BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 1004

Original sin redux: a model-based evaluation

by Boris Hofmann, Nikhil Patel and Steve Pak Yeung Wu

Monetary and Economic Department

February 2022

JEL classification: E3, E5, F3, F4, F6, G1.

Keywords: emerging market, capital flows, exchange rate, currency mismatch

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Original sin redux: a model-based evaluation[*]

Boris Hofmann[†]
Nikhil Patel[‡]
Steve Pak Yeung Wu[§]

February 21, 2022

Abstract

Many emerging markets (EMs) have graduated from "original sin" and are able to borrow from abroad in their local currency. Using a two-country model, this paper shows that the shift from foreign currency to local currency external borrowing does not eliminate the vulnerability of EMs to foreign financial shocks but instead results in "original sin redux" (Carstens and Shin (2019)). Even under local currency borrowing from foreign lenders, a monetary tightening abroad is propagated to EM financial conditions through a tightening of foreign lenders' financial constraints. Moreover, local currency borrowing does not eliminate currency mismatches, but shifts them from the balance sheets of EM borrowers to the balance sheets of financially constrained global lenders, so that amplifying financial effects of exchange rate fluctuations remain. We provide empirical evidence in line with this prediction of the model using data on currency composition of external debt of emerging and advanced economies. Our model-based analysis further suggests that foreign exchange intervention and capital flow management measures can mitigate the adverse effects of capital flow swings in the short run and that a larger domestic investor base can reduce the vulnerability to such swings in the longer run.

JEL codes: E3, E5, F3, F4, F6, G1
Keywords: emerging market, capital flows, exchange rate, currency mismatch

[*]We are grateful to Ozge Akinci, Laura Alfaro, Ryan Banerjee, Julien Bengui, Paolo Cavallino, Michael Devereux, Charles Engel, Chris Erceg, Christian Friedrich, Hans Genberg, Gita Gopinath, Daniel Kaufmann, Jesper Linde, Giovanni Lombardo, Enrique Mendoza, Mehmet Ozsoy, Hyun Song Shin, Goetz von Peter, Linda Tesar, James Yetman and seminar participants at the Asia School of Business, Bank of Korea, Bank of Lithuania, ECB, ESCP Business School, European Economic Association Annual Meeting 2021, IMF, Indian School of Business, Ozyegin University, Society of Economic Dynamics Annual Meeting 2021, University of British Columbia and the University of Neuchatel for helpful comments and feedback, and Marjorie Santos and Bat-el Berger for assistance with the data. The views expressed here are those of the authors and do not necessarily correspond to those of the BIS or the IMF.

[†]Bank for International Settlements. E-mail: boris.hofmann@bis.org.

[‡]International Monetary Fund. E-mail: npatel@imf.org.

[§]University of California, San Diego. E-mail:stevepywu@gmail.com

1 Introduction

Emerging markets (EMs) have traditionally been unable to borrow abroad in their domestic currency, a phenomenon referred to as "original sin" (Eichengreen and Hausmann (1999), Eichengreen et al. (2002) and Eichengreen et al. (2005)). Since EM borrower assets are typically denominated in local currency, foreign currency debt often induces currency mismatches on their balance sheets which make them vulnerable to exchange rate depreciation. Such currency mismatches have played a key role in many of the EM twin exchange rate and financial crises of the 1990s, such as the 1997 Asian financial crisis, when sudden and sharp exchange rate depreciation fueled financial and economic meltdowns.

In the wake of these crises, many EMs have developed and deepened their local currency sovereign bond markets and attracted foreign investors by bringing down inflation and strengthening creditor rights. As a consequence, they can now routinely borrow from abroad in their own currency. However, overcoming original sin has not led to "redemption". EMs have remained vulnerable to capital flow and exchange rate swings because foreign investors often play an important role in their local currency bond markets (BIS (2019), Hofmann et al. (2020a)). This vulnerability was also exposed during the Covid-19 induced selloff in EM local currency bond markets in March 2020, when record bond fund outflows and sharp exchange rate depreciation went hand in hand with steep increases in local currency bond yields (Hofmann et al. (2020b), Hördahl and Shim (2020)).

Carstens and Shin (2019) refer to this persistent vulnerability of EMs to external shocks as "original sin redux". They point out that EM local currency borrowing from foreign lenders has not eliminated currency mismatches, but has shifted them from domestic borrowers' to foreign lenders' balance sheets. Carstens and Shin (2019) further argue that the causes of EMs' vulnerability go beyond original sin, as they are rooted in the shallowness of their financial markets and the lack of a sizable domestic investor base. This makes EMs dependent on external borrowing (irrespective of the currency of denomination) in the first place, and makes it difficult for international lenders to hedge currency risks, which in turn increases their risk aversion towards EMs in times of market stress.

This paper provides a model-based evaluation of the original sin redux hypothesis. To this end, we set up, following Banerjee et al. (2016), a two-country New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model featuring an EM (the home economy) and an advanced economy (AE, the foreign economy). This is an important deviation from the bulk of the literature which has typically studied the implications of capital flows in a small open economy setting.[1] We show that a full dynamic general equilibrium characterization of the

[1] See for instance Adrian et al. (2020), Basu et al. (2020), Engel and Park (2018) and Ottonello and Perez

balance sheet constraints of AE lenders, which is based on Gertler and Karadi (2011), and their implications for EM borrowers is critical to analyze the original sin redux hypothesis.

In the baseline model, EM firms borrow from domestic financial intermediaries to finance investment. EM intermediaries in turn obtain their funding from AE financial intermediaries and from domestic households. Both EM and AE financial intermediaries face a funding constraint that is governed by their net worth.[2]

The presence of financial frictions on both borrower (EM) and lender (AE) balance sheets allows us to study in a meaningful way the impact of foreign and domestic shocks on EMs under foreign currency borrowing (original sin, OS) and under local currency borrowing (original sin redux, OSR). Intermediary balance sheet constraints and financial feedback effects of the exchange rate play an important role under both scenarios. Specifically, when the EM currency depreciates in the wake of a foreign financial tightening, the value of loans, which are in local currency, declines relative to the value of liabilities, which are in foreign currency. This leads to a drop in net worth for the EM bank in the case of OS, and for the AE bank in the case of OSR. In either case, there is a tightening in lending conditions that affects the real economy in the EM. The effect is muted in the case of OSR because financial constraints of EM banks are tighter than those of AE lenders. At the same time, AE lenders' balance sheet constraints are a key channel of transmission of AE financial shocks to EMs independent from any exchange rate amplification effects. The tightening of balance sheet constraints of AE lenders through a tightening of AE financial conditions directly leads to a cut back in credit supply to EMs even if currency mismatches are completely absent (e.g. because of hedging).

Based on this analytical framework, we obtain the following main findings. First, in the absence of financial constraints of AE lenders, local currency borrowing eliminates much of the vulnerability to external shocks in the EM. In this sense, local currency borrowing does lead to a "redemption" of OS, as would be concluded from small open economy models that do not take account of financial constraints of global lenders. The trade channel dominates in this case, so that exchange rate depreciation in the wake of a foreign monetary tightening triggers output expansion in EMs. On the other hand, under the OS scenario, the financial channel of the exchange rate operating via borrower balance sheets dominates and output falls.

(2019).

[2]We focus on the currency mismatch problem in the financial sector, which is the focus in many recent studies, such as Bruno and Shin (2015). In the model, production firms and banks can be viewed as one single entity, so the model features currency mismatch in the private sector in a broad sense. As currency denomination is the key for our analysis, we abstract from sovereign debt in our baseline model to avoid any monetary commitment issue (inflating away local currency debt). That said, section 6 provides a simple extension of the model with sovereign debt.

Second, when financial frictions are present in both AE and EM financial sectors, an AE monetary tightening triggers a tightening of EM financial conditions and a fall in EM output even under the OSR scenario. This is because the shock which originates in the AE leads to a decline in the net worth of AE lenders, limiting their ability to lend to EMs. EM currency depreciation triggers further deterioration in AE financial intermediary balance sheet conditions and limits their lending capacity even more. Local currency borrowing does therefore not eliminate EMs' vulnerability to foreign financial shocks. The effects are however smaller compared to the OS scenario, implying that OSR still yields a reduction in EM vulnerability. The adverse effects of a foreign financial tightening on the EM are further reduced but still not eliminated under a hedging scenario when financial exchange rate amplification effects on borrower or lender balance sheets are switched off.

Third, defensive policies such as foreign exchange (FX) intervention and capital flow management measures can mitigate the adverse consequences of foreign financial shocks for EMs under both OS and OSR. In particular, we show that sterilized FX intervention can help mitigate the negative impact of external financial shocks via a "debt limit" channel.[3] Specifically, a sterilized intervention that sells FX reserves and transfers the proceeds to domestic financial institutions relaxes their leverage constraint and increases the available funds for lending, thereby mitigating the impact of the shock. On the other hand, FX intervention targeted at agents that are not financially constrained (such as households in our model) does not provide any benefits. As such, our results imply that it is not FX intervention per se, but rather liquidity-providing central bank balance sheet policy more generally that matters.

Fourth, in the longer run, financial development and deepening is key to reduce EMs' vulnerability to capital flow fluctuations. We find that a larger domestic investor base reduces the impact of external shocks on EM financial and economic conditions under both OS and OSR. This happens because greater availability of domestic funding sources reduces the dependence on borrowing from abroad.

Finally, the currency domination of foreign borrowing also affects the strength of domestic monetary transmission in EMs. Specifically, under OSR a change in the domestic stance of monetary policy has a greater financial and economic impact. This happens because expected future exchange rate changes after the initial exchange rate adjustment induce foreign lenders to change lending conditions in a way that reinforces the effects of domestic monetary policy. Domestic monetary transmission is further strengthened if the domestic investor base is larger

[3] This is consistent with recent survey evidence on the motives of EM central banks' FX intervention which suggests that interventions are increasingly used to counter the financial, as opposed to the trade channel of exchange rates (Cavallino and Patel (2019)).

because a larger share of funding sources is then influenced by changes in domestic rather than foreign monetary policy.

