The 'Hidden Cost' of Sustainable Debt Financing in Emerging Markets

J. Rickman[1], S. Kothari[1]†, N. Ameli[1]

[1]Institute for Sustainable Resources, University College London, UK

†corresponding authors: sumit.kothari@ucl.ac.uk

Abstract

International sustainable debt markets are a critical source of capital for EMDEs progressing sustainable development and climate goals. However, finance provided in 'hard' currencies preferred by international investors, rather than local currencies in which borrowers earn revenue, transfers currency risk from developed country lenders to EMDE borrowers. This shift amplifies financial vulnerabilities at both the micro and macroeconomic level. Here we investigate the risk factors influencing the currency composition of EMDE sustainable corporate debt over the past two decades. We show that EMDE borrowers choose hard currency financing as the price for market access during volatile periods, creating a 'hidden cost' of sustainable debt. In addition to currency risk, global uncertainty depresses access to local currency financing in a 'flight-to-safety' phenomenon. A 'ratings trap' further develops whereby improved sovereign credit ratings increase foreign currency borrowing with potentially negative feedback effects on sovereign credit stability and ongoing access to debt markets.

Introduction

Emerging markets and developing economies (EMDEs) face a crucial challenge to decarbonize their economies while pursuing essential sustainable development goals (SDGs). Based on current policies and committed targets, greenhouse gas emissions from EMDEs are set to grow by five gigatons over the next two decades without an unprecedented increase in investments in clean energy and emissions reduction technologies[1]. Transitioning to low-carbon economies in a just and timely manner while making progress on SDGs, requires climate finance flows in these countries to increase by a factor of between four and seven up to 2030[2], in excess of 2.4 trillion USD annually[3]. While this constitutes about 40% of global investment needs for the low-

carbon transition, EMDEs hold only 10% of global wealth[1]. Low levels of capital stock, constrained public finances and competing development priorities, mean that governments have limited capacity to generate financial resources to progress climate and SDG targets[4]. Bilateral and multilateral flows of climate finance, while critically important and catalytic for financing sustainable development and climate adaptation projects, also cannot bridge the transition financing gap in EMDEs; up to 70% of the required investment must instead be sourced from the private sector and a large portion of this must be mobilized from developed country markets[1, 5]. Indeed, the mobilization of climate finance from industrialized high-income countries to middle and low-income countries forms an important component of international climate agreements[6].

International debt markets carry large pools of financial capital, estimated at over 140 trillion[7] USD, that are channeled through banks and institutional investors in widely used financial instruments such as corporate bonds and loans. These markets are therefore being considered as a crucial source of financing, particularly for commercially viable projects. Scaling these mainstream debt instruments for sustainable activities through green, social, sustainable and sustainability-linked bonds and loans ('sustainable debt' hereon) could drive sustainable development[8] and the low-carbon transition[9] in EMDEs. The demand for sustainable debt instruments issued by EMDE corporates has seen rapid growth in recent years as investors seek climate-safe investments over long-term horizons[10] and EMDE markets offer attractive yields and diversification opportunities[11, 12]. For example, sustainable bond issuance in EMDEs (excluding China) rose 58% between 2020 and 2021 to 35.2 billion USD[11]. While sustainable bonds have seen the fastest growth, the non-bond segment, e.g., commercial loans, continues to be a significant source of finance, accounting for almost half of the total issuance in 2021[13].

However, the majority of sustainable debt issuance is denominated in 'hard currencies' that are preferred by international investors, predominantly US dollars and euros[13]. As of 2023, EMDEs (excluding China) represented 6% global green bond issuance, but only 1% of global green bonds were issued in EMDE currencies[9]. The preference for these currencies arises from the unwillingness of international lenders to bear local currency risk, i.e., the risk of a depreciation in the value of investments and debt servicing repayments due to unfavorable movements in the exchange rates of local currencies against dominant international currencies. The risk premium required by international investors as compensation for local currency risk is estimated to push the cost of capital for EMDE borrowers by between 3% and 9% higher than developed country

borrowers[14, 15], making access to international markets in local currencies prohibitively costly, and with serious implications for the cost and pace of the energy transition[15, 16]. Effectively the choice faced by EMDE borrowers is between a hard currency loan - for which the borrower bears the currency risk - or no loan at all, as domestic capital markets typically lack the depth required to provide financing at scale. Evidence from the broader corporate debt market suggests that faced with this choice EMDE corporates are choosing to borrow in hard currencies and take on the currency risk in search of lower borrowing costs and access to international markets[17]. The result is a growing 'currency mismatch' on EMDE corporate balance sheets, i.e., a mismatch between corporate sector revenues, primarily denominated in local currencies, and their debt obligations denominated in hard currencies. This mismatch creates financial exposures at the micro- and macro-level. At the firm (micro) level, companies are exposed to exchange rate fluctuations, increasing their financial vulnerability and the risk of default. At the macroeconomic level, widespread currency mismatches can amplify the impact of economic shocks, constrain economic policy and lead to sovereign credit rating downgrades[17-19]. As a result, global currency risk-mitigation and guarantee solutions are being called for by the international climate community[9, 14, 20, 21] to mobilize sustainable debt to EMDEs without increasing the financial vulnerability of the domestic corporate sector.

A rich literature has described and analyzed the struggles of EMDE sovereigns to borrow in their local currency – a phenomenon coined 'original sin' – from the turn of the century[22, 23] up to now[24, 25]. But only a few studies have explored this dimension of EMDE corporate borrowing, and none to our knowledge have focused on corporate sustainable debt. Several studies looking at the borrowing behavior of emerging market corporates between 2000-2015 identified firms issuing dollar debt to take advantage of a period of low US interest rates and high global liquidity[26-28], while a more recent analysis of emerging Asian firms covering the period 2000-2019 found such opportunistic behavior was reserved for mature firms only[29]. However, sustainable debt is a distinct subset of the broader debt universe that has undergone substantial development since 2019 through a period of unique economic conditions generated by the Covid-19 pandemic, the Russia-Ukraine war, and a growing demand for sustainable investments[12]. Moreover, evidence suggests sustainable debt markets have distinct characteristics with specific risk transmission channels and heightened sensitivities to economic and political uncertainty[30, 31], which in turn shapes the risks associated with local versus hard currency debt. An analysis of the specific influence of macro-risks on foreign currency borrowing in EMDE sustainable debt markets, including its most recent years of growth, has not yet been

undertaken and we aim to fill this gap. As these sustainable debt markets continue to grow as a critical channel of climate finance, such an analysis can inform the effective design and implementation of local currency financing solutions, which have recently become a focus of International and government initiatives.

