of booked loss in Table 7 is smaller than the tax rate, since a firm without taxable profit in the year has no tax for the loss to reduce.

Robustness. Regressing current tax directly on foreign-currency debt times the depreciation, with the controls of the first regression of Table 7 and pretax income excluding the exchange-rate result, estimates the two links at once. In the main specification, the first

Table 31: Currency mismatch and the nominal exchange rate against the US dollar

<i>Panel A. Firm profitability and investment</i>			
	ROA	Loss indicator	Investment
Currency mismatch $_{i,c,t-1} \times s_{c,t}^{\$}$	−2.23 (1.77)	+21.0 (15.4)	−2.1 (6.5)
Observations	267,933	267,933	179,539
R ²	0.38	0.36	0.45
<i>Panel B. Sovereign CDS spread (pp)</i>			
	(1)	(2)	
Corp. currency mismatch $_{c,t-1} \times s_{c,t}^{\$}$	+10.49*** (3.62)		
Corp. currency mismatch $_{c,t-1} \times \text{dep}_{c,t}^{\$}$		+16.75** (7.61)	
Corp. currency mismatch $_{c,t-1} \times \text{app}_{c,t}^{\$}$		+16.40** (8.01)	
$s_{c,t}^{\$}$	+3.01*** (0.87)		
$\text{dep}_{c,t}^{\$}$		+4.69*** (0.82)	
$\text{app}_{c,t}^{\$}$		+4.15*** (0.96)	
Observations	1,542	1,542	
Countries	30	30	
R ²	0.84	0.85	

Notes: The 30 emerging markets. $s_{c,t}^{\$} = \Delta \log e_{c,t}$, the quarterly change in local currency per US dollar, and $\text{dep}^{\$}$ and $\text{app}^{\$}$ are its two sides. Panel A has firm and country-by-quarter fixed effects and controls for lagged log revenue and leverage. Investment is capital expenditure over quarters t to $t + 3$ over fixed assets at the end of quarter $t - 1$, in percent, with $s_{c,t}^{\$}$ summed over the same four quarters. Panel B has country and quarter fixed effects and controls, all lagged, for inflation, real GDP growth, the log nominal exchange rate and government debt to GDP. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

row of Table 32, current tax falls with the debt where the loss is deducted as booked, -0.033 (0.018), and rises slightly where it is deducted on settlement or never, $+0.014$ (0.024), a difference of -0.047 (0.033). The table re-estimates this regression. With the exporter controls, on the firm-years with segment data, the slopes are -0.026 and $+0.019$. The difference is larger on the pure subsets (defined in the notes to Table 32), -0.069 , significant at the 1 percent level, and with the nominal depreciation against the dollar, -0.052 , significant at the 5 percent level. It keeps its size, about -0.04 , when Poland's election is coded as booked or left out, when the Gulf countries are included and on local-currency books only, and it is -0.068 with a one-sided depreciation. In the following fiscal year the as-booked slope is -0.011 (0.020) and the other group's zero. The difference keeps its sign when any one of the 25 emerging markets is dropped. With the net mismatch in place of gross debt neither link shows anything, for the accounting reason above.

B.7 Tax revenue and the sovereign spread

Table 8 in Section 2 uses the 351 country-years with both corporate and other tax revenue, so that the two taxes are compared on the same sample. Without the current-account control the corporate-tax estimate is -0.146 (0.098), and adding the 19 country-years with corporate but no other tax revenue, most of them in the Gulf, gives -0.043 (0.126). Leaving out one country at a time, the estimate of column (1) stays at least twice its standard error in 18 of the 29 samples.