Overall, the results highlight that while EMs can partially reduce their vulnerability to external financial shocks by overcoming OS and borrowing in their domestic currency, they cannot fully eliminate it if AE lenders are financially constrained. Activation of additional policy tools, such as FX intervention and capital flow measures, can help address the persisting challenges faced by EMs from fluctuations in global financial conditions. These results are consistent with the observation that EMs have remained vulnerable to capital flow swings also after overcoming OS and that they responded to this challenge through a pragmatic design of their macro-financial stability frameworks, commonly combining inflation targeting with FX intervention and macroprudential tools (BIS (2019)). In the longer run, reducing vulnerability to external shocks requires addressing its root cause, which is the shallowness of EM financial markets reflected in particular in a thin domestic investor base (Carstens and Shin (2019)).

The remainder of the paper is structured as follows. This section ends with a brief overview of the related literature. Section 2 presents stylized facts that motivate this paper, and conducts an empirical exercise to uncover the role of currency of denomination of external debt in determining the vulnerability of EMs to foreign shocks. Section 3 presents the model. Section 4 discusses the main results of the comparison of OS and OSR. Section 5 analyzes policy implications of OSR, focusing on FX intervention and capital flow measures for short-run stabilization, the role of the domestic investor base for reducing vulnerability in the longer run as well as on the implications of OSR for domestic monetary transmission. Section 6 presents an extension of the model that introduces sovereign debt. Section 7 concludes.

Literature Review

This paper relates to the large literature on original sin, pioneered by Eichengreen et al. (2002) and Eichengreen et al. (2005). This literature has emphasized the inability of EMs to issue external debt in domestic currency, giving rise to balance sheet vulnerabilities from currency mismatches. As a result, in EMs, exchange rates may not play the stabilizing role through the standard trade channel that is at the core of the traditional Mundell-Fleming framework. This has provided a rationale for the widespread adoption of managed exchange rate regimes in EMs, a phenomena that Calvo and Reinhart (2002) term "fear of floating", and has motivated the first generation of models exploring the implications of debt dollarization for spillovers and monetary policy in EMs (e.g. Aghion et al. (2001), Céspedes et al. (2004)

and Cook (2004)).

The subsequent literature has focused on the implications of currency mismatches in the presence of financial amplifications mechanisms based on small open economy models with financial frictions in the spirit of Bernanke et al. (1999) and Gertler et al. (2010). Prominent examples of this strand of the literature include Akinci and Queralto (2018), Aoki et al. (2016), Gourinchas (2018) and Mendoza and Rojas (2019). Akinci and Queralto (2018) consider a two-country model with dollar invoicing and dollar debt and show that these features imply large spillovers from US monetary policy to EMs. Aoki et al. (2016) consider a model with both domestic and external (foreign currency) debt, and show that foreign shocks, in particular interest rate shocks, can lead to large spillovers, with financial channels dominating the trade channel. Similar to our paper, they show that additional policy tools (macroprudential policies in their case) can be a valuable addition to the toolkit of policymakers. Recent papers developed under the IMF's integrated policy framework (IPF) initiative highlight the relevance of additional policy tools in the face of capital flow swings more generally (Basu et al. (2020), Adrian et al. (2020)). These papers also take a small open economy perspective, focussing on financial frictions on the EM borrowers' (and not lenders') balance sheets.

Inspired by the global financial cycle hypothesis of Rey (2013), several recent papers have shifted the focus of analysis from borrowers' to lenders' balance sheet frictions. Prominent examples include Morelli et al. (2021), Bruno and Shin (2014), and Banerjee et al. (2016). Among these, our framework is closest to Banerjee et al. (2016), Devereux et al. (2020) and Chen et al. (2021), which in turn build on the framework of banking frictions of Gertler and Karadi (2011). Banerjee et al. (2016) show that international monetary policy coordination does not yield welfare improvements compared to optimal self-oriented monetary policies. Devereux et al. (2020) assess how optimal practical rules for monetary policy trading off domestic inflation volatility with foreign factors and financial imbalances can be characterized in financially integrated economies. Chen et al. (2021) explore, focusing on Asian EMs, the role of the banking sector in transmitting global financial spillovers and evaluate the effectiveness of FX intervention and other macroeconomic policies in responding to external financing shocks. Our focus is different, namely on the effect of switching from foreign to local currency denominated external borrowing and the associated policy implications.

On the empirical front, there is a growing literature on the financial channel of capital flows and the exchange rate. For instance, Kearns and Patel (2016) show that the financial channel of exchange rates is particularly strong in EMs, and more or less offsets the trade channel. Banerjee et al. (2020) document that exchange rates affect corporate investment primarily via a financial, as opposed to a trade channel. Bruno and Shin (2019) show that even for exporting firms the financial channel of the exchange rate often tends to dominate the trade channel through its impact on trade credit conditions. Hofmann et al. (2020a) analyze the impact of exchange rate shocks on EM local currency bond spreads and find that currency appreciation shocks lead to a compression of bond spreads. Bertaut et al. (2020) use a detailed database of US investor flows to emerging markets to show that local currency flows are even more volatile than hard currency flows, driven in large part by mutual fund flows which tend to be more cyclical and carry heavier investments in local currency bonds on average. We provide, based on a DSGE model, conceptual support for this empirical evidence, highlighting the critical role of balance sheet constraints on the lenders' side.

Lastly, our paper also links to the literature evaluating the effectiveness of FX intervention in the presence of financial frictions (see for instance Cavallino (2019), Chang (2018), Cavallino and Sandri (2020) and Hofmann et al. (2019)). We contribute to this literature, by analyzing how FX intervention can address global financial spillovers also when EMs borrow from abroad in their local currency.

2 Motivating stylized facts and evidence

2.1 External borrowing and financial structure of EMs

Many EMs have made significant progress towards overcoming original sin over the last two decades and are increasingly borrowing from abroad in their local currency. Figure 1 shows for a balanced sample of 14 EMs the share of total external debt liabilities thatis denominated in local currency. The chart suggests that the median share has more than doubled since 2000, from under 0.1 to above 0.2 in 2017. The figure also suggests that, according to this measure of OS, EMs have become very similar to AEs where the median share stood at about 0.25 in recent years.[4]

However, despite high and rising shares of external debt denominated in local currency,

[4]The share might however be biased downward due to incomplete coverage of corporate sector external borrowing in local currency in EMs. Du and Schreger (2021) document that local currency borrowing in EMs takes place largely through the government sector where the local currency share in external debt amounts to more than 60%, while corporates still rely almost exclusively on FX debt with a local currency external borrowing share of only about 10%. However, local currency borrowing from abroad by corporates might be underestimated because indirect borrowing from abroad through domestic banks is not accounted for. As documented by Avdjiev et al. (2020), corporates can borrow from abroad in three ways: (i) direct bond issuance in international markets, (ii) direct cross-border borrowing from foreign banks, and (iii) indirect borrowing from abroad through domestic banks. The local currency share in the latter component appears to be considerably larger than that in the first two components on which the literature has focused. Specifically, for a group of 10 major EMs for which data are available from the BIS locational banking statistics, the local currency share in corporate external debt more than doubles on average over the period 2018-2020 when indirect borrowing is taken into account.

EMs remain more vulnerable to capital flow swings than AEs, as seen e.g. during the taper tantrum and in the Covid pandemic. This raises the question why EMs remain more vulnerable, given that the role of currency mismatches has declined over time as documented above.

BIS (2019) suggests that the answer to this question lies in the shallowness of financial markets in EMs compared to their advanced economy counterparts. Figure 2 illustrates this point along two dimensions: FX hedging markets and size of domestic institutional investors. Figure 2a shows that the size of the FX derivatives market for EM currencies is significantly smaller compared to AE currencies. This means that hedging exchange rate risk in EM currencies is much more limited in scope and more costly, even for global lenders and investors. Figure 2b shows that the size of domestic institutional investors, i.e. the size of the assets of pension funds and insurance companies in relation to GDP, is also much smaller in EMs than in AEs. As a consequence, EMs are more vulnerable to a pull-back and tightening in funding supply from abroad as they do not have a strong domestic investor base to fall back on when foreign capital flows out.

2.2 Spillovers of foreign financial conditions to EMs

To understand the role played by the currency denomination of external debt in determining the sensitivity of EMs to external financial shocks, we conduct a panel analysis using cross-country data on investment and external borrowing by currency for 16 EMs and 8 AEs. We study how the response of investment to a US monetary tightening shock depends on the currency denomination of external debt and how the effect differs between EMs and AEs. To this end, we estimate a dynamic panel regression model specified as as follows:

$$\begin{aligned} y_{i,t+4} - y_{i,t-1} = {} & \alpha_y \triangle y_{i,t-1} + \alpha_{os} os_{it-1} + \alpha_{osr} osr_{i,t-1} + \beta_r \triangle r^{us}_{t-1} \\ & + \beta_{os} * \triangle r^{us}_{t-1} * os_{it-1} + \beta_{osr} \triangle r^{us}_{t-1} * osr_{it-1} + \beta_X X_{i,t-1} + \alpha_t + \alpha_i + \epsilon_{i,t} \end{aligned} \tag{2.1}$$

The model is estimated at quarterly frequency. y denotes the log of investment, measured as real gross fixed capital formation. The dependent variable is therefore the four quarter change in real investment. os and osr are measures of OS and OSR respectively. We use data on currency composition of external debt liabilities from Benetrix et al. (2019) and measure os as the ratio of external debt liabilities denominated in USD to GDP, while osr is measured as the ratio of non-USD denominated external debt liabilities to GDP, the bulk of which are in local currency.[5] Given the relatively high unconditional correlation between

[5]We generate quarterly values from annual ones available in the original database through linear interpola-

os and osr of around 0.7, we conduct a first stage regression of osr on os, and include the residuals from this first stage when estimating equation 2.1. $\triangle r_{t-1}$ is a measure of the shock to the US policy rate computed using the narrative approach of Romer and Romer (2004) (updated to 2013 based on the latest available data).[6] $X_{i,t-1}$ are additional country level controls including lagged inflation and the policy rate (as well as US inflation and growth in specifications where time fixed effects are not used).