Here, we investigate the currency denomination for EMDE corporate sustainable debt over the past two decades. We first show that investments in EMDEs have persisted despite high currency risk, as borrowers choose hard currency loans as the price for market access. As a result, currency risk is increasingly shifted from developed country lenders to EMDE borrowers. We calculate this 'hidden cost' of sustainable debt financing in foreign currencies. Building on studies modelling the determinants of currency choice[26, 29, 32-36], we identify significant macroeconomic risk factors influencing the currency composition of corporate debt in six major EMDEs. Our findings show that, beyond currency risk, global uncertainty strongly depresses access to local currency financing in a 'flight-to-safety' phenomenon. Additionally, we uncover an unexpected effect of sovereign credit ratings on currency composition, whereby stronger sovereign credit ratings lead to a higher share of foreign currency debt. This points to a 'ratings trap', where improved economic and political conditions enhance risk-adjusted returns and credit ratings, driving increased foreign currency borrowing in EMDEs. Over time, this could exacerbate currency mismatches across the economy, with potentially negative feedback effects on financial stability and sovereign ratings.

Stranding EMDE corporates with currency risk as the price of access to international markets for sustainability and climate finance goes against the principles of equity that underlie international climate agreements. Transfers of finance from developed to developing economies are expected to relieve, rather than increase, their financial burdens through greater investment in sustainable development. With the 'hidden cost' of EMDE sustainable debt set to increase as global uncertainty persists[37], a global currency solution is, then, at once more urgent and more necessary than current debate suggests.

Results

Landscape of green, social, and sustainable debt in EMDEs

Using Bloomberg data we construct a global, instrument-level dataset of bonds and loans that have been labeled as green, social, sustainable or sustainability-linked (comprising the GSSS debt securities market) (further details in Methods). Green, social and sustainability debt instruments largely follow a 'use-of-proceeds' model, whereby the proceeds of the bond or loan are tracked and allocated towards eligible sustainable projects. In contrast, sustainability-linked debt instruments involve setting sustainability performance targets that are linked to the borrowing terms of the debt instrument, which may reward or penalize borrowers based on their performance against these targets. Together, these sustainable debt markets (referring to the market for GSSS debt securities hereon) finance a wide variety of sectors, encompassing direct investments in green projects as well as initiatives that lead to concrete improvements in organizational sustainability, such as through improvements in energy efficiency. The full dataset has a global coverage of sustainable debt issuances from 1996 to 2024, thereby covering the entire development of the market. In this study, we focus on sustainable debt issuances by corporate organizations in countries that are classified as emerging markets and developing economies (EMDEs). These include all middle and low income countries based on the income classification provided by the World Bank. China, however, is excluded from our analysis due to its large market size and unique economic characteristics - its corporate sector sustainable debt issuance almost equals that of the rest of the EMDE countries combined as of 2024. The filtered dataset for EMDE countries comprises 239 billion USD of sustainable debt (750 bonds and 1111 loans) issued by corporates between 2004 and Q2 2024.

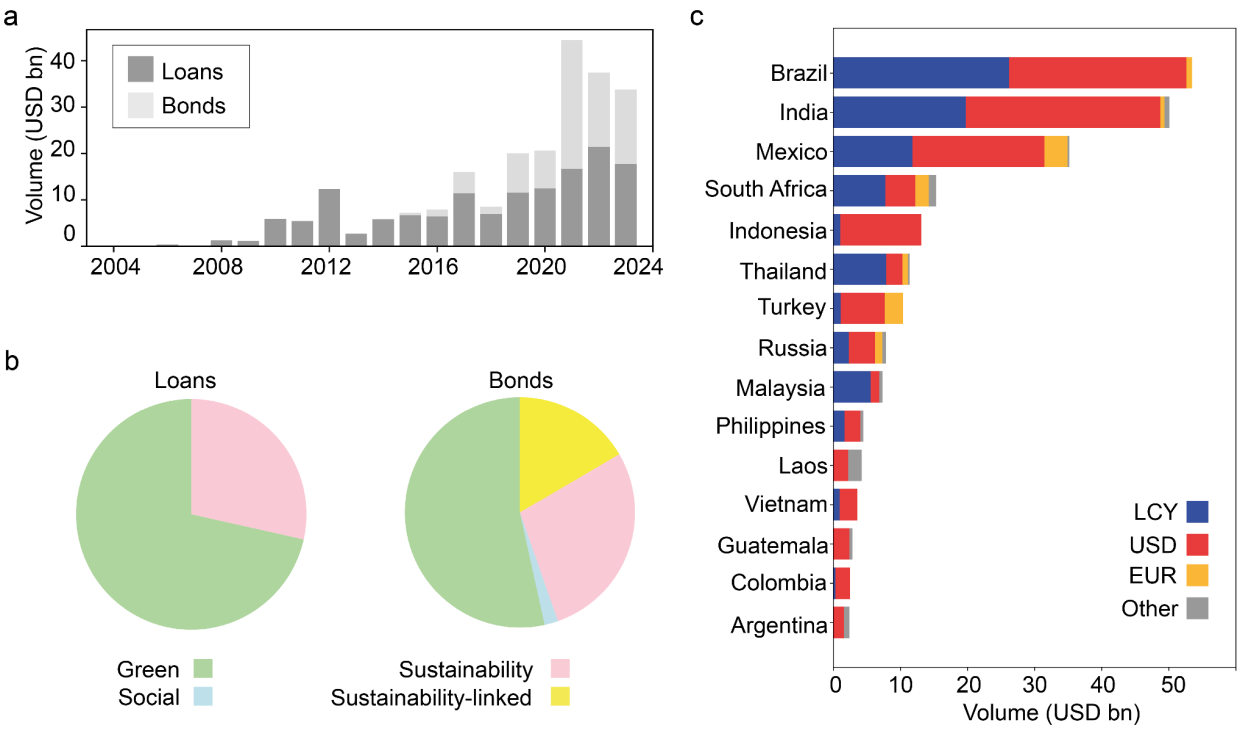


Figure 1. Landscape of green, social, sustainability, and sustainability-linked bonds and loans in EMDEs. a) Stacked bar chart shows annual issued volumes of sustainable loans (dark gray) and bonds (light gray) in EMDEs, excluding China. b) Pie charts show break-down of sustainable bonds and loans by theme. c) Stacked bar charts show total issued volumes of sustainable debt for the top 15 EMDEs in the dataset disaggregated by currency; local currency (LCY), US dollars (USD), euros (EUR).

Significant growth in EMDE sustainable debt markets did not begin until the period 2010-2012 when utility and energy companies in major emerging markets (India, Brazil and Thailand) began raising green and sustainability-linked loans in large numbers (Fig. 1a). In the early years sustainable loans provided the more familiar channel for financing green projects in EMDEs, whereas sustainable bonds are a newer instrument that made negligible contributions to sustainable financing before 2015. Since then, the sustainable bond market has grown steadily with investor appetite, spurred by the signing of the Paris Agreement. Between 2019 and 2023 it represented a 48% share of the EMDE sustainable debt universe (Fig. 1a). Thematically, the labeled bond market is split between green (49%), sustainability-linked (25%), sustainability (15%) and social (2%), while loans are predominantly green (72%) or sustainability-linked (28%) (Fig. 1b). Phases of rapid growth and phases of stagnation are observed in annual issuance volumes (Fig. 1a), with a notable growth period in recent years (2021-2023) attributable to post-Pandemic recovery spending and greater demand for sustainable investments from investors increasingly cognizant of climate risks[12]. The annual issued volume increased 116% between

2020 and 2021, from 21 bn USD to 44 bn USD, and has stayed at similarly high levels since (Fig. 1a).