Table 32: The firms' current tax and the tax rule: robustness

	Deducted as booked	On settlement or never	Difference	Firm-years
Main specification	−0.033* (0.018)	+0.014 (0.024)	−0.047 (0.033)	113,574
Exporter controls (firm-years with segment data)	−0.026 (0.022)	+0.019 (0.019)	−0.045 (0.030)	35,618
Pure subsets only (6 as booked, 6 on settlement)	−0.034*** (0.012)	+0.035* (0.019)	−0.069*** (0.023)	15,927
Poland (election when filing) coded as booked	−0.031* (0.017)	+0.013 (0.025)	−0.044 (0.033)	113,574
Poland (election when filing) excluded	−0.033* (0.017)	+0.013 (0.027)	−0.046 (0.035)	108,665
Gulf countries included as not deducted	−0.033* (0.018)	+0.012 (0.023)	−0.045 (0.032)	115,967
Local-currency books only	−0.035* (0.020)	+0.007 (0.022)	−0.043 (0.033)	110,653
One-sided depreciation, $\max(0, s)$	−0.046* (0.024)	+0.022 (0.030)	−0.068 (0.042)	113,574
Nominal depreciation against the dollar	−0.028** (0.013)	+0.024 (0.020)	−0.052** (0.024)	113,574
Current tax, next fiscal year	−0.011 (0.020)	+0.003 (0.017)	−0.014 (0.029)	100,225
Net mismatch in place of gross debt	+0.000 (0.011)	−0.011 (0.013)	+0.011 (0.018)	42,365

Notes: Current tax expense over lagged assets on foreign-currency debt over assets times the fiscal-year real depreciation, by rule, with the controls of the first regression of Table 7 and pretax income excluding the exchange-rate result. The difference is the as-booked slope minus the other. The exporter controls are the export share and the foreign-asset share and their products with the depreciation, from the geographic segment data. The 25 emerging markets with an established rule. Pure subsets: Argentina, Bulgaria, Chile, Mexico, Morocco and Thailand deduct the loss as booked with no qualification, and Colombia (from 2017), Kenya, Nigeria, Oman, the Philippines and Sri Lanka deduct it only on settlement, with no election. Local-currency books: firms that report in the currency most firms of their country use. Firm and country-by-fiscal-year fixed effects. Standard errors clustered by country in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

C Model

C.1 Rewriting the firm's problem

This appendix rewrites the firm's problem (5)–(8) as a consumption–saving problem with a portfolio choice, and derives its first-order conditions. Write $u \equiv u_{\text{owner}}$ and $\beta \equiv \beta_{\text{owner}}$.

Labor. Labor is chosen after the shocks and affects only today's output and wage bill. Taking the wage w as given, the firm chooses ℓ to maximize $(1 - \tau_y) e(s) z k^\alpha \ell^{1-\alpha} - w\ell$, so that $(1 - \tau_y)(1 - \alpha) e(s) z k^\alpha \ell^{-\alpha} = w$, the labor demand (16). The wage is a function of the aggregate state, $W(\mathcal{S}) = \chi \ell(K, z, s)^{\omega-1}$ by (15) and (17), and the firm does not substitute it into its own problem.

Net worth. Once labor is chosen, the terms of the budget constraint (6) that the firm inherits make up its net worth (10),

$$n = (1 - \tau_\pi^+) \pi + p_I(s) k - (q_L^- b + q_F^- s^- b^*),$$

and the budget becomes

$$d = n - p_I(s) k' + F, \quad F \equiv q_L b' + q_F s b^{*'},$$

where F is the funds raised. With one-period debt, b and b^* enter only through n , and so does k , since new and installed capital trade at the same price $p_I(s)$ whether the stock is kept or sold. The firm's own state is therefore n alone.

Choices. Replace the two new face values, b' and $b^{*'}$, by the utilization of the collateral limit and the foreign-good share of new borrowing (9),

$$\varphi \equiv \frac{F}{\theta p_I(s) k'} \in [0, 1], \quad \eta \equiv \frac{q_F s b^{*'}}{F} \in [0, 1].$$

The map is one to one for $k' > 0$. Given (k', φ, η) , the funds are $F = \varphi \theta p_I(s) k'$, with $q_L b' = (1 - \eta)F$ and $q_F s b^{*'} = \eta F$. The collateral constraint (8) becomes $\varphi \leq 1$, and the dividend is

$$d = n - (1 - \theta \varphi) p_I(s) k',$$

so dividend non-negativity becomes $(1 - \theta \varphi) p_I(s) k' \leq n$. The term $1 - \theta \varphi$ is what the owners put up per local good of capital once the borrowing that good supports is netted out.