Table 1 presents the estimates. The estimates reported in Column 1.1 and 1.2 correspond to a simple OLS regression (with standard errors clustered by country), for EMs and AEs respectively. The subsequent two columns present estimates for EMs from models with richer specifications, including country fixed effects (Column 2) and country and time fixed effects (Column 3).

The estimates in Table 1 reveal three key results. First, higher degrees of OS tend to lead to sharper declines in investment in EMs in response to a US monetary contraction ($\beta_{os} < 0$). This is the canonical OS effect that has been studied in the literature. Second, even after controlling for OS, higher local currency borrowing from abroad (relative to domestically sourced) also leads to a sharper decline in investment in response to the shock ($\beta_{osr} < 0$). This is to our knowledge the first macro-level evidence in favor of the OSR hypothesis. Third, we find that for EMs, the impact of OS is consistently higher than that of OSR, i.e $|\beta_{os}| > |\beta_{osr}|$.[7] This indicates that while local currency borrowing does not prove to be a redemption from OS, it does yield an improvement. Fourth, we do not see a significant effect of either original sin or its redux for AEs (Column 1.2). This suggests that, despite borrowing substantially from abroad in both local and foreign currency, AEs are not as vulnerable to external shocks as EMs. The next sections are devoted to developing and analyzing a simple two-country model that can help rationalize these results and derive policy implications.

3 Model

The model is based on the asymmetric two-country model developed by Banerjee et al. (2016), which in turn is an open economy extension of Gertler and Karadi (2011). Figure 3 provides a diagrammatic representation of the model. The two countries are the EM,

tion.

[6]The narrative approach uses the the Federal Reserve's Greenbook forecasts which are only available with a significant lag, and hence the sample cannot include recent years. That said, we still believe that his offers the best monetary policy shock series in our setting. Alternatives including high frequency approaches such as Gertler and Karadi (2015) are less suited due to the low frequency of the macro data (quarterly) and debt data (annual) that we use.

[7]The difference between β_{os} and β_{osr} is also statistically significant for two out of the three specifications for EMs.

comprising a mass $0 < n < 0.5$ of the world economy, and the AE, comprising the remaining mass of $(1-n)$. Both economies feature households, capital producers, production firms, banks (financial intermediaries)[8] and a monetary authority. The EM borrows from the advanced economy in foreign or local currency. The model does not include a government sector for ease of exposition and does therefore not feature external borrowing through the government sector. However, we show that a more complex model where the government is borrowing from abroad and government financing conditions affect the private sector yields qualitatively equivalent results.

The remainder of this section focuses on describing the modeling of the sectors in each economy in detail and on discussing our calibration strategy to quantify the model. The extension of the baseline model including a government sector is presented in Section 6.

3.1 The emerging market

3.1.1 Household

EM households take consumption and labor supply decisions and trade foreign and domestic financial assets with the objective of maximizing the following utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^e)^{1-\sigma}}{1-\sigma} - \frac{(H_t^e)^{1+\psi}}{1+\psi} \right] \tag{3.1}$$

where C_t^e is a consumption basket and H_t^e is labor supply.

Denote $C_{e,t}^e$ and $C_{c,t}^e$ to be the EM households' consumption of EM goods and AE goods. The consumption basket takes the following form:

$$C_t^e = [(\nu^e)^{\frac{1}{\eta}} (C_{e,t}^e)^{\frac{\eta-1}{\eta}} + (1-\nu^e)^{\frac{1}{\eta}} (C_{c,t}^e)^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{3.2}$$

where η is the cross-country elasticity of substitution between EM and AE goods.

The EM price index is given by:

$$P_t^e = [\nu^e (P_{e,t}^e)^{1-\eta} + (1-\nu^e)(P_{c,t}^e)^{1-\eta}]^{\frac{1}{1-\eta}} \tag{3.3}$$

The EM household budget constraint in nominal local currency terms is:

[8] We use the word "banks" to represent the financial sector in general, which broadly includes bank finance and non-bank finance such as investment funds, institutional investors and retail asset managers.

$$P_t^e C_t^e + S_t P_t^c B_t^e + \gamma_B (B_t^e - B_{SS}^e)^2 + P_t^e D_t^e \tag{3.4}$$
$$= P_t^e W_t^e H_t^e + \Pi_t^e + R_{t-1}^c S_t P_{t-1}^c B_{t-1}^e + R_{t-1}^e P_{t-1}^e D_{t-1}^e + T_t^e$$

where S_t is the exchange rate, which is the price of the AE currency in terms of the EM currency so that an EM currency depreciation is an increase in S_t. B_t^e is the EM households' holding of the AE risk-free bond, which is denominated in AE currency and pays a nominal return of R_t^c. D_t^e is the domestic deposit in the EM banking system. W_t^e is the real wage rate. Π_t^e is the total nominal profit from EM firms and banks. T_t^e is a lump sum transfer from the government (monetary authority). B_{SS}^e is the steady state EM households' holding of the AE risk-free bond and γ_B is a parameter that introduces a small convex transaction cost in international portfolio adjustment for stationarity as in Schmitt-Grohé and Uribe (2003).

The Euler equation resulting from the household's first order conditions for domestic deposits and foreign bonds in the vicinity of the steady state yields the familiar uncovered interest parity (UIP) condition which determines the evolution of the nominal exchange rate S_t:

$$E_t \left(\frac{S_{t+1}}{S_t} \right) = \frac{R_t^e}{R_t^c} \tag{3.5}$$

The exchange rate is defined in terms of units of EM currency per unit of AE currency, so that an increase represents a devaluation of the EM currency.

3.1.2 Capital goods producers

Capital producing firms in the EM buy back old capital from banks at price Q_t^e (in units of the consumption aggregator) and produce new capital from the final good in the EM economy subject to the following adjustment cost function:

$$\Gamma(I_t^e, I_{t-1}^e) = \varsigma \left(\frac{I_t^e}{I_{t-1}^e} - 1 \right)^2 I_t^e \tag{3.6}$$

where I_t^e is the EM investment in terms of the aggregate EM good.

The EM banks then rent the capital to production firms. Denote K_t^e as the capital stock of the EM with the law of motion given by:

$$K_t^e = I_t^e + (1-\delta) K_{t-1}^e \tag{3.7}$$

3.1.3 Banks

The modeling of the banking sector follows Gertler and Karadi (2011). There is a mass n of competitive banks. Each period, a fraction $1-\theta$ of the banks exit and repatriate all their profits to households. The remaining fraction θ continues to operate and accumulate net worth. To replace the exiting banks, the non-bank households are randomly assigned to be new banks, with a start up capital of δ_T of existing banking capital injected by households, to keep the banking mass constant.[9] Banks are subject to an incentive constraint described below. The net worth of bank i is denoted by $N^e_{i,t}$.

The banks raise their funds (liabilities) from two sources - loans from global banks and deposits in local currency from domestic household (D^e_t). We denote the loans in the contract currency in real terms (CPI of EM) as $V^e_{i,t}$. Bank i's balance sheet in local currency real terms is then given by:

$$N^e_{i,t} + (RER_t)^{ld} V^e_{i,t} + D^e_t = Q^e_t K^e_{i,t} + TB^e_t \tag{3.8}$$

where $RER_t \equiv \frac{S_t P^c_t}{P^e_t}$ is the real exchange rate and ld (for liability dollarization) is an indicator which is equal to one if the loan is in foreign (AE) currency and zero if it is in local (EM) currency. The term TB^e_t represents a lump sum transfer from the government or the monetary authority.

Each period, the banker i's real net worth is the return generated from last period investment, minus the debt repayment to AE banks and domestic depositors.

$$N^e_{i,t} = R^e_{k,t} Q^e_{t-1} K^e_{i,t-1} - (RER_t)^{ld} \frac{R_{b,t-1}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}} V^e_{i,t-1} - \frac{R^e_{t-1}}{\pi^e_t} D^e_{t-1} \tag{3.9}$$

where $R^e_{k,t}$ is the real capital rate of return, $R_{b,t-1}$ is the nominal interest rate charged by the AE banks, $\pi^c_t \equiv \frac{P^c_t}{P^c_{t-1}}$ and $\pi^e_t \equiv \frac{P^e_t}{P^e_{t-1}}$ are the AE and EM inflation rates.

Incentive constraint

We model the financial friction following Gertler and Karadi (2011) as an incentive problem. Specifically, at the beginning of each period, the banker has the ability to abscond with a fraction κ^e of the assets. Therefore, lenders will not be willing to lend to the EM banks unless the following incentive compatibility constraint is satisfied.

$$J^e_{i,t} \geq \kappa^e Q^e_t K^e_{i,t} \tag{3.10}$$

where $J^e_{i,t}$ is the value function of bank i at time t.

[9] As in Gertler and Karadi (2011), this assumption of a turnover in the banking sector is needed to ensure that banks do not accumulate a large enough net worth which would make the leverage constraint irrelevant.

Limits on domestic deposits as a source of funding

We limit the share of domestic deposits in the model as a simple way to capture financial sector under-development in EMs. Specifically, we assume that domestic deposits cannot be larger than $\frac{\varphi_D - 1}{\varphi_D}$ of total liabilities, where $\varphi_D \geq 1$ is an exogenous parameter. In equilibrium, deposits therefore amount to:

$$D^e_{i,t} = (\varphi_D - 1) RER^{ld}_t V^e_{i,t} \tag{3.11}$$

The maximization problem of EM banks is:

$$J^e_{i,t} = \max_{K^e_{i,t}, V^e_{i,t}, D^e_{i,t},} E_t \Lambda^e_{t+1|t} [(1-\theta) N^e_{i,t+1} + \theta J^e_{i,t+1}] \tag{3.12}$$

subject to 3.8, 3.9, 3.10 and 3.11. $\Lambda^e_{t+1|t} \equiv \beta (\frac{C^e_t}{C^e_{t-1}})^{-\sigma}$ is the stochastic discount factor of the household.