The size and currency composition of sustainable debt financing varies across EMDE countries. In most cases foreign currency denominated debt comprises a large proportion of the overall debt issuance (Fig. 1c). Of the top 15 sustainable debt issuing EMDE countries shown in Figure 1c, the share of foreign currency debt issued over the study period ranges from 25% (Malaysia) to 100% (Laos) with an average of 70%. The dominant foreign currency is US dollars, representing 80% of all foreign currency debt, followed by the Euro (9%) (Fig. 1c). Malaysia stands out as a country with the lowest reliance on foreign currency debt reflecting its financial market development and status as one of the leading markets for Islamic 'sukuk' green bonds in the Asian region[38].

Currency mismatch is growing with EMDE sustainable debt markets

Currency mismatch has been growing on the balance sheets of EMDE corporates accessing sustainable debt. The share of foreign currency denominated debt in EMDE sustainable debt markets has risen steadily from an average of 17% in the first half of the period studied (2004 - 2013) to 61% in the second half (2014 - 2023). This proportion is considerably larger than the levels observed in the wider corporate debt markets in which the share of foreign currency debt averaged at 40% between 2010 and 2018[39]. Sustainability projects in EMDEs are thus becoming increasingly exposed to fluctuations in their domestic currencies against the US dollar, the predominant foreign currency (Fig. 1c). Additionally, many of the borrowers accessing the sustainable debt markets, such as energy and utility companies, primarily produce goods and services that are not traded internationally (Fig. S1). Consequently, they lack natural currency hedging mechanisms, i.e., they do not earn revenues in foreign currencies to offset their obligations on debt payments and have few limited recourse to alternative hedging strategies[40], leaving them vulnerable to local currency depreciation in the short and long term.

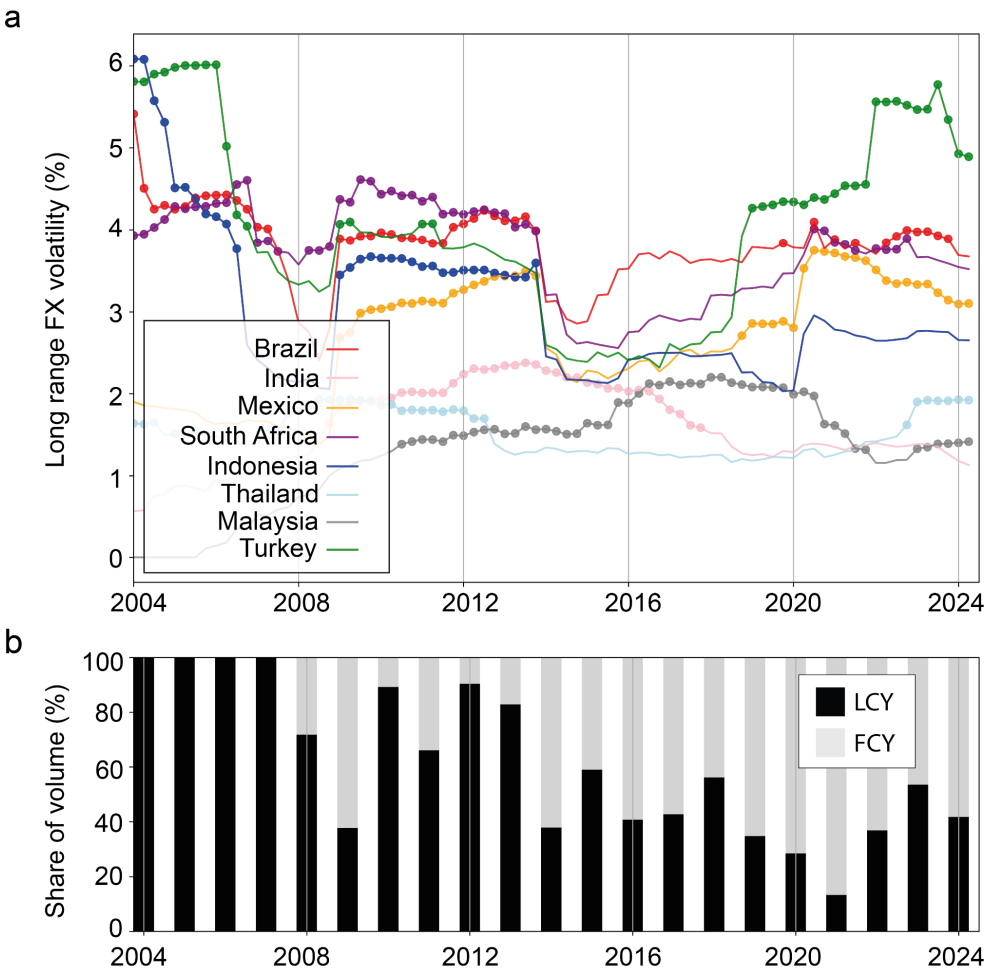


Figure 2. Currency volatility and currency composition of sustainable debt. a) Line graph shows long-run quarterly foreign exchange (FX) volatility for the top eight EMDEs between 2004 and 2024. Circle markers indicate quarters where FX volatility is above the 2000-2024 average in each country. Data source: St Louis Federal Reserve Bank economic database. b) Bar chart shows the share of total annual issued volumes in foreign currency (FCY) and local currency (LCY) across the top eight EMDEs.

The increase in the share of foreign currency debt coincides with a period of significant growth in the EMDE sustainable debt markets attributable to post-pandemic recovery spending and an increased awareness of climate risk in the investment community (Fig. 1). During this period, substantial volumes of sustainable debt were issued in countries that also experienced higher than average levels of currency risk (Fig. 2a), due to fluctuating exchange rates characteristic of the volatile economic environment[41]. For instance, among the top eight EMDEs with a cumulative sustainable debt issuance volume of over 10 billion USD (Brazil, South Africa, Turkey, Mexico, Thailand, India, Malaysia and Indonesia; Fig 1c), we observe that five of them (Brazil, South Africa, Turkey, Mexico, Thailand and Malaysia) have above average foreign

exchange (FX) volatility (a measure of currency risk, see Methods). A simple country-level regression of FX volatility against annual shares of sustainable debt issuance by country (see Methods), shows no indication that high currency risk is related to low growth, in aggregate or at the country level (Fig. S2). Taken together, these findings suggest that currency risk has not blocked the growth of EMDE sustainable debt markets. Rather, it influences their currency composition, leading to an increase in foreign currency borrowing, and debt dollarization. This shift increases the exposure of borrowers in EMDE countries to exchange rate fluctuations and currency risk, thereby making them more vulnerable to financial shocks and the ebb and flow of global economic conditions.