Next period. The share η does not enter today's dividend. It enters only through tomorrow's repayment, $b' + s' b^{*'} = \varphi \theta p_I(s) k' [(1 - \eta)(1 + r_L) + \eta(1 + r_F) s'/s]$, with $1 + r_L \equiv 1/q_L$ and $1 + r_F \equiv 1/q_F$. Tomorrow's net worth is (10) one period ahead,

$$\begin{aligned} n' &= (1 - \tau_\pi^{+'}) \pi' + p_I(s') k' - \varphi \theta p_I(s) k', \\ \pi' &= (1 - \tau_y) e(s') z' k'^{\alpha} \ell'^{1-\alpha} - w' \ell' - \delta_K p_I(s') k' \\ &\quad - \varphi \theta p_I(s) k' \left[(1 - \eta) r_L + \eta \left((1 + r_F) \frac{s'}{s} - 1 \right) \right], \end{aligned}$$

where the last term of π' is the interest on both debts plus the exchange-rate loss on the foreign-good debt, and $\tau_\pi^{+'}$ is τ_π if $\pi' \geq 0$ and zero otherwise, as in (7). The firm therefore chooses how much to pay out and how much to invest, a consumption–saving problem for its owners, and how to split its debt between the two goods, a portfolio problem. On its own state n together with the aggregate state,

$$W(n; \mathcal{S}) = \max_{k', \varphi, \eta} u(n - (1 - \theta \varphi) p_I(s) k') + \beta \mathbb{E}[W(n'; \mathcal{S}') | \mathcal{S}],$$

subject to $\varphi \leq 1$ and $d \geq 0$, taking w , q_F and q_L as given.

First-order conditions. The envelope condition is $\partial W / \partial n = u'(d)$. Let $\mu \geq 0$ be the multiplier on the collateral limit, per local good of funds. Away from $\pi' = 0$, where $\tau_\pi^{+'}$ switches, tomorrow's net worth responds to today's choices by

$$\begin{aligned} \frac{\partial n'}{\partial b'} &= -[1 - \tau_\pi^{+'}(1 - q_L)], & \frac{\partial n'}{\partial b^{*'}} &= -[s' - \tau_\pi^{+'}(s' - s q_F)], \\ \frac{\partial n'}{\partial k'} &= p_I(s') + (1 - \tau_\pi^{+'})(MPK' - \delta_K p_I(s')), & MPK' &\equiv (1 - \tau_y) \alpha e(s') z' k'^{\alpha-1} \ell'^{1-\alpha}. \end{aligned}$$

A unit of local face costs one local good tomorrow, and its interest, $1 - q_L$, is deductible. A unit of foreign face costs s' local goods, and its interest and exchange-rate loss, $s' - s q_F$ in all, are deductible. A unit of capital returns its value at tomorrow's price, which is not taxed, plus its after-tax marginal revenue product net of depreciation at that price. Differentiating with respect to b' , to $b^{*'}$ and to k' , and dividing the second condition by s :

$$(LC) \quad u'(d) q_L = \beta \mathbb{E}[u'(d') (1 - \tau_\pi^{+'}(1 - q_L))] + \mu q_L, \quad (31)$$

$$(FC) \quad u'(d) q_F = \beta \mathbb{E}\left[u'(d') \left(\frac{s'}{s} - \tau_\pi^{+'} \left(\frac{s'}{s} - q_F \right) \right)\right] + \mu q_F, \quad (32)$$

$$(K) \quad u'(d) p_I(s) = \beta \mathbb{E}[u'(d') (p_I(s') + (1 - \tau_\pi^{+'})(MPK' - \delta_K p_I(s')))] + \mu \theta p_I(s), \quad (33)$$

$$(CS) \quad \mu \geq 0, \quad F \leq \theta p_I(s) k', \quad \mu (\theta p_I(s) k' - F) = 0. \quad (34)$$