The aggregate net worth at any point of time is the sum of surviving banks and newly adjusted capital:

$$\begin{aligned} N^e_t \equiv & \int N^e_{i,t} di \\ = & \theta \left\{ R^e_{k,t} - \left(\frac{RER_t}{RER_{t-1}} \right)^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D} \right\} Q^e_{t-1} K^e_{t-1} \\ & + \theta \left(\frac{RER_t}{RER_{t-1}} \right)^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D} (N^e_{t-1} - TB^e_{t-1}) \\ & + \delta_T Q^e_t K^e_{t-1} \end{aligned} \tag{3.13}$$

where $\tilde{R}_{b,t-1} = [\frac{R_{b,t-1}}{(\pi^c_t)^{ld} (\pi^e_t)^{1-ld}} + \frac{R_{e,t-1}}{\pi^e_t} (\varphi_D - 1)]$ is the average cost of funding for one unit of loan.

3.1.4 Production firms

The productions firms operate as in standard New Keynesian models. There are competitive intermediate firms and monopolistic final goods firms. A representative intermediate firm has the following production function:

$$Y^e_t = A^e_t (H^e_t)^{1-\alpha} (K^e_{t-1})^{\alpha} \tag{3.14}$$

For each period, the rate of return on investment for the EM banks is:

$$R^e_{k,t} = \frac{R^e_{z,t} + (1-\delta)Q^e_t}{Q^e_{t-1}} \tag{3.15}$$

where $R^e_{z,t}$ is the rental rate on capital and δ is the rate of depreciation of capital.

The competitive assumption yields the following demand functions for capital and labor:

$$MC^e_t(1-\alpha)A^e_t(H^e_t)^{-\alpha}(K^e_{t-1})^{\alpha} = W^e_t \tag{3.16}$$

$$MC^e_t(\alpha)A^e_t(H^e_t)^{1-\alpha}(K^e_{t-1})^{\alpha-1} = R^e_{z,t} \tag{3.17}$$

where MC^e_t is the real marginal cost of production, the price at which intermediate goods firms sell their output.

Monopolistic final goods firms buy goods from the intermediate firms, re-package them into differentiated goods, and sell them to domestic or foreign households in a monopolistically competitive setting. Several recent papers have emphasized the role of dollar invoicing in understanding the transmission of shocks across countries.[10] To capture this phenomenon, we allow the monopolistic firms to set two different prices, one for the domestic market in the EM currency and one for foreign markets in the foreign currency. Each of these prices are subject to the staggered setting in Calvo (1983), and the same random fraction $1-\varsigma$ of firms adjusts their prices each period for both currencies. This set up gives rise to two Phillips curves, one for domestic price inflation (($\pi^{PPI}_{e,t}$), and one for export price inflation (π^{*ec}_t)).

$$\pi^*_{e,t} = \frac{\sigma_p}{\sigma_p - 1}\frac{F_{e,t}}{G_{e,t}}\pi^{PPI}_{e,t} \tag{3.18}$$

$$F_{e,t} = Y_{e,t}MC_{e,t} + E_t[\beta\varsigma\Lambda^e_{t,t+1}(\pi^{PPI}_{e,t+1})^{\eta}F_{e,t+1}] \tag{3.19}$$

$$G_{e,t} = Y^{ee}_{,t}P^{ee}_{,t} + E_t[\beta\varsigma\Lambda^e_{t,t+1}(\pi^{PPI}_{e,t+1})^{-1+\eta}G_{e,t+1}] \tag{3.20}$$

$$(\pi^{PPI}_{e,t})^{1-\eta} = \varsigma + (1-\varsigma)(\pi^*_{e,t})^{1-\eta} \tag{3.21}$$

$$\pi^{*e,c}_t = \frac{\sigma_p}{\sigma_p - 1}\frac{F^{e,c}_t}{G^{e,c}_t} \tag{3.22}$$

$$F^{e,c}_t = Y^{ec}_t MC^e_t + E_t\left[\zeta\Lambda^e_{t+1}\pi^{ec}_{t+1}F^{ec}_{t+1}\right] \tag{3.23}$$

[10]See for instance Akinci and Queralto (2018), Gopinath et al. (2020) and Cook and Patel (2020).

$$G_t^{ec} = Y_t^{ec} P_t^{ec} RER_t + E_t\left[\zeta \Lambda_{t+1}^{e} \pi_{t+1}^{ec\,(\sigma_p-1)} G_{t+1}^{ec}\right] \tag{3.24}$$

$$(\pi_{,t}^{ec})^{1-\eta} = \varsigma + (1-\varsigma)(\pi_{,t}^{*ec})^{1-\eta} \tag{3.25}$$

where σ_p is the cross-good elasticity among goods within the country. $\pi_{e,t}^{PPI}$ is the PPI inflation rate.

3.1.5 Monetary authority

The central bank sets the domestic currency risk-free rate following a simple inertial Taylor rule of the form:

$$R_t^e = \lambda_r^e R_{t-1}^e + (1-\lambda_r^e)[\lambda_\pi^e(\pi_t^e - \pi_{ss}^e) + \lambda_y^e(Y_t^e - Y_{ss}^e)] + \epsilon_t^e \tag{3.26}$$

The central bank is thus assumed to respond to deviations of inflation and output from their steady state levels in an inertial way, captured by the presence of the lagged policy rate in the reaction function. We therefore assume that the central bank responds to external shocks and exchange rate fluctuations only to the extent that they affect domestic inflation and output, in line with the standard inflation targeting paradigm.

3.2 The advanced economy

AE variables are superscripted with c. The household, capital producer, production firm sectors and monetary policy in the AE are modeled in the same way as in the EM. The modeling of the banking sector is different and is described below.

3.2.1 Banks

The banks directly receive funding from deposits of AE households, invest in the domestic capital stock and make loans to EM banks.

For the representative AE bank j, the balance sheet in real terms is given by:

$$N_{j,t}^c + D_{j,t}^c = Q_t^c K_{j,t}^c + V_{j,t}^e/(RER_t)^{1-ld} \tag{3.27}$$

where $N_{j,t}^c$ is the net worth, $D_{j,t}^c$ are deposits from the domestic households in AE and $Q_t^c K_{j,t}^c$ is the investment in the capital stock in the AE.

Each period, bank j's real net worth is the return generated from last period investment in domestic capital stock and EM loans, less the debt repayment to domestic depositors:

$$N^c_{j,t} = R^c_{k,t} Q^c_{t-1} K^c_{i,t-1} + \frac{R_{b,t-1}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}} V^e_{i,t-1}/(RER_{t-1})^{1-ld} - \frac{R^c_{t-1}}{\pi^c_t} D^c_{t-1} \tag{3.28}$$

Incentive constraint

The AE banks face the same type of incentive constraint as EM banks do:

$$J^c_{j,t} \geq \kappa^c_t (Q^c_t K^c_{j,t} + V^e_{j,t}/(RER_t)^{1-ld}) \tag{3.29}$$

The maximization problem of the AE banks is:

$$J^c_{j,t} = \max_{K^c_{j,t}, V^e_{j,t}, D^c_{j,t},} E_t \Lambda^c_{t+1|t} [(1-\theta) N^c_{i,t+1} + \theta J^c_{i,t+1}] \tag{3.30}$$

subject to 3.27, 3.28 and 3.29.

Similar to 3.13, AE bank net worth is given by:

$$\begin{aligned}
N^c_t &\equiv \int N^c_{j,t} dj \\
&= \theta \left(R^c_{k,t} - \frac{R^c_{t-1}}{\pi^c_t} \right) Q^c_{t-1} K^c_{t-1} + \theta \frac{R^c_{t-1}}{\pi^c_t} N^c_{t-1} \\
&+ \theta \frac{n}{1-n} \left(\frac{R_{b,t-1}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}} - \frac{R^c_{t-1}}{\pi^c_t} \right) \left(\frac{RER_{t-1}}{RER_t} \right)^{1-ld} V^e_{t-1}
\end{aligned}$$

The first order condition w.r.t. $V^e_{j,t}$ is:

$$\Lambda^c_{t+1|t} \left[(1-\theta) + \theta J^{c'}_{j,t+1} \right] \left[\frac{R_{b,t}}{(\pi^c_{t+1})^{ld}(\pi^e_{t+1})^{1-ld}} \left(\frac{RER_t}{RER_{t+1}} \right)^{1-ld} - \frac{R^c_t}{\pi^c_{t+1}} \right] = \kappa^c_t \gamma^c_t \tag{3.31}$$

where γ^c_t is the Lagrangian multiplier associated with 3.29.

3.3 Taking stock of the key mechanisms in the model

Table 2 summarizes the different channels through which a foreign financial shock, specifically a monetary contraction in the AE which will be the focus of the analysis in the next sections, affects EM GDP in the model. There are two main channels at work, the traditional trade channel and the financial channel. On the trade side, the shock leads to a contraction in AE aggregate demand, which spills over to cause a contraction in EM aggregate demand due to a decline in imports (Column 1a). At the same time, via the uncovered interest rate parity condition (equation 3.5), the shock causes the EM currency to depreciate, boosting net exports through an improvement in price competitiveness (Column 1b). Since these two mechanisms affect EM GDP in opposite directions, the overall effect through the trade channel is unclear a priori.

On the financial side, the shock adversely affects EM financial conditions and GDP through direct credit supply effects and balance sheet effects of the exchange rate. Specifically, a monetary tightening in the AE induces a tightening of the balance sheet constraints of AE financial institutions, leading to a cut back of credit supply to the EM, pushing up borrowing rates and dampening investment (Column 2a). At the same time, the induced EM currency depreciation increases the local currency value of liabilities and lowers EM banks' net worth in the OS case, while it lowers the local currency value of assets and lowers the net worth of AE lenders in the OSR case (Column 2b). These balance sheet effects of the exchange rate induce further credit supply cut backs, further dampening investment under both the OS and the OSR scenario.