The hidden cost of sustainable debt

The depreciation of domestic currencies against a prominent foreign currency such as US dollars creates a hidden cost for borrowers that are servicing foreign currency debt but earning revenues in domestic currency. Medium to long-term currency depreciation may be observed in EMDE countries as a result of global shocks that propagate through international trade and commodity prices or domestic uncertainty that impacts the stability and growth prospects of the economy. In the case of sustainable debt, the additional cost to EMDE borrowers can be measured by looking at how the value of the debt, in terms of the domestic currency, changes due to movements in exchange rates (see Methods). For example, the exchange rate for the Indian rupee (INR) almost doubled between 2008 and 2023 from 40 INR/USD to 80 INR/USD. For an Indian energy firm, with revenues in Indian rupees, this means that the cost of servicing a bond of 100 million USD would have doubled between 2008 and 2023 in terms of its domestic currency. This would equate to an additional debt burden of 100 million USD that would need to be serviced through additional revenues and hiking domestic prices. This increased cost to corporate borrowers, which might not be immediately apparent when the debt is issued, represents the hidden cost of foreign currency borrowing.

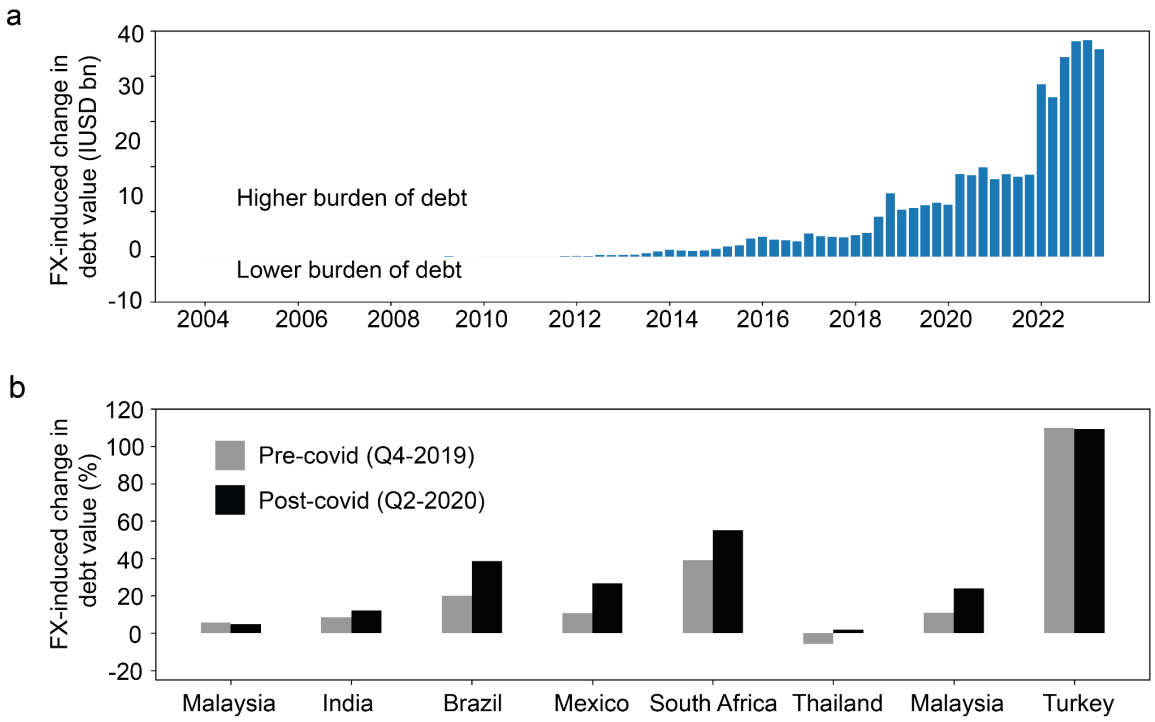


Figure 3. FX-induced changes in foreign currency sustainable debt in the top eight EMDEs. a) Bar chart shows quarterly foreign-exchange (FX) induced change in debt value (see methods) between Q1-2004 and Q2-2024 aggregated across the top eight EMDEs. b) Bar charts show FX induced change in debt value at country-level in a pre-Covid (Q4-2019) and post-Covid (Q2-2020) snapshot.

Fig. 3a illustrates the effect of these FX-induced changes in the value of foreign currency debt holdings in the eight largest EMDEs between 2004 and 2023. The increased debt burden becomes apparent with the onset of significant of foreign currency borrowing in 2012 and fluctuates with annual issued volumes (Fig. 1a) and exchange rates (Fig S3).

To illustrate the effect of financial shocks on the debt burden faced by EMDEs, we highlight the sudden increase in debt burden observed in the first quarter of 2020, when EMDE currencies dropped against the US dollar due to pandemic-related economic volatility (Fig. S3). EMDE corporates in these eight major economies were faced with servicing the equivalent of an additional 16 billion USD of debt in the second quarter of 2020, a 66% increase from the previous quarter. The burden was not shared equally across countries; figure 3b shows the percentage increase in debt burden disaggregated across countries in a pre- and post-pandemic snapshot. Brazil, Mexico, and Indonesia faced the worst exchange rate shocks that led to their debt burden at least doubling in domestic terms.

Modeling determinants of the sustainable debt composition in EMDEs

The additional debt burden faced by EMDE corporates raising finance for their sustainability transitions depends critically on the currency composition of their debt. This in turn, will be dependent on country-level and global risk factors, including currency risk, sovereign credit risk, political stability and global economic conditions which shape the attractiveness and cost of foreign versus local currency debt in sustainable sectors. For instance, sovereign credit risk includes the risk a sovereign could change laws relating to local currency debt e.g., suspend currency convertibility, or impose capital controls[42], while political risks include the risks of sudden climate policy reversals that could affect the viability of sustainable investments[43].

To elucidate the role played by these factors across countries, we develop a binary logistic model of currency choice with country fixed effects where the discrete outcome variable takes the value 1 if a sustainable bond or loan is issued in foreign currency and 0 if it is issued in domestic currency. We constrain the set of countries in the model to those that have a statistically relevant number of sustainable debt issuances (>100). Thus, excluding China, the data used for fitting the model covers Malaysia, India, Brazil, Turkey, South Africa, Mexico, Thailand, and Indonesia - all major emerging economies with fully convertible currencies. In our baseline model we further exclude Malaysia and Turkey from this list due to their distinct characteristics within this set of EMDEs. Malaysia is the leading market for Islamic Sukuk bonds that have a specific investor base with a strong preference for local currency - 97% of Malaysian bonds and loans by volume were issued in the Malaysian Ringgit. By contrast, Turkey is a strong trading partner with the EU - the sustainable debt issuance in euros accounts for 43% of the total issuance whereas the share of issuance in Turkish Lira comes to just 2% by volume. In the remaining countries the share of foreign currency sustainable debt is 58% on average, with Thailand having the lowest share (35%) and Indonesia the highest (87%). Including Malaysia and Turkey in the model data and allowing these country idiosyncrasies to be absorbed by country fixed effects does not affect the main results of the analysis (see Table S2). The dataset used for the baseline model reports 371 bonds and 741 loans. Of these 1112 debt issues, 322 were issued in foreign currency.