Each condition says that the value today of what one more unit raises equals the expected after-tax cost of repaying it tomorrow plus the shadow value of the collateral it uses. (LC) is per unit of local face. One more unit raises d by q_L , costs one local good tomorrow less the tax saved on its interest, and uses q_L of the limit. One more unit of foreign face raises d by $s q_F$, costs s' local goods tomorrow less the tax saved on its interest and exchange-rate loss, and uses $s q_F$ of the limit, and (FC) is that condition divided by s . Per unit of funds, dividing (LC) by q_L and (FC) by q_F , the two costs are $1 + (1 - \tau_\pi^{+'}) r_L$ and $1 + (1 - \tau_\pi^{+'}) [(1 + r_F) s'/s - 1]$, the forms quoted in Section 3. (K) is per unit of capital, which costs $p_I(s)$ local goods today and relaxes the limit by $\theta p_I(s)$. Its marginal product is the price-taking one. The firm differentiates $(1 - \tau_y) e(s') z' k'^\alpha \ell'^{1-\alpha} - w' \ell'$ holding the wage fixed, so the return is $(1 - \tau_y) \alpha e(s') z' k'^{\alpha-1} \ell'^{1-\alpha}$ at the equilibrium labor $\ell' = \ell(k', z', s')$. Substituting the equilibrium wage before differentiating would give α^2 in place of α . Where the firm has a loss tomorrow, $\tau_\pi^{+'} = 0$ and the three conditions are the ones without the tax.

Utilization follows from (LC): $\mu = u'(d) - \beta \mathbb{E}[u'(d')(1 - \tau_\pi^{+'}(1 - q_L))]/q_L$. The firm borrows to the limit when one local good raised today is worth more than its discounted expected after-tax repayment, and keeps slack otherwise, in which case $\mu = 0$ and (LC) holds with equality at an interior φ . Whether the limit binds is therefore an outcome of the solution.

C.2 The foreign-good share to first order

Dividing (LC) by q_L and (FC) by q_F , μ drops out, and the two conditions give the mix condition (25), in the owners' marginal utility net of the tax shield, $\tilde{u}' = (1 - \tau_\pi^{+'}) u'(d')$. Dividing it by $\mathbb{E}[\tilde{u}']$ and splitting the expectation of a product into a product of expectations and a covariance gives (26), which is exact. With the rates (11)–(12), the factor $1 + r^*$ cancels and (26) becomes

$$(1 + \Omega_F) \left(\mathbb{E} \left[\frac{s'}{s} \right] + \Pi(\eta) \right) = \frac{1 + \Omega_L}{\varepsilon(s)}, \quad \Pi(\eta) \equiv \frac{\text{Cov}(\tilde{u}', s'/s)}{\mathbb{E}[\tilde{u}']}. \quad (35)$$

The term $\Pi(\eta)$ is the price the owners put on the exchange-rate risk in foreign-good face. Write $\Delta \equiv \log s' - \log s$, $\hat{e} \equiv \mathbb{E}[\Delta]$ and $\sigma^2 \equiv \text{Var}[\Delta]$, all conditional on today's s . Here σ^2 is the innovation variance of the exchange-rate process. Each of the premia Ω_F and Ω_L , the expected depreciation $\hat{e}$, the variance σ^2 and the risk price $\Pi(\eta)$ is at most a few hundred basis points. To first order I keep the terms linear in these quantities and drop their products and squares.