As shown in the next section, the overall effect on EM GDP depends on the relative strengths of these channels, as well as policy responses to the shock in the EM.

3.4 Model parameterization, shocks and scenarios

The model is parameterized to quarterly frequency. Table 3 reports the parameters used. Our focus is on understanding the qualitative implications of the model rather than a precise quantitative assessment of the various channels at play. That said, our calibration closely follows previous papers, in particular Banerjee et al. (2016) and Gertler and Karadi (2011).

Specifically, the discount factor (β) is chosen to ensure a steady state real rate of return of 4% in either economy. The size of the EM in the global economy n is fixed at 0.2.[11] The cross-country elasticity of substitution η is set at 2, whereas the within country elasticity of substitution (σ_p) is fixed at 6, implying a steady state markup of 20%. The Calvo parameters (ς) are set to 0.85, implying that prices are sticky on average for a year and a half.

We follow Gertler and Karadi (2011) for the calibration of the banking sector parameters. In particular, the survival rate of banks (θ) is set at 0.97, the steady state value of the leverage constraint parameter (κ) is 0.38, and the capital injection share of new banks (δ_T) is 0.004. The other parameters, such as the depreciation rate of capital, are fixed at their conventional values from the literature.

[11] The EM is therefore to be interpreted as the group of EMs that rely on external sources of funding, rather than a single EM. Similarly, the advanced economy represents the group of AEs rather than a single AE.

The log-linearized model is solved by first-order approximation around the non-stochastic steady state, assuming that the constraint is always binding. Given our primary interest of understanding the implications of shocks that lead to capital outflows and a depreciation of the EM currency, we build the simulation exercise around a 100 basis points increase (tightening) in the advanced economy risk free rate as the main shock.

We compare three regimes in the simulation exercises to study the role of currency denomination of external debt on the one hand, and the role of external vs domestic debt on the other:

- Foreign currency external debt (OS: $ld = 1$,$\varphi_D = 0$)
- Local currency external debt (OSR: $ld = 0$, $\varphi_D = 0$)
- Domestic deposits (75% domestic, 25% external local currency deposits: $ld = 0$, $\varphi_D = 0.75$)

4 Original sin vs original sin redux

In order to flesh out the different channels and to illustrate the mechanisms of the model, we simulate the AE monetary tightening for different versions of the model: (i) without financial friction in the AE financial sector; (ii) with financial friction in the AE financial sector; and (iii) without exchange rate feedback effects on borrower or lender balance sheets respectively under the OS and the OSR scenario. The latter exercise can be seen as a simple test of the implications of financial sector FX hedging on the dynamics of the model.

4.1 Absence of advanced economy financial friction

In order to illustrate the role of financial constraints in the AE banking sector, we first analyze in this section the model dynamics when such constraints are absent, i.e. $\kappa_t^c = 0$. Figure 4 plots the IRFs (% deviation from the steady-state) for the case of loans from the AE (or global) lenders in foreign currency (original sin, OS: $ld = 1$, blue lines) and in local currency (original sin redux, OSR: $ld = 0$,red lines) in response to a 100 basis points monetary tightening shock in the AE.

Under both scenarios, the AE monetary tightening is associated with a drop in AE output, a decline in AE bank net worth and an EM currency depreciation.[12] The impact on EM

[12]Note that the impact of the 100 bps monetary policy shock on the AE policy rate itself is smaller at about 80 basis points, reflecting the endogenous response of monetary policy to the induced drop in output and inflation through the Taylor rule.

financial conditions and real economy however differ significantly under OS compared to OSR. When the loans are denominated in foreign currency (OS), the EM experiences a significant tightening in financial conditions. The currency depreciation harms the EM banks' net worth, since their assets are denominated in local currency whereas liabilities are in foreign currency. This leads to an increase in borrowing costs, falling asset prices, a credit contraction, and consequently a sharp fall in investment. EM GDP drops substantially, by 1.5% at the peak, driven primarily by the drop in real investment. Inflation rises on impact reflecting the effect of exchange rate depreciation through the pass-through channel, but then falls as the real economy tanks.

When loans are denominated in local currency (OSR), EM GDP increases relative to the steady-state level on impact. This reflects the conventional trade channel of the exchange rate - the increase is mainly due to the expenditure switching effect that tends to increase EM net exports. The financial channel of the exchange rate is largely absent in this case. Since there is no financial friction in the AE banking sector, the spread of the lending rate over the policy rate does not change even if AE bank net worth declines. As a result, the borrowing rate faced by EM banks is effectively unchanged, because the increase in the AE interest rate is compensated by the expected appreciation of the EM currency.

To summarize, the results of this exercise illustrate the strong macro-financial repercussions of the financial channel of exchange rates operating through EM borrower balance sheets, which outweighs the trade channel of exchange rates under OS. In the absence of financial frictions on AE balance sheets, local currency debt (OSR) largely insulates the EM economy from the financial channel by moving the exchange rate vulnerability from the balance sheet of the financially constrained EM financial sector to the unconstrained AE financial sector. This leads to a more stable financial sector overall. This is consistent with the traditional prescription of promoting debt liability denomination in local currency to enhance the resilience of EMs to capital flow swings. However, as we show next, the picture changes substantially once we take a global perspective on financial frictions, allowing them to be present in both EM and AE financial sectors.

4.2 Presence of advanced economy financial friction

We replicate the simulation exercise for the case when financial frictions are also present in the AE banking sector in addition to the EM banking sector. We set $\kappa_t^c = 0.38$, which is the same as Gertler and Karadi (2011). Figure 5 plots the impulse responses for two cases where there is a 100 basis point monetary tightening shock in the AE in the presence of financial frictions on the side of both AE (or global) lenders and EM borrowers. 1) $ld = 1$

(OS) and 2) $ld = 0$ (OSR), the local (EM) currency debt or "original sin redux" case.

The blue line in Figure 5, which represents the OS case, behaves similar to the blue line in Figure 4, albeit it is not identical due to the presence of financial frictions in AE. With financial frictions in the AE financial sector, the OS scenario features a stronger reduction in EM GDP by more than 3% that is as before driven by a large drop in EM investment. The effect is more than twice as large as when there are no financial frictions in AE financial sector, highlighting the importance of these frictions in the transmission of global spillovers.

This is also reflected in the IRFs of the OSR case, which now behave very differently from the case when there is no AE financial friction. EM real GDP now drops substantially also under the OSR scenario, by more than 2%. Because AE banks face a financial constraint, the reduction in their net worth brought about by the AE monetary tightening translates into a reduction in credit supply to EMs, pushing EM borrowing rates up and EM asset prices and bank net worth down. The unexpected EM currency depreciation erodes the local currency loan return for AE banks, which further impairs AE banks' net worth and therefore pushes up the lending rate to EM banks even more. In other words, the valuation effects of exchange rate fluctuations have migrated from EM bank balance sheets to AE bank balance sheets.

Thus, once we consider the implications of local currency borrowing in a general equilibrium setting with financial frictions in financial sectors being present globally, local currency borrowing does not imply a redemption from original sin. Also under local currency borrowing, there are significant spillovers from a tightening of AE financial conditions to EM financial conditions as financially constrained AE banks cut back credit supply to EMs. Also, one way or the other, the currency mismatch problem remains in the global financial system, either on the lenders' or on borrowers' balance sheets. That said, while the spillovers are qualitatively similar under the OS and OSR scenarios when AE financial frictions are present, the effects are quantitatively smaller under OSR suggesting that moving from foreign currency to local currency borrowing does yield an improvement in EM resilience to global financial spillovers.[13]

4.3 Exchange rate amplification effects and FX hedging

In the presence of financial frictions on the side of AE lenders, the overall impact of an AE monetary tightening on financial conditions in EMs is the result of two effects: (i) the direct effect of the monetary tightening on the AE lender balance sheet constraining credit supply to EMs; and (ii) the amplification effect of the associated depreciation of the EM currency

[13] However, by considering a first order approximation around the non-stochastic steady state, our model does not capture the fact that exchange rate risk on the AE bank balance sheet with $ld = 0$ is likely to lead to a "precautionary saving" type effect, whereby the AE bank would charge a higher interest rate on EM currency as compared to dollar debt, as is often observed in the data. This would further reduce the benefits of local currency debt from an EM welfare perspective.

working through the borrower (OS) or lender (OSR) balance sheet. In order to disentangle the two effects, we replicate the simulations switching off the exchange rate feedback effect on borrower or lender balance sheets.

The results of this exercise are shown in Figure 6. The solid lines replicate the baseline results shown in the previous sub-section, the broken lines show the effects when exchange rate feedback effects through borrower and lender balance sheets are switched off. The figure reveals that both under OS and OSR the amplification effects through exchange rate depreciation are considerable. The effects are materially reduced when the financial channel of the exchange rate is deactivated, but they remain economically significant. Thus, seen from a different perspective, these results suggest that the significance of the spillover effects of an AE monetary tightening do not hinge on the balance sheet effects of exchange rate depreciation alone. Even when the exchange rate amplification effects are switched off, the spillovers are sizable for both OS and OSR, being as before somewhat smaller in the latter case.