We explore four key variables as macro-risk factors influencing the currency composition of EMDE sustainable corporate debt; currency risk, sovereign credit risk, political risk and global economic conditions. Heightened local currency risk is expected to increase the likelihood of

borrowers issuing in foreign currency, as investors are less willing to lend in local currency under such conditions and require prohibitively costly currency risk premia[14]. We proxy currency risk with a backward-looking measure of exchange rate volatility (FX_RISK) over a 1-year time horizon. Sovereign risk can affect the attractiveness of local currency debt through a number of channels e.g., sovereigns can make legal changes affecting debt covenants, heightened sovereign risk can have negative effects on currency volatility[42, 44] and, on the flip side, an uplift in sovereign credit-worthiness may boost investor confidence and appetite for local currency debt. We proxy sovereign risk (SOV_RISK) with sovereign foreign credit ratings published by Moody's, one of the three major credit rating agencies (CRAs), which capture a wide range of country indicators related to economic, institutional, and political strength. Political risk is closely interlinked with sovereign credit risk, since the risk of a sovereign defaulting on a debt payment will be greatly increased by political instability. However, political risk may have an additional bearing on sustainable debt investments as sudden climate policy reversals (e.g., due to a change of government) can harm the profitability of sustainable assets. As a proxy for political risk (POL_RISK) we use the Worldwide Governance Indicator 'political stability and absence of violence/terrorism' from the World Bank which has, for some countries, a moderate positive correlation with our sovereign risk variable. We therefore run two regressions treating political risk as an additional (baseline regression) and alternative proxy to sovereign risk. Lastly, the foreign currency share of EMDE sustainable debt is also expected to increase in times of global uncertainty as investors seek 'safe' dollar assets[45]. We proxy global uncertainty with VIX, the 30-day expected volatility of the S&P 500 index. Guided by the most recent and relevant modeling literature on the determinants of foreign versus local currency borrowing[26, 34-36], we further add a number of deal-level control variables to our model (described in detail in the Methods); the dummy variable HEDGE reflects a firms' capacity to hedge foreign currency exposure; the dummy variable BOND captures whether the debt instrument is a bond or loan; the variables AMOUNT and TENOR are the size and maturity of the loan respectively. As a country-level control we add annual GDP growth, GDP_GROWTH, in addition to country fixed effects to mitigate against omitted variable bias (see Methods for details on variables and sample statistics). For robustness we further test a number of alternative proxies for each variable, and a variety of model specifications (see Methods).

Currency volatility, global uncertainty and credit ratings drive currency choice

The results of our baseline model are reported in Table 1. The regression statistics suggest a good model fit with a McFadden's pseudo-R^2 of 0.42 and a model accuracy of 85% compared to the naive prediction accuracy of 71%. Foreign versus local currency debt issuance forecast by the baseline model as compared to the empirical data is shown in Fig. S4.

	Reg 1	Reg 2
FX_RISK	78.69* (12.54)	106.26* (11.43)
SOV_RISK	0.33* (0.07)	
POL_RISK	0.14 (0.41)	0.44 (0.40)
VIX	0.04* (0.01)	0.06* (0.01)
AMOUNT	0.69* (0.07)	0.66* (0.07)
DOMESTIC	-5.47* (0.69)	-4.08* (0.45)
BOND	-1.93* (0.25)	-1.66* (0.23)
GDP_GROWTH	0.03 (0.03)	0.05*(0.03)
TENOR	-0.09* (0.02)	-0.06* (0.02)
Observations	1112	1112
R^2	0.41	0.4
Accuracy	84.7	84.2

Table 1. Results of baseline regressions. Table reports maximum likelihood logit regression results of the baseline model (regression 1) and an alternative specification where POL_RISK is treated as an alternative to SOV_RISK (regression 2). Standard errors shown in brackets. FX_RISK is a backward-looking measure of short-run (1-year) foreign exchange (FX) volatility (see methods); SOV_RISK is Moody's foreign currency sovereign credit rating; POL_RISK is a political risk proxy from the World Bank Governance Indicators; VIX proxies market uncertainty and is a volatility index of the S&P 500; AMOUNT is the size of the bond/loan; DOMESTIC is a dummy variable equal to 1 if the firm is domiciled in the country that the bond/loan was issued; GDP_GROWTH is a proxy for macroeconomic strength and is the annual percentage change in GDP from the World Bank; TENOR is the maturity of the bond/loan; McFadden's pseudo-R^2 and accuracy scores indicate model goodness-of-fit (see methods). *Significant at $p < 0.01$. N = 1112.

Our results show currency volatility, sovereign credit ratings and global uncertainty are all significant factors affecting the likelihood of an EMDE borrower issuing foreign currency debt. (Table 1). Currency risk is the most significant factor in our model (Table S3), with high currency volatility increasing the risks associated with domestic currency debt meaning the associated risk premium is prohibitively costly and, as a result, borrowers choose to issue debt in foreign currencies and bear currency risk themselves. To illustrate the effect size of currency risk on the composition of EMDE corporate debt we run a model scenario in which currency risk is held at its minimum level over the period and find a reduction in the amount of foreign debt held by EMDEs in 2023 of 20 billion USD, or 24% (Fig 4a).

The model also highlights the role of global uncertainty through the VIX variable, which measures market volatility and investor sentiment. The positive coefficient of the VIX suggests that increased global uncertainty drives a 'flight-to-safety' phenomenon, where investors prefer dollar-denominated assets. To illustrate the effect size of global uncertainty we run a model scenario in which VIX is held at its minimum value and find a reduction in the amount of foreign debt held by EMDEs in 2023 of 32 billion USD, or 39%. This underscores how global economic conditions influence investors preferences, with heightened uncertainty depressing the demand for local currency debt. The difference in foreign debt holdings between the baseline model and two simulated scenarios ('FX_min' - currency risk held at its minimum values; 'VIX_min' - global uncertainty held at its minimum value) increases over time from 9% in 2016 to 61% in 2023 capturing the impact of the increased currency volatility and global uncertainty over the covid-19 pandemic (Fig. 4a).

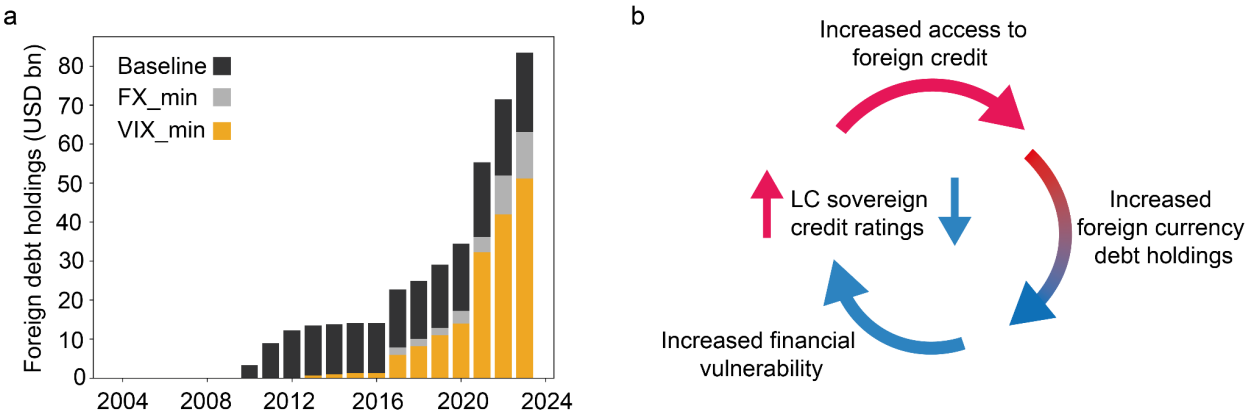


Figure 4. Effects of currency risk, global uncertainty and credit ratings on EMDE sustainable debt markets. a) Bar chart shows forecast of foreign currency debt holdings over time evaluated in the baseline model (Baseline); a

model scenario in which FX-volatility held at its minimum value in all countries (FX_min) and a model scenario in which VIX is held at its minimum value (VIX_min). b) Schematic illustrating a potential negative feedback loop generated through the interaction between sovereign credit ratings and foreign currency debt holdings.