Put together. A second-order expansion of the exponential gives $\mathbb{E}[s'/s] = \mathbb{E}[e^\Delta] \approx 1 + \hat{e} + \frac{1}{2}\sigma^2$ and $\mathcal{E}(s) = \mathbb{E}[e^{-\Delta}] \approx 1 - \hat{e} + \frac{1}{2}\sigma^2$, so that $1/\mathcal{E}(s) \approx 1 + \hat{e} - \frac{1}{2}\sigma^2$. Inserting these and dropping products of small terms,

$$1 + \Omega_F + \hat{e} + \frac{1}{2}\sigma^2 + \Pi(\eta) \approx 1 + \Omega_L + \hat{e} - \frac{1}{2}\sigma^2.$$

Both pools price the expected depreciation, so it cancels, and what remains is $\Omega_L \approx \Omega_F + \sigma^2 + \Pi(\eta)$, which is (27). The local premium is the foreign premium plus the Jensen term σ^2 plus the owners' risk price. The Jensen term is not a risk premium, and it is present even with risk-neutral owners. By the convexity of the exponential, $\mathbb{E}[s'/s]$ and $\mathbb{E}[s/s']$ each exceed $e^{\pm\hat{e}}$ by $\frac{1}{2}\sigma^2$. Half of the term enters through the definition of Ω_L and half through the owners' expected repayment.

The risk price. Tomorrow's exchange rate affects d' , and hence $\tilde{u}'$, in two ways. It changes the repayment $s'b^*$, which grows with the firm's own η . It also changes the prices at which the firm borrows tomorrow and the value of its foreign sales and of its capital abroad, which do not depend on η . A first-order expansion in η gives

$$\Pi(\eta) \approx \Pi_0 + \tilde{\rho}\eta, \quad \Pi_0 \equiv \Pi(0), \quad \tilde{\rho} \equiv \Pi'(0).$$

The intercept Π_0 is the risk price of a firm without foreign-good debt. I do not set it to zero, and the condition becomes

$$\Omega_L \approx \Omega_F + \Pi_0 + \tilde{\rho}\eta + \sigma^2. \quad (36)$$

Clearing. Let $X^* \equiv X_F^* + X_L^*$ be the firms' total funds in foreign goods. Since η is the foreign-good share of these funds, $X_F^* = \eta X^*$ and $X_L^* = (1 - \eta)X^*$, and (13) gives $\Omega_F = \Gamma_F X^* \eta$ and $\Omega_L = \Gamma_L X^* (1 - \eta)$ exactly. Substituting Ω_F and Ω_L into (36) and solving for η gives (28).

Accuracy of the approximation. The model is computed using the exact first-order conditions (31)–(34). At the calibrated point $\Omega_F = 271$ and $\Omega_L = 294$ basis points and $\sigma^2 \approx 20$ basis points. The ratio $\Gamma_L/(\Gamma_L + \Gamma_F)$ is 0.473, while the solved model's average share is 0.453. The Jensen and risk-price terms in (28) account for the difference.

C.3 Long-term sovereign bond pricing and the spread

Government debt is a long-term bond with geometric amortization and no coupon. A unit bought today pays, next period and only if the government repays, the maturing fraction

δ_B in foreign goods plus the market value $q_F^g(B_g^{*'}; S')$ of the $1 - \delta_B$ units that remain. If the government defaults, the holder gets nothing. Risk-neutral international lenders who discount at r^* break even, which gives the recursion (23). There $p(B_g^{*'}; S')$ is the default probability in next period's state and $B_g^{*'}$ is the debt policy in that state. The bond's yield r is the rate at which the promised stream is worth its price, $q = \sum_{j \geq 1} (1 - \delta_B)^{j-1} \delta_B / (1 + r)^j = \delta_B / (r + \delta_B)$, so $r = \delta_B / q - \delta_B$. A default-free bond of the same design, discounted at β^* , has the price $\delta_B / (r^* + \delta_B)$ and yields r^* , and the reported spread is $\delta_B / q_F^g - \delta_B - r^*$.