This finding also implies that the existence of macro-financial repercussions of an AE monetary tightening qualitatively do not depend on the assumed extent of hedging of exchange rate risk. The analysis so far assumes no hedging so that an exchange rate change fully impacts economic agents, in particular financial intermediary balance sheets, through currency mismatches. While hedging markets in EM currencies are less liquid than those in AE currencies as shown before, it is still reasonable to assume that some part of exchange rate risk in EMs is hedged, not least since banks are often required to hedge such risk by regulation. The results shown in Figure 6 suggest that even in the unrealistic extreme case of full hedging of exchange rate risk on intermediary balance sheets, the spillovers to EMs remain considerable.[14]

5 Policy implications of original sin redux

Having established the spillovers of a foreign financial tightening to EMs, we next delve into an analysis of policy implications. We assess the usefulness of additional policy tools to address financial spillovers in the context of OSR, specifically of FX intervention and capital flow management measures. We also explore the role of financial development to address

[14] Assuming away exchange rate feedback effects on balance sheets is of course an extremely simplistic characterization of hedging policies. In reality, hedging will not be complete. The real world situation is therefore somewhere between the two polar cases of no hedging, which we is our baseline considered so far, and full hedging. Moreover, hedging comes at a cost and the exchange rate risk will ultimately have to be borne by someone. That said, the simplistic perspective taken here is still fit for purpose to make the general point. A fully fledged modeling and integration of hedging is beyond the scope of this paper and is therefore left for future research.

the root cause of EMs' vulnerability to spillovers in the longer run. Finally, we look at the implications of OSR for the stabilizing capacity of domestic monetary policy.

5.1 FX intervention and capital flow management measures

In our model, monetary policy is a rather ineffective tool for dealing with external shocks in EMs. This is because a domestic monetary policy easing affects output through two channels that tend to offset each other. The first is the standard new Keynesian aggregate demand channel, which tends to boost aggregate demand and increase output. But the monetary easing also leads to a depreciation of the exchange rate, which tends to reduce EM or AE bank net worth and generate a credit contraction that depresses investment and output. This increases the value of additional policy tools in the toolkit of central banks, such as FX intervention, capital flow management measures and macroprudential policies (see for instance Chen et al. (2021) and Davis et al. (2021)). Indeed, EM central banks have systematically resorted to FX intervention, macroprudential tools and capital flow management tools to address the challenges from capital flow and exchange rate swings (BIS (2019)). In this sub-section we analyze the value of such tools in a context of OSR from the perspective of our model. Specifically, we assess the effectiveness of sterilized FX intervention and a capital flow tax as additional policy instruments to cushion the fallout of external shocks from the perspective of our model, focusing on the case of OSR (external borrowing in local currency).[15]

5.1.1 FX intervention

To introduce a role for FX intervention, we need to describe how the economy responds to the change in foreign exchange reserves (FX reserves), and how FX reserves respond to economic conditions. We model (sterilized) FX intervention as in Devereux and Yetman (2014), Chang (2018) and Arce et al. (2019), assuming that FX intervention is conducted with the goal to stabilize the exchange rate around its steady state level. Specifically, we assume that the monetary authority conducts FX intervention by adjusting FX reserves in response to the exchange rate with the following rule:

$$\Delta FR_t = \left(\frac{RER_t}{RER_{SS}}\right)^{\chi} - 1 \tag{5.1}$$

[15] The capital flow management tax can be interpreted as a form of macroprudential policy. An alternative macroprudential policy would be one which targets the capital requirement of domestic banks. Given our focus on foreign shocks and foreign capital flows and the absence of domestic deposits and investors in the baseline scenario, our model is better equipped to analyze capital flow measures as opposed to domestically oriented macroprudential measures.

where RER_{SS} denotes the steady state RER and χ is a parameter that governs the strength of the intervention.

We further assume that changes in FX reserves are financed by lump sum taxes or transfers, which is equivalent to sterilization operations conducted in the form of sales and purchases of sterilization bonds that drain or inject liquidity. The two lump sum taxes on households and banks we described above serve this purpose, so we can express the change in FX reserves in the following way:

$$\Delta FR_t = FR_t - R^c_{t-1} FR_{t-1} = (1-\Psi)T^e_t + \Psi TB^e_t \tag{5.2}$$

where FR_t is the level of FX reserves at time t and Ψ is the share of reserves that is distributed to the banking sector. For example, if Ψ=0, then all the reserves accumulation/decumulation is financed through sterilization operations with the households.

Figure 7 shows the impulse responses for an AE monetary tightening shock when FX intervention is activated. We consider two types of FX interventions, namely the case when the sterilization operation targets households ($\Psi = 0$) and alternatively the case when it targets the banking sector ($\Psi = 1$, Equation 5.2). When households are the counterparty of the sterilization operation, the intervention is essentially ineffective. The IRFs with FX intervention (red lines) are basically identical with those when there is no intervention (blue lines, not visible as superimposed by red lines). This is consistent with the finding of Backus and Kehoe (1989) in which FX intervention is ineffective in a frictionless market.[16]

The effectiveness of FX intervention increases substantially when sterilization operations are conducted with the banking sector (yellow lines), as is normally the case in reality. GDP falls much less in this case. The intervention also succeeds in dampening the depreciation of the exchange rate. The main effect of the intervention is however the stabilization of EM banks' balance sheets through the sterilization operation. The sterilized FX intervention in response to a foreign financial tightening involves selling foreign reserves and transferring the proceeds to banks. In a model with sterilization bonds, the FX intervention in this case would be offset by purchases of sterilization bonds. The associated injection of liquid funds frees up resources in the EM banking sector, buffering the drop in net worth and enhancing its lending capacity. The FX intervention is effective here as it relaxes the financial constraint faced by EM banks precisely when an exogenous shock tightens it. The smaller reduction in banking net worth reduces the fall in investment and ultimately of GDP. This "debt limit channel" of FX intervention is also discussed in Chang and Velasco (2017), Chang (2018),

[16] The slight difference in the impulse responses is due to the fact that the household portfolio market is not exactly frictionless in our model, but it has a very small portfolio adjustment cost to ensure stationarity (Schmitt-Grohé and Uribe (2003)).

Cavallino and Sandri (2020) and Hofmann et al. (2019).

A couple of caveats regarding the use of FX intervention as a policy tool are in order. First, our model highlights the benefits of FX intervention, but does not capture its costs. For instance, FX reserves typically entail a lower rate of return on average than alternative investments, and this opportunity cost should be factored into any analysis on the cost and benefits of holding reserves for intervention purposes. Second, our model also abstracts from moral hazard concerns that may arise when the central bank makes frequent use of FX intervention, leading to excessive risk taking by private agents (see for instance McKinnon (2000)). It may also hamper market development and incentivize private agents to continue to maintain unhedged FX exposures.

5.1.2 Capital flow tax

We next consider the effectiveness of capital flow measures in cushioning the impact of an AE monetary tightening. We illustrate this point by modeling capital flow measures through a time varying tax on cross-border capital flows to the EM. The tax takes the following form:

$$\tau_t^{inflow} = \tau_0 \left(\frac{V_t^e}{V_{steadystate}^e} - 1 \right) \tag{5.3}$$

This implies that the tax on capital inflows is an increasing function of the total capital inflow into the EM (V_t^e) relative to its steady state value ($V_{steadystate}^e$). Therefore, during episodes of capital outflows, the tax rate decreases to offset the effects of the outflow shock to some extent. Figure 8 shows that having such a tax in place can help cushion the impact of the shock by mitigating the degree to which borrowing costs in the EM rise and depress investment and output. Similar to the case of FX intervention, our results for the capital flow tax are merely geared towards illustrating the potential benefits of having the tool in place, rather than a precise cost-benefit analysis, for which we would have to model the costs of having such taxes in place more realistically.

5.2 Financial development

Carstens and Shin (2019) argue that developing a strong domestic investor base is key for EMs to overcome vulnerability to capital flow volatility in the long run. CGFS (2019) makes the same argument and in addition points to the need to develop deeper currency hedging markets to reduce vulnerability to exchange rate swings. Our analysis in section 4.3 supports the latter notion, showing that elimination of exchange rate amplification effects through intermediary balance sheets reduces spillovers, albeit it does not eliminate them. We now assess the former point on the role of the size of the domestic investor base.

In Figure 9 we compare the effects of an AE monetary tightening shock (100 basis points) in an OSR scenario with 75% of the EM bank funds sourced from domestic deposits (red lines) compared to the baseline OSR scenario with no domestic deposits (blue lines). In both cases, AE GDP and banks' net worth reductions are similar. However, the borrowing rate that the EM faces is much lower in the case with domestic deposits. The smaller increase in the borrowing cost translates into a small reduction of EM banks' net worth and investment, resulting in a smaller drop in EM GDP.

The reduction in the vulnerability of EMs to foreign shocks when the domestic investor base is larger occurs via two channels. First, domestic investors evaluate their returns in the domestic currency. As a result, there is no currency mismatch problem on either the borrower or the lender's balance sheet. Second, lending from the domestic investor base to the domestic firm is only subject to one layer of financial frictions, namely those involving the domestic banks. On the other hand, lending from foreign investors is subject to two layers of financial frictions - those involving the foreign and the domestic banks respectively. Since the reduction in credit supply in the wake of an AE monetary tightening is to a significant extent transmitted through the financial constraints of the AE banking sector, reducing dependence on this source of funding also reduces vulnerability to foreign financial shocks. Assuming financial frictions to be more stringent in international borrowing as opposed to domestic borrowing (as assumed by Akinci and Queralto (2018)) would therefore further increase the benefits of a larger domestic investor base.

The beneficial effects of a deeper domestic investor base suggested by the analysis in this section should not be interpreted as supporting financial autarky. They should rather be seen as supporting policies that promote deep and liquid financial markets which allow EM borrowers to diversify sources of funding and provide hedging opportunities to better cope with foreign financial shocks. For instance, a large domestic investor base that also invests in foreign assets benefits EM borrowers in at least two ways. First, it allows EM borrowers to shift sources of funding from foreign to local markets in the face of external shocks. This is particularly valuable as a cushion during episodes characterized by global cross-border capital flow retrenchment. Second, domestic investors investing abroad form a natural counter-party for foreign lenders or EM financial intermediaries looking to hedge against depreciations of the EM currency, since the former are long foreign currency and short local currency. They therefore promote the development of FX derivatives markets that enable access to the benefits of hedging currency exposures illustrated in Figure 6.[17]

[17]Indeed, as argued by Chan-Lau (2005) for the case of Chile, hedging motives of institutional investors have played an important role in the growth of FX derivatives markets.