In contradiction to our expectations, the positive coefficient of SOV_RISK suggests that lower sovereign credit risk (indicated by a higher sovereign credit rating) does not facilitate access to local currency financing but rather increases the likelihood of foreign currency debt issuance. This counterintuitive outcome indicates that improved domestic conditions, reflected in an uplift of sovereign credit ratings, provides greater access to foreign capital for EMDE borrowers and greater borrowing in foreign currencies, rather than increasing international appetite for local currency debt and lowering domestic currency risk premiums. However, this increased reliance on foreign currency debt could create a negative feedback loop which we term a 'ratings trap'. A greater share of foreign currency debt on corporate balance sheets creates financial fragilities at the firm- and country-level which, in turn, may increase borrowing costs and further complicate access to both local and foreign currency financing and eventually lead to a deterioration in sovereign credit ratings. Thus, while stronger credit ratings initially may provide greater access to foreign capital, they also introduce risks that could have detrimental downstream effects on credit stability (Fig. 4b). Interestingly, although political risk can be considered a subset of sovereign risk and is indeed an input to sovereign credit rating, we do not find it has a significant effect on the probability of foreign currency issuance, either when included as an additional or alternative variable to sovereign credit risk.

Discussion

Sustainable debt markets are becoming an important channel for financing climate and sustainability projects in EMDEs through the vast capacity of international private finance. The distribution of risks between lenders and issuers however is uneven, leading to a growing currency mismatch in sustainable corporate debt issuance that surpasses levels seen in the wider corporate debt markets. Borrowers are choosing hard currency loans as the price for access to international capital markets leading to a gradual accumulation of currency risk. At the firm-level this leaves borrowers exposed to adverse exchange rate movements caused by numerous external factors beyond their capacity to manage. Further, since firms accessing sustainable debt finance in EMDEs have been observed to be typically non-exporting, they have no natural hedging capacity and market instruments such as currency derivatives are both limited and prohibitively costly for EMDE currencies. At the country level, the currency mismatch

on corporate balance sheets aggregates to create macro-economic fragility and exposes EMDEs to the ebb and flow of global economic conditions, a problem which is set to become more acute as sustainable debt markets continue their rapid growth.

Our results demonstrate the influence of prominent country level and global factors on the currency composition of sustainable debt. High currency volatility, which bears most directly on currency risk premiums, is the most significant factor depressing the supply of local currency debt financing in EMDEs. We also identify a 'flight-to-safety' phenomenon which is observed when international investors move towards hard currency debt financing in times of global economic uncertainty, as has been seen through the covid-19 pandemic and Russia-Ukraine war. As a relatively new asset class, sustainable debt is considered a climate hedge rather than a safe haven[46] and thus may be even more sensitive to investor perceptions and risk aversion than broader corporate debt markets. The effects of global uncertainty and currency risk are moreover interlinked - with high global uncertainty increasing the likelihood of currency volatility. The compounding effects of these two drivers warrants consideration given the uncertain and challenging macroeconomic context in which the global low-carbon transition is unfolding[37].

We further identify a 'ratings trap' whereby an upgrade in sovereign credit rating (reflecting the sovereign credit risk), acts to increase the share of foreign currency debt, likely through increased access to international markets. This suggests that despite improvements in a country's economic, political or governance contexts, EMDE borrowers have little choice in terms of debt products. A lack of market power in international markets means that international investors, rather than EMDE borrowers, determine the extent to which improved ratings translate to a lowering of interest rates or a shift in the currency denomination of EMDE sustainable debt. Evidence from this study suggests that decreased sovereign risk is, in itself, unable to adequately compensate for the existing currency risk, and a reconfiguring of risks might be crucial to reach a tipping point that leads to a shift in the currency denomination of sustainable debt towards local currencies. Moreover, higher levels of foreign currency borrowing can have negative downstream impacts on sovereign ratings in a negative feedback loop. High levels of foreign currency debt creates exposures and hidden costs that can weaken sovereign credit positions during periods of global uncertainty. Interestingly, while political risk is a subset of sovereign risk and is included as part of Moodys' sovereign ratings methodology, we do not find political risk to be a significant determinant of currency composition. This points to a greater influence of credit ratings on investor sentiment that goes beyond objective measures of

individual risks[47]. Further studies may need to investigate how different risks combine to shape perceptions of risks and the assignment of credit ratings.

Addressing the currency risk for EMDE sustainable debt is therefore essential to enable these markets to deliver the climate and development finance needed without causing economic instability and indebtedness in EMDEs. Solutions have been proposed to address currency risk and increase local currency financing in EMDEs, such as using publicly-funded FX guarantees or consolidating currency risk across diverse markets in a multilateral intermediary institution. These mechanisms can work alongside the development of domestic debt markets by inducing domestic and international finance through public-private investment structures where multilateral institutions assume a greater proportion of investment risks and provide technical assistance for market operations. Our results highlight the urgency of instituting these solutions given the growing currency mismatch and increasing debt servicing costs associated with hard currency debt in EMDEs. Adequate financing in reasonably priced local currency debt can lead to sustainability advances without creating financial vulnerability for companies or the economy. Equity demands that climate finance provide greater sustainable development outcomes without increasing the debt burden or diverting domestic resources away from priorities such as education and health infrastructure.

By identifying the relevant factors which exacerbate the currency mismatch, we also point to specific design and implementation elements that policy-makers should consider. First, the currency-risk mitigation mechanism must strengthen in times of global uncertainty to counteract the ‘flight-to-safety’ phenomenon and an associated increase in foreign currency borrowing in times of global stress. Interestingly, counter-cyclicality is a specific design element in the partial exchange guarantee mechanism suggested by Persaud[14], which argues that distortions to FX markets are greatest during periods of global macroeconomic volatility. Second, breaking the ‘ratings trap’ will require the deepening of local capital markets facilitated by currency risk-mitigation and public-private investment mechanisms[48], so that EMDE borrowers can access a domestic pool of sustainable finance and insulate themselves from global uncertainties and shifts in investment preferences of international investors. A better understanding of contextual and localized risk factors can also alter perceptions and lead to more accurate pricing of risk that corresponds to realized outcomes. Rather than being alternatives, these solutions can work collectively to create a financial architecture that provides sizable local currency flows of finance for sustainable development and low-carbon projects.