C.4 Brazil

The model is calibrated to Brazil by the procedure of Section 4. The risk aversions, the capital share, the depreciation rate, the labor curvature and the world rate keep the values of Table 9, and every other parameter is set from Brazilian data. The net income tax rate is 0.34, the statutory corporate income tax and social contribution together, and the output tax rate 0.28, Brazil's tax revenue other than the corporate income tax over GDP (OECD), the same mapping that gives Indonesia 0.08. The foreign share of the firms' capital is 0.131, the eligible firms' foreign assets over assets, so, with the same margin of 0.05, the foreign share of revenue is 0.181 against 0.186 in the data. The real exchange rate process is estimated on the annual real effective rate over 1999–2025 by least squares, without the small-sample correction, which in Brazil's case would give a unit root. The persistence is 0.866 and the innovation standard deviation 0.105, so the process has an unconditional standard deviation of 0.21 (the sample standard deviation in Table 11 is 0.20), twice Indonesia's. Productivity has persistence 0.886 and innovation standard deviation 0.027. The maturity parameter is 0.064, from an average issuance maturity of 15.6 years, and the re-entry probability is the emerging-market average, 0.208, since Brazil's own default episodes end before the sample. The six internal parameters are fitted to the six moments of Table 33, computed from the Brazilian data of Table 11.

Table 33 reports the parameters and the fit. The four firm targets are matched to within 1 percent, except the standard deviation of leverage at 2.8 against 2.7 percentage points, and the two sovereign targets to within half a percent, and the firms' mismatch follows at -4.5 percent of assets against -4.6 in the data. Two moments are missed: the volatility of the investment rate, 0.032 against 0.009 in the data, and the corporate income tax's share of revenue, 14.8 percent against 10.0. Mean capital is 44 percent of the Indonesian economy's, because a tax on gross revenue at 0.28 taxes the return to capital, which Brazil's consumption and payroll taxes largely do not, and because the owners' impatience needed for Brazil's leverage targets raises the required return. The spread's stan-

dard deviation, untargeted, is 0.81 percentage points against 0.88 in the data, and all taxes are 33 percent of output against 32.

Table 33: Calibration to Brazil

Parameter	Target	Data	Model
$\theta = 0.322$	debt / assets, mean	33.0%	32.8%
$\beta_{\text{owner}} = 0.925$	debt / assets, s.d.	2.7 pp	2.8 pp
$\Gamma_L = 0.069$	foreign-currency share of debt	25.9%	26.0%
$\Gamma_F = 0.151$	dollar bond spread at issue	3.00 pp	3.02 pp
$\beta_{\text{worker}} = 0.945$	sovereign spread, mean	1.86 pp	1.86 pp
$\kappa = 0.0161$	foreign-currency public debt / GDP	4.1%	4.1%
Set outside the model: $\tau_\pi = 0.34$, $\tau_y = 0.28$, $m = 0.131$, $\chi = 0.181$, $\rho_s = 0.866$, $\sigma_s = 0.105$, $\rho_z = 0.886$, $\sigma_z = 0.027$, $\delta_B = 0.064$, $\lambda = 0.208$			

Notes: The six internal parameters are chosen by the simulated method of moments of (29) and (30), and the external parameters as described in the text. Data: the eligible listed non-financial firms and the sovereign series of Table 11.

Table 34 reports for Brazil the spread's response in the baseline and in the $\eta = 0$ economy, the Shapley split of Table 13 and the three policies of Table 15. Its Shapley split is computed with elastic hours kept on, and gives the net income tax 80 percent and the borrowing limit 20 percent of the 0.063 percentage points, per 10 percent of depreciation, that the two features together remove.

C.5 Depreciations and appreciations in the model

Table 35 runs the split regression of Table 26 on the simulated panels of Table 12. When depreciations and appreciations enter separately, the model's interaction is larger for depreciations, as in the data. But the model's spread also falls after appreciations, on its own and more so where mismatch is higher, and in the emerging markets' data neither is significant. The impulse responses show the same pattern. After an appreciation, scaled to 10 percent as in Section 5, the spread falls by 0.15 percentage points more in the Indonesian baseline than in the $\eta = 0$ economy (standard error 0.006), against an extra rise of 0.20 after a depreciation.