5.3 Domestic monetary transmission

While the focus of our paper is on spillovers from foreign monetary shocks, the currency denomination of borrowing from abroad and the strength of the domestic investor base may also affect the transmission of domestic monetary policy and hence the ability of the domestic central bank to conduct effective stabilization policy. We address this question by simulating the effect of a domestic monetary policy shock under the OS and the OSR scenario as well as under different assumptions about the size of the domestic institutional investor base.

Figure 10 shows, for the case of a domestic policy rate cut of 100 basis points, that relative to foreign currency external borrowing (OS), domestic currency external borrowing (OSR) leads to a significant strengthening in the transmission of domestic monetary policy to output. This is because the domestic policy rate cut leads to a sharp depreciation of the EM currency on impact, which is subsequently reversed in the following quarters. This reversal translates into an appreciation of the EM currency beginning in the period right after the shock. In anticipation of this appreciation, foreign lenders reduce the premium charged on local currency loans since they gain from exchange rate movements. Consequently, credit to the real economy expands more in the OSR case, leading to a stronger boost to GDP.

Finally, Figure 10 further shows that a large domestic investor base not only makes the economy less vulnerable to foreign shocks, but that it also increases the strength of the transmission of domestic monetary policy to domestic output and investment. This is because with a larger domestic investor base, a larger fraction of EM banks' funding is linked directly to, and can be influenced by the changes in the domestic policy rate. This enhances the effectiveness of domestic monetary policy.[18]

6 Original sin redux in a model with sovereign debt

Our baseline model illustrates the implications of OS and OSR when external borrowing is done by the private sector of the economy to finance real investment. This provides a clear link between external borrowing and the real economy. This modeling approach abstracts, for ease of exposition, from the fact that it was in particular EM sovereigns who increased their borrowing in local currency from abroad over the past couple of decades. In this section, we consider an extension of the model where it is the sovereign who can borrow from abroad in local currency while the private sector borrows in foreign currency, and reexamine the consequences for the effects of foreign monetary shocks on domestic financial conditions and

[18] A similar observation is also made by Obstfeld (2015), who argues that under the GFC, domestic monetary policy was less effective since long-term rates were affected by the GFC's influence on global borrowing costs.

output.

Unlike the corporate sector, we assume that the government borrows directly from the AE bank in either domestic or foreign currency. A schematic representation of this augmented model is given in Figure 11. We model the fiscal side in the spirit of Kumhof and Laxton (2013), abstracting from endogenous sovereign debt and consider a case where the government raises a fixed amount of debt from foreign banks each period, in either local or foreign currency.

To describe how the fiscal sector interacts with the private sector, we start by setting out the fiscal rule (or equivalently the government budget constraint). The fiscal government's surplus each period is:

$$surplus_t \equiv \tau_t + \underbrace{B_t^{Ge}(RER_t)^{ldgovt}}_{\text{new debt}} - \underbrace{B_{t-1}^{Ge}\frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt}(\pi_t^e)^{1-ldgovt}}(\frac{RER_t}{RER_{t-1}})^{ldgovt}}_{\text{debt repayment}} \tag{6.1}$$

where τ_t is the tax revenue from taxing firm profits, B_t^{Ge} is the amount of government debt in period t and $ldgovt$ is an indicator to indicate whether the contract is denominated in foreign currency or local currency (with $ldgovt = 0$ denotes local currency and $ldgovt = 1$ denotes foreign currency). The government taxes firm profits for the repayment of the debt. Its fiscal/tax policy is assumed to follow a simple rule:

$$surplus_t = \alpha_1 + \alpha_2 ln(Y_t^e - Y_{ss}^e) \tag{6.2}$$

where the parameter α_2 governs the degree of cyclicality of fiscal policy.[19]

The AE bank incentive constraint now becomes:

$$J_{j,t}^c \geq \kappa^c(Q_t^c K_{j,t}^c) + \kappa_t^{c,EM}(x_t^{EM})(V_{j,t}^e/(RER_t)^{1-ld} + B_{j,t}^{Ge}/(RER_t)^{1-ldgovt}) \tag{6.3}$$

and the AE bank net worth equation becomes

$$\begin{aligned} N_t^c = \quad & \theta\{(R_{k,t}^c - \tfrac{R_{t-1}^c}{\pi_t^c})Q_{t-1}^c K_{t-1}^c + \tfrac{n}{1-n}[(\tfrac{R_{b,t-1}}{(\pi_t^c)^{ld}(\pi_t^e)^{1-ld}} - \tfrac{R_{t-1}^c}{\pi_t^c})(\tfrac{RER_{t-1}}{RER_t})^{1-ld}V_{t-1}^e] \\ & + \tfrac{n}{1-n}[\tfrac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt}(\pi_t^e)^{1-ldgovt}} - \tfrac{R_{t-1}^c}{\pi_t^c})(\tfrac{RER_{t-1}}{RER_t})^{1-ldgovt}V_{t-1}^{Ge}] + \tfrac{R_{t-1}^c}{\pi_t^c}N_{t-1}^c\} \end{aligned} \tag{6.4}$$

We assume κ on EM assets is a function of EM variables (x_t^{EM}) and depends linearly on the deviation of repayment to GDP from steady state that the sovereign needs to make with

[19]Equation 6.1 and equation 6.2 can be combined to yield the tax revenue (tax rate), which is the main instrument for the fiscal authority.

$\kappa_t^{c,EM}(x_t^{EM} = 0) = \kappa_t^c$, i.e.:

$$x_t^{EM} = B_{t-1}^{Ge} \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt}(\pi_t^e)^{1-ldgovt}} (\frac{RER_t}{RER_{t-1}})^{ldgovt} - B_{SS}^{Ge} \frac{R_{SS}^{govt}}{(\pi_{SS}^c)^{ldgovt}(\pi_{SS}^e)^{1-ldgovt}} (\frac{RER_{SS}}{RER_{SS}})^{ldgovt}$$

The introduction of this time varying κ gives rise to a higher EM spread when the sovereign repayment is high, which is consistent with the data.[20]

$$\kappa_t^e = F \left[\underbrace{\frac{B_{t-1}^{Ge} \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt}(\pi_t^e)^{1-ldgovt}} (\frac{RER_t}{RER_{t-1}})^{ldgovt}}{Y^e}}_{\text{repayment}_t^{govt}/\text{GDP}} - \underbrace{\frac{B_{SS}^{Ge} \frac{R_{SS}^{govt}}{(\pi_{SS}^c)^{ldgovt}(\pi_{SS}^e)^{1-ldgovt}} (\frac{RER_{SS}}{RER_{SS}})^{ldgovt}}{Y_{SS}^e}}_{\text{steady state repayment}_t^{govt}/\text{GDP}} \right] \quad (6.5)$$

6.1 Sovereign external borrowing without feedback to the private sector

Throughout the section, we assume that private sector borrowing is denominated entirely in foreign currency. We first consider the benchmark case where there is no direct feedback between the sovereign and the private sector, i.e. we set $\alpha_2 = 0$ and keep κ^e time invariant. Figure 12 shows the impulse response to a foreign monetary tightening for the two cases of EM sovereign external borrowing in foreign currency (blue lines) and in local currency (red lines). We note that the net worth of global banks falls more when they lend to the EM government in local currency. This is on account of the fact that they have a currency mismatch on their balance sheet when lending in the EM currency, which lowers the value of their loan (assets, which are in local currency) as opposed to liabilities (which are in dollars) when the EM currency depreciates. On the other hand, the consequences of currency mismatch when borrowing in dollars are negligible for the EM government, since unlike the EM banks, they are not financially constrained under this case of no feedback to the private sector.

Consequently, EM GDP falls more when the government is borrowing in local currency, due to the larger fall in net worth of global banks which leads to larger credit contraction to the EM banks. However, the borrowing rate rises less in this case, since the expected

[20] See Aoki et al. (2016) for a recent example of a time varying κ in the parameterized form. There are multiple ways to microfound this constraint. We provide a simple model in Appendix A

appreciation of the EM exchange rate starting in the period after the shock makes global banks willing to lend to the EM government in local currency at a lower rate.[21]

6.2 Sovereign external borrowing with feedback to the private sector

The ability to impose taxes and transfers gives the sovereign sector the unique ability to divert resources from other parts of the economy to cover its fiscal needs. As a result, sovereign funding conditions can be expected to have a a significant bearing on the funding conditions of the private sector.[22] Motivated by this literature on sovereign-bank funding interactions, we modify the benchmark specification allowing for interactions between the EM sovereign and the EM banks. We allow κ^e to vary according to equation 6.5, and set the fiscal policy parameter α_2 to be 0.5, allowing for some counter-cyclical fiscal policy.[23]

Figure 13 shows the impulse response of an AE monetary tightening for this case where sovereign funding conditions have a direct effect on private funding conditions. We note that, as before, the net worth of the global bank still declines more when the sovereign borrows in the EM currency. However, different from the previous case, now the contraction in GDP is sharper when the sovereign borrows in foreign currency. This is due to the fact that the government's repayment burden rises much more when debt is denominated in foreign currency (since $ldgovt = 1$ and RER_t increases). Consequently, κ_t^e rises much more sharply in this case, leading to a sharper increase in domestic interest rates, decline in credit and hence output.

To summarize, when government debt is risk free, and there is no direct feedback between sovereign and private borrowing conditions, local currency borrowing (original sin redux) can leave the EM even more vulnerable than foreign currency borrowing (original sin), since the financial constrained global banking sector bears greater exchange rate risk in the former case. A more realistic specification with spillovers between the sovereign and private sector funding conditions however makes local currency debt more preferable, but as with the baseline model without sovereign debt, it does not completely eliminate the vulnerability of the EM to changes in AE monetary conditions.

[21]See Hofmann et al. (2020a) for empirical evidence on the impact of exchange rate shocks on local currency sovereign spreads in EMs that is consistent with our results.