Methods

Data

The data was downloaded from Bloomberg League Tables for green, social, sustainable or sustainability-linked (GSSS) bonds and loans. Bonds and loans are labeled as GSSS using Bloomberg's own research-based methodology, reflective of the Green Bond/Loan Principles, Social Bond/Loan Principles, Sustainability Bond Guidelines and the Sustainability-linked Bond/Loan Principles. The data include information on the borrowing firm e.g., parent company, country of domicile and industry, as well as information on the type of instrument (bond or loan), theme (green, social, sustainable, or sustainability-linked), the issued amount, the currency of issue, and the country of issue. This data was augmented with the maturity (or tenor) of each bond/loan issued using Bloomberg search functions which retrieved information for 85% of the deals. For the remaining 15% of deals, missing tenor values were filled with the average tenor. The data was further augmented by labeling each bond/loan with an income level (as defined by the World Bank) according to the country of issue.

Growth of sustainable debt markets and currency risk

We use foreign exchange (FX) volatility as a proxy of currency risk. FX volatility was calculated as the standard deviation of first difference of logarithms of the monthly exchange rate[49] over both short-run (1-year) and long-run (5-year period). Monthly spot exchange rate data was sourced from the St. Louis Federal Reserve Bank's economic database. To explore the relationship between growth in sustainable debt markets and currency risk, we then looked at the relationship between average annual currency volatility and the share of annual issued debt volumes across 8 major EMDEs using a simple linear regression. To control for time effects and global factors influencing the growth of sustainable debt markets, we first calculated each country's percentage share, v_{ct}, of total annual issued volumes each year. We then demeaned this percentage share under the expectation that, all things being equal, a country's percentage share of total annual issued volumes is constant over time. The de-meaned percentage share of annual issued debt volume for each country, $\hat{v}_{ct}$, is then given by;

$$\hat{v}_{ct} = v_{ct} - \frac{1}{T}\sum_{t'} v_{ct'}$$

The estimated linear regression for each country is then given by;

$$\hat{v}_{ct} = \beta_{0c} + \beta_{1c} x_{tc} + \varepsilon_c,$$

where x_{tc} is the average annual currency volatility in country *c*. If high currency volatility impacted the growth of sustainable debt markets we would expect a negative coefficient between the de-meaned percentage share of each country's annual growth and the average currency volatility that year. No significant relationship ($p<0.01$) was observed either on aggregate or at country-level (Fig. S2).

FX-induced changes in debt valuation

We calculate the FX-induced changes in the value of a country's sustainable debt in the following way; first we sum the value of all foreign currency bonds and loans held in a given quarter where the value of each deal is calculated as the foreign currency value at the time of issuance. Then we sum the value of all bonds and loans held in a given quarter, where the value of each deal is calculated as the foreign currency value in that quarter. The difference in these two values is the FX-induced change in debt value, with a positive number reflecting an increased debt burden and a negative number reflecting a decreased debt burden.

Binary logistic regression with country fixed effects

To analyze the determinants of the currency composition of sustainable debt in six major EMDEs (India, South Africa, Brazil, Mexico, Thailand, Indonesia), we use a binary logistic regression model where the discrete outcome variable takes the value 1 if a sustainable bond or loan is issued in foreign currency and 0 if it is issued in local currency. We regress this variable against a number of country-level, deal-level and global variables and add country fixed effects to control for inter-country variations and omitted variable bias. Formally we estimate the following equation:

$$f(y_{ct} |\, x_{ct}, \beta, \alpha_c) = p_{ct}^{y_{ct}} (1 - p_{ct})^{1 - y_{ct}}$$

$$p_{ct} = Pr(y_{ct} = 1 | x_{ct}, \beta, \alpha_c) = \frac{1}{1 + e^{-\alpha_c - x_{ct}\beta}}$$

Where β is the (M X 1) coefficient vector of the M regressors x_{ct} and α_c are the fixed-effects which can be arbitrarily correlated with the regressors. We use a maximum likelihood estimation method using the limited-memory Broyden–Fletcher–Goldfarb–Shanno optimization algorithm.

Below we discuss the variables used in our baseline model and a number of alternative variables and model specifications tested to assess the robustness of our results (Tables S2-S5). Models were evaluated using accuracy scores, likelihood ratios (Table S3), and

McFadden's pseudo-R-squared[50]. Model accuracy is obtained by dividing the data into a training set (75% of data) and test set (25% of data) and calculating the percentage of correctly predicted outcomes. Log-likelihood ratios are used to evaluate the significance of key variables by comparing the goodness-of-fit of a model specification with and without these variables (Table S3). Model fit was further evaluated by examining binned residuals.

Data sources and variable definitions

Table 2 shows the number of local and foreign currency corporate bonds or loans issued between 2004 and 2024 in the top eight countries in our data. In the baseline model Malaysia and Turkey are excluded due to the unique characteristics of their sustainable debt markets, described in the main text. An alternative model specification including Malaysia and Turkey was tested and the results are qualitatively unchanged (Table S2). Model variables are summarized in Table 3 and described in detail below. Descriptive statistics for the variables reported in the baseline model and alternative variables are given in Table S1.

	LCY	FCY	Period
Malaysia	428	15	2011-2024
Thailand	146	33	2010-2024
Mexico	136	93	2009-2024
India	330	141	2004-2024
Brazil	288	69	2008-2024
South Africa	148	37	2008-2024
Turkey	16	233	2008-2024
Indonesia	43	82	2009-2024

Table 2. Sample statistics. Number of foreign and local currency sustainable debt issues and period of issuance in the top 8 countries in the dataset. Note: Malaysia and Turkey are not included in the baseline model.

Variable	**Name**	**Proxy Definition**
Currency risk	FX_RISK/ FX_RISK_LONG	Standard deviation of the first difference of logarithms of the monthly spot exchange rate a short-run (1-year) period (FX_RISK). An alternative long-

Variable	Name	Proxy Definition
		run (5-year) measure is also tested (FX_RISK_LONG). Source: St. Louis Federal Reserve Bank's economic database
Political risk	POL_RISK	Measure of political stability and the absence of violence/terrorism, reported annually. Higher score indicates lower risk. Source: World Bank.
Sovereign credit risk	SOV_RISK	Moody's foreign sovereign credit rating provided annually. Source: Moody's.
Global uncertainty	VIX/WUI	VIX is the 30-day expected volatility of the S&P 500 index. Source: Cboe. The World Uncertainty Index (WUI) is tested as an alternative. This is constructed by text-mining country reports from the Economist Intelligence Unit. Source: World Uncertainty Index.
Controls		
Hedging	DOMESTIC	Dummy variable equal to 1 if the country of issue is the same as the country in which the firm is domiciled and zero otherwise. Source: Bloomberg.
Instrument type	BOND	Dummy variable equal to 1/0 for a bond/loan. Source: Bloomberg.
Regulation/Access	AMOUNT	Principal issued amount. Larger deal sizes are required for access to international markets. Source: Bloomberg.
Interest rate costs	TENOR	Time to maturity of bond/loan. Source: Bloomberg.
Economic outlook	GDP_GROWTH	Yearly growth rate of gross domestic product (%). Source: World Bank.