C.6 The extra response with features switched off

Table 36 reports the eight economies behind the Shapley split of Table 13. In seven of them, one, two or all three features are switched off in both the Indonesian baseline and

Table 34: Brazil: decomposition and policies

	Setting	Spread			Welfare (%)	
		response (pp)	η	Capital (%)	Workers	Owners
Brazilian baseline		0.23	0.26			
All debt in the local good	$\eta = 0$	0.15	0	+2.0		
Ending the deduction of exchange-rate losses	$\zeta = 0$	0.18	0.26	-0.2	-0.20 (0.03)	+0.28 (0.03)
Tax on foreign-good borrowing	$\tau_F = 1\%$	0.20	0.15	-2.1	-1.34 (0.00)	-2.23 (0.00)
	$\tau_F = 2\%$	0.17	0.06	-3.9	-2.88 (0.01)	-4.30 (0.01)
	$\tau_F = 4\%$	0.15	0.00	-5.3	-4.01 (0.01)	-5.61 (0.01)
Cap on the foreign-good share	$\eta_{cap} = 20\%$	0.21	0.20	-0.4	-0.39 (0.00)	-0.56 (0.00)
	$\eta_{cap} = 10\%$	0.19	0.10	-2.3	-1.82 (0.00)	-2.56 (0.01)
	$\eta_{cap} = 0$	0.15	0	-5.3	-4.02 (0.01)	-5.63 (0.01)
Shapley split of $\mathcal{A}$		net income tax 80%, borrowing limit 20%				

Notes: As in Tables 13 and 15, for the Brazilian economy. The spread's response is to a 10 percent depreciation, in percentage points. The Shapley split keeps elastic hours on in every economy, so it divides $\mathcal{A}$ between the net income tax and the borrowing limit. The tax and cap rows are solved as in Table 15, with the standard errors of 100 paired simulated histories in parentheses. The $\zeta = 0$ row reports the baseline response less the fall from ending the deduction (-0.05), the mean share, and capital and welfare as changes, with bootstrap standard errors in parentheses.

Table 35: Depreciations and appreciations in the data and the model

	Data	Model, Indonesia	Model, Brazil
$\text{Mismatch}_{c,t-1} \times \text{dep}_{c,t}$	+22.40** (10.89)	+10.16	+6.48
$\text{Mismatch}_{c,t-1} \times \text{app}_{c,t}$	-3.60 (15.98)	-7.72	-5.53
$\text{dep}_{c,t}$	+5.43*** (1.06)	+3.33	+2.42
$\text{app}_{c,t}$	+0.16 (2.08)	-3.15	-2.68

Notes: The dependent variable is the sovereign spread in percentage points, with $\text{dep}_{c,t} = \max(0, s_{c,t})$ and $\text{app}_{c,t} = \max(0, -s_{c,t})$, where $s_{c,t}$ is the real depreciation rate of Section 2 (in the model, the annual change in log s). Data: the emerging markets, column (2) of Panel B of Table 22, with standard errors clustered by country in parentheses. Model: the same regression on the simulated panels of Table 12, built and estimated as described there. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

the $\eta = 0$ economy, and $\mathcal{A}$ is the difference between their spread responses. The net income tax is switched off by setting $\tau_\pi = 0$ and raising τ_y from 0.08 to 0.111, which keeps revenue unchanged. Elastic hours are switched off by fixing $\ell = 1$. The borrowing limit is switched off by raising θ from 0.29 to 0.70, where it never binds, and by multiplying both pools' premium slopes by 2.74, which keeps leverage close to the baseline's (28.4 against 29.1 percent). The owners' discount factor keeps its calibrated value in every economy. In the four economies without the borrowing limit, the firm's solution is accepted when the relative change in the dividend policy falls below 2×10^{-3} rather than 10^{-5} . With the limit off and the net income tax on, the government defaults in 4 to 9 percent of years, against 1.1 percent in the baseline, so the Shapley shares compare economies with very different default rates.

Table 36: The extra response with features switched off

Features switched off	$\mathcal{A}$ (pp)	s.e.
None (Indonesian baseline)	0.204	(0.007)
Net income tax	0.075	(0.005)
Elastic hours	0.123	(0.004)
Borrowing limit	0.116	(0.009)
Net income tax and elastic hours	0.004	(0.002)
Net income tax and borrowing limit	0.037	(0.005)
Elastic hours and borrowing limit	0.041	(0.007)
All three	0.006	(0.001)

Notes: $\mathcal{A}$ is the spread's response on impact to a 10 percent depreciation in the Indonesian baseline minus the response in the $\eta = 0$ economy, with the listed features switched off in both. Standard errors from the dispersion across starting states.

C.7 Which differences between Indonesia and Brazil decide the workers' result

Table 37 solves the firms of each country's economy again with one group of parameters taken from the other country, under the law and without the deduction of exchange-rate losses. As in steps 1 and 2 of Table 16, the change in revenue is passed to the workers in the period it is collected. The tax rates are the only group that reverses the workers' result from both sides, and each of Brazil's two rates alone reverses Indonesia's. The net income tax rate matters because each untaxed gain escapes it. The output tax rate matters because it makes firms smaller: with Indonesia's financiers, smaller firms move the premia less when they shift their borrowing, so timing costs them less. The exchange-rate process changes the size of the result but not its sign, because its volatility scales the untaxed

gains and the average loss the treasury stops sharing in the same way. Productivity, and the firms' foreign assets and sales, change the result little. The firms' financing parameters reverse Brazil's result but not Indonesia's. With Indonesia's financing parameters, under which the premia rise less with borrowing, the Brazilian firms time their foreign-good borrowing so cheaply that capital rises by 0.8 percent.

Three further differences between the two economies affect how large the untaxed gains are relative to the average loss the treasury stops sharing. Brazil's exchange rate reverts faster (Table 11), which makes its moves easier to predict, and its firms have less foreign-good debt, which makes the average loss smaller. Both make the untaxed gains relatively larger. Brazil's premia, however, rise faster with borrowing, which makes timing more costly for its firms and the gains relatively smaller.

Table 37: The workers' result with one group of parameters from the other country

	Workers	Owners	Capital (%)
<i>A. Indonesia's economy</i>			
Indonesia	+0.05	+0.26	+0.01
with Brazil's tax rates	−0.16	−0.11	−0.07
with Brazil's net income tax rate only	−0.05	+0.02	−0.12
with Brazil's output tax rate only	−0.08	−0.05	−0.10
with Brazil's exchange-rate process	+0.13	+1.22	+0.31
with Brazil's productivity process	+0.05	+0.30	+0.02
with Brazil's foreign assets and sales	+0.04	+0.23	+0.01
with Brazil's financing parameters	+0.16	+0.46	+0.21
<i>B. Brazil's economy</i>			
Brazil	−0.18	+0.28	−0.22
with Indonesia's tax rates	+0.26	+1.00	+0.41
with Indonesia's exchange-rate process	−0.05	−0.05	−0.07
with Indonesia's exchange-rate and productivity processes	−0.05	−0.06	−0.08
with Indonesia's financing parameters	+0.16	+1.01	+0.78

Notes: Welfare change from ending the deduction of exchange-rate losses ($\zeta = 0$), in percent of the realized lifetime consumption equivalent, with the change in revenue passed to the workers in the period it is collected, and the change in capital. Each row solves the firms again, under the law and without the deduction. Tax rates: the net income tax rate and the output tax rate. Exchange-rate and productivity processes: persistence and volatility. Foreign assets and sales: the shares m and x . Financing parameters: θ , β_{owner} , Γ_L , Γ_F and the constant χ that fixes the unit of labor.