[22]In line with this hypothesis, there is an extensive literature documenting the spillovers between sovereign and private borrowing conditions. For instance Corsetti et al. (2014), Durbin and Ng (2005) and Bedendo and Colla (2015) find that the cost of borrowing in global markets for corporate borrowers tends to be correlated with the yields that their sovereigns pay on their debt. More related to the present model, the literature has also documented extensive evidence on spillovers between sovereign and bank funding conditions (for instance De Bruyckere et al. (2013), Alter and Beyer (2014) and Mendoza and Yue (2012)).

[23]Qualitatively, the results do not change much if we set $\alpha_2 = 0$ as before.

7 Conclusion

On the back of rapid growth in local currency debt markets over the last two decades, EMs have reduced their reliance on external foreign currency borrowing – the so-called "original sin". However, even when borrowing in local currency, EMs still rely heavily on foreign sources of funding as they have a less developed base of domestic institutional investors. This leaves them vulnerable to capital flow reversals and currency mismatches which are now sitting on the balance sheets of global lenders, giving rise to the phenomenon of "original sin redux" (Carstens and Shin (2019)). This paper presents a model-based evaluation of the original sin redux hypothesis by analyzing the vulnerability of EMs to an advanced economy monetary tightening shock using a two-country new Keynesian DSGE model where financial frictions are present in both EM and advanced economy financial systems.

The main takeaways from the analysis can be summarized as follows. First, while borrowing from abroad in local currency reduces the vulnerability of EMs to foreign financial shocks compared to the original sin case, it falls short of eliminating it. Adverse amplification effects of exchange rate depreciation working through the currency mismatches on advanced economy lenders' balance sheets play an important role in this result. However, even if exchange rate amplification effects on borrower or lender balance sheets would be eliminated, e.g. through hedging, adverse spillover effects would persist as financial frictions in advanced economy financial systems give rise to direct reductions of credit supply to EMs when advanced economy financial conditions tighten. Second, additional macro-financial stability policy tools can mitigate the challenges from capital flow swings also in an original sin redux scenario. Foreign exchange intervention turns out to an effective tool, with the main stabilizing effect of the intervention coming from an easing of the financial constraint of the domestic financial sector through the sterilization operation. Similar effects could therefore be achieved through central bank balance sheet operations in local currency.[24] Capital flow measures also mitigate the effect of external shocks in a manner similar to FX intervention. Third, a larger domestic investor base reduces the vulnerability of EMs to capital flow swings in the longer run. Finally, local currency external borrowing and a stronger domestic investor base strengthen the transmission of domestic monetary policy in EMs, thus providing more traction to EM central banks.

The analysis of the paper is based on a tractable two-country general equilibrium framework to highlight the role of financial frictions that give rise to EMs' vulnerability to financial shocks originating in AEs under different scenarios for financial structure. As such, it leaves open

[24]See Adrian et al. (2022) for a discussion of the effectiveness and risks associated with the increased use of central bank balance sheet policies in EMs.

several avenues for future research. For instance, the different scenarios considered (currency of denomination of debt and the share of domestic deposits) are fixed exogenously throughout the analysis so that agents are not allowed to adjust the composition of their funding in response to shocks. While this appears to be a restrictive assumption, there is a large body of evidence documenting that sources of funding (for both firms and banks) are fairly sticky, especially at business cycle frequencies considered in this paper.[25] Nevertheless, allowing for endogenous switching between sources of funding would be an interesting extension of our analysis going forward.

Lastly, the focus of the paper is primarily positive and we do not explore implications for optimal policy. An extension of the analysis to characterize optimal policy in the presence of multiple policy instruments could be a useful avenue for future research against the background of the ongoing debate about the design of macro-financial stability frameworks in EMs.

Bibliography

Adrian, Tobias, Christopher Erceg, Simon Gray, and Ratna Sahay (2022) "Emerging-Market central bank asset purchases can be effective but carry risks," *IMF Blog*.

Adrian, Tobias, Christopher J Erceg, Jesper Lindé, Pawel Zabczyk, and Jianping Zhou (2020) "A quantitative model for the integrated policy framework," *IMF Working Papers* (122).

Aghion, Philippe, Philippe Bacchetta, and Abhijit Banerjee (2001) "Currency crises and monetary policy in an economy with credit constraints," *European Economic Review*, 45 (7), 1121–1150.

Akinci, Ozge and Albert Queralto (2018) "Exchange rate dynamics and monetary spillovers with imperfect financial markets," *FRB of New York Staff Report* (849).

Alter, Adrian and Andreas Beyer (2014) "The dynamics of spillover effects during the European sovereign debt turmoil," *Journal of Banking & Finance*, 42, 134–153.

Aoki, Kosuke, Gianluca Benigno, and Nobuhiro Kiyotaki (2016) "Monetary and financial policies in emerging markets," *memo, London School of Economics.*

Arce, Fernando, Julien Bengui, and Javier Bianchi (2019) "A macroprudential theory of foreign reserve accumulation," *National Bureau of Economic Research* (No. w26236).

[25] See for instance see for instance Ivashina et al. (2015), Degryse et al. (2019), Khwaja and Mian (2008), Jiménez et al. (2012), Paravisini (2008) and Paravisini et al. (2015)).

Arellano, Cristina, Yan Bai, and Luigi Bocola (2017) "Sovereign default risk and firm heterogeneity," *National Bureau of Economic Research* (No. w23314).

Arellano, Cristina, Yan Bai, and Gabriel P Mihalache (2020a) "Deadly debt crises: COVID-19 in emerging markets," *National Bureau of Economic Research* (No. w27275).

——— (2020b) "Monetary policy and sovereign risk in emerging economies (nk-default)," *National Bureau of Economic Research* (No. w26671).

Avdjiev, Stefan, Patrick McGuire, and Goetz von Peter (2020) "International dimensions of EME corporate debt," *BIS Quarterly Review, June.*

Backus, David K and Patrick J Kehoe (1989) "On the denomination of government debt: a critique of the portfolio balance approach," *Journal of Monetary Economics*, 23 (3), 359–376.

Banerjee, Ryan, Michael B Devereux, and Giovanni Lombardo (2016) "Self-oriented monetary policy, global financial markets and excess volatility of international capital flows," *Journal of International Money and Finance*, 68, 275–297.

Banerjee, Ryan Niladri, Boris Hofmann, and Aaron Mehrotra (2020) "Corporate investment and the exchange rate: The financial channel," *BIS Working Papers* (No 839).

Basu, Suman, Emine Boz, Gita Gopinath, Francisco Roch, and Filiz Unsal (2020) "A conceptual model for the integrated policy framework," *IMF Working Paper No. 20/121.*

Bedendo, Mascia and Paolo Colla (2015) "Sovereign and corporate credit risk: evidence from the eurozone," *Journal of Corporate Finance*, 33, 34–52.

Benetrix, Agustin, Deepali Gautam, Luciana Juvenal, and Martin Schmitz (2019) "Cross-border currency exposures," *IMF Working Paper* (No. 19/299).

Bernanke, Ben S, Mark Gertler, and Simon Gilchrist (1999) "The financial accelerator in a quantitative business cycle framework," *Handbook of Macroeconomics*, 1, 1341–1393.

Bertaut, C, Valentina Bruno, and Hyun Song Shin (2020) "Original sin redux," *Manuscript.*

BIS (2019) "Monetary policy frameworks in EMEs: inflation targeting, the exchange rate and financial stability," *Annual Economic Report, Chapter 2.*

Bruno, Valentina and Hyun Song Shin (2014) "Cross-border banking and global liquidity," *The Review of Economic Studies.*

——— (2015) "Capital flows and the risk-taking channel of monetary policy," *Journal of Monetary Economics*, 71, 119–132.

——— (2019) "Dollar exchange rate as a credit supply factor–evidence from firm-level exports," *BIS Working Papers* (No 819).

Calvo, Guillermo A (1983) "Staggered prices in a utility-maximizing framework," *Journal of Monetary Economics*, 12 (3), 383–398.

Calvo, Guillermo A and Carmen M Reinhart (2002) "Fear of floating," *The Quarterly journal of economics*, 117 (2), 379–408.

Carstens, Agustin and Hyun Song Shin (2019) "Emerging markets aren't out of the woods yet," *Foreign Affairs Magazine*, March.

Cavallino, Paolo (2019) "Capital flows and foreign exchange intervention," *American Economic Journal: Macroeconomics*, 11 (2), 127–70.

Cavallino, Paolo and Nikhil Patel (2019) "FX intervention: goals, strategies and tactics," *BIS Papers No. 104b.*

Cavallino, Paolo and Damiano Sandri (2020) "The open-economy ELB: contractionary monetary easing and the trilemma."

Céspedes, Luis Felipe, Roberto Chang, and Andrés Velasco (2004) "Balance sheets and exchange rate policy," *The American Economic Review*, 94 (4), 1183.

CGFS (2019) "Establishing viable capital markets," *Committee on the Global Financial System Papers* (No. 63).

Chan-Lau, Jorge A (2005) "Pension funds and emerging markets," *Financial Markets, Institutions Instruments*, 14 (3), 107–134.

Chang, Roberto (2018) "Foreign exchange intervention redux," *National Bureau of Economic Research* (No. w24463).

Chang, Roberto and Andrés Velasco (2017) "Financial frictions and unconventional monetary policy in emerging economies," *IMF Economic Review*, 65 (1), 154–191.

Chen, Zefeng, Sanaa Nadeem, and Shanaka J Peiris (2021) "Bank balance sheets and external shocks in asia: the role of fxi, mpms and cfms," *International Monetary Fund Working Papers 21/10.*

Cook, David (2004) “Monetary policy in emerging markets: Can liability dollarization explain contractionary devaluations?” *Journal of Monetary Economics*, 51 (6), 1155–1181.

Cook, David E and Nikhil Patel (2020) “Dollar invoicing, global value chains, and the business cycle dynamics of international trade,” *BIS Working Papers*, No 