Table 3. Dependent variables and empirical proxies. Name, definition, and source of model variables used in baseline regression and alternative specifications.

Currency risk

As stated above we use a backward-looking measure of FX volatility as a proxy for currency risk (see Methods: FX-induced changes in debt valuation). In our baseline model we use the short-range (1-year) FX volatility. For robustness we also test long-range (5-year) volatility and the results are qualitatively unchanged (Table S3).

Sovereign credit risk

As a proxy for sovereign credit risk, we use Moody's sovereign credit ratings. Moody's is one of the three leading CRA's and its ratings act as a key benchmark and signal to international investors in EMDEs. Moody's credit ratings methodology includes several quantitative and qualitative factors. Quantitative factors capture four dimensions of sovereign credit risk; economic strength, institutions and governance strength, fiscal strength, and susceptibility to event risk, using a variety of proxies. These factors are then weighted and may be adjusted, and

other factors considered, based on subjective assessments of individual country circumstances. Moody's assigns credit ratings to both local and foreign sovereign credit. The Pearson's correlation coefficient between all countries foreign and local sovereign credit scores is > 0.9 except for India (r = 0.58). In our baseline model SOV_RISK is the foreign credit score. Moody's alphabetic ratings, from B3 to Aaa were converted to numeric values on a linear scale for modeling purposes[51].

Political risk

As a proxy for political risk we use the political risk metric from the World Bank Governance Indicator database - Political Stability and Absence of Violence/Terrorism, a higher POL_RISK score is therefore reflective of greater political stability. The World Bank database provides data from 2004-2022. Values for Q1-2023 - Q2-2024 were carried forward from the last available date. Political risk and sovereign credit risk are closely interlinked as political risks capture political and governance factors that can affect the ability of willingness of a sovereign to meet its debt obligations. Indeed, the political risk proxy is a sub-indicator of Moody's sovereign credit ratings methodology and carries the highest weighting of all sub-indicators. For example, a lack of government effectiveness and loss of political stability can slow recoveries from sovereign rating crises as sovereigns are less able to implement strong economic policies. We therefore test this proxy as both a separate variable (in the baseline model) and an alternative variable to sovereign risk (Table 1).

Global Uncertainty

As a proxy for global economic uncertainty we use the VIX index, a measure of 30-day expected volatility of weighted prices of the S&P 500 index, the core index for US equities. The VIX index, provided by the Chicago Board Options Exchange (Cboe) is globally recognised by investors and market participants as a barometer of market uncertainty. As an alternative proxy we also test the World Uncertainty Index[52], which is computed by counting the percent of the word 'uncertain' (or its variants) in country reports from the Economist Intelligence Unit. The WUI is then rescaled by multiplying by 1,000,000. Results using WUI as an alternative to VIX are reported in Table S4.

Hedging

A firm's 'natural' hedging capacity, which affects their preference for domestic or foreign currency, is determined by the currencies of their countries where their assets/subsidiaries are

located[36]. Lacking granular information on the location of firms' assets, we construct a dummy variable as a proxy for a firms' natural hedging capacity that is equal to 1 if the firm is domiciled in the country where the debt was issued and 0 if the firm is domiciled abroad.

Instrument type

The currency composition of debt on corporate balance sheets is determined by the currency of both bonds and bank loans which are both influenced by a shared set of factors. To capture any differences in the influence such factors have on the currency denomination of a bond versus loan, we include a control dummy variable in our model equal to one if the debt issued is a bond and 0 if it is a bank loan.

Amount

The decision to issue in foreign currency will also depend on the size of the bond of loan since issuing in a foreign currency involves fixed transaction costs e.g., as legal costs, road-showing the issue to international markets[36]. In addition, international investors may prefer larger bond issues as they are more liquid and can be included in international indices[11]. We therefore include the principal amount as a control variable in the model. The distribution of principal amounts is heavy-tailed with few, high-value issues. Inspection of binned residual plots of principal against predicted probability of issuing in a foreign currency shows some degree of curvature, we therefore log-transform the principal values in constructing this variable.

Tenor

Debt with a longer tenor may be more expensive to issue in foreign currency, as counterparty risk rises along the duration spectrum. In addition, the tenor of a bond is closely associated with the average duration of the underlying government bond market, with bonds of a longer duration depending on a liquid benchmark i.e., government bonds. At the microeconomic level, this implies that demand for a bond with a longer duration will depend on the government bond curve displaying a long duration[35]. We therefore add the tenor of each bond or loan as a variable in our model to control for this effect. Because the government bond curve is idiosyncratic across markets, we also run an additional model for robustness adding a tenor fixed effect by separating the debt issues into maturity tranches; 0-5 years, 5-10 years and greater than 10 years. The tenor fixed effect thus allows for non-monotonicity in the response of the outcome variable along the tenor spectrum. The results are qualitatively unchanged (Table S5).

Economic strength

We further add GDP growth to our model as a proxy for countries economic strength. High GDP growth may be associated with a greater share of local currency denominated debt as domestic banking systems become stronger and deeper[26]. Annual GDP growth data was obtained from the World Bank database.

Other variables

We further investigated the role of interest rate differentials in determining the choice of currency in light of evidence that firms borrow in foreign currency to take advantage of lower interest rates and therefore lower cost of capital[28, 35]. Our model is a binary logit that estimates the probability of issuing in a foreign or local currency, as opposed to a multinomial logit in which there is a choice of foreign currencies. This additional level of complexity would be unjustified since 83% of foreign currency bonds/loans are issued in dollars and only 13% in euros (other foreign currencies each represent <1% of all issues). We therefore conducted a preliminary test of the effect of interest rates by including the difference in interest rates between local currency and US dollars (source: St Louis Federal Reserve Bank) and found that this variable was not significant under any model specification. This supports an understanding that EMDE borrowers do not have free choice of currency denomination in which interest rates may play a decisive role, but are rather constrained by investor demand. The effect of interest rate differentials were therefore not included in our main results.

We also explored several proxies capturing financial market development and depth; the financial development index (source: IMF), corporate bond issuance volume as a percentage of GDP (source: World Bank) and domestic credit to the private sector as a percentage of GDP (source: World Bank). Inter-country variation between these proxies was found to be much larger than intra-country variation meaning estimated coefficients would be imprecise and difficult to interpret in our fixed-effects model. Such factors are therefore not explicitly included but rather are incorporated into country fixed effects.

Data availability

The data used in this study are available under restricted access as they remain the commercial property of Bloomberg. Licences to use these data can be obtained from Bloomberg who require

compensation to cover the cost of producing and maintaining them. The data is then available for the term of the license.

Code availability

Model and figure code is available at https://github.com/LINKS-ERC/.

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Author Contributions Statement

Jamie Rickman: Conceptualization, Methodology, Analysis, Writing - Original Draft. Sumit Kothari: Writing - Original Draft. Nadia Ameli: Conceptualization, Writing - Review & Editing, Supervision.

Competing Interests Statements

The authors declare no competing interests.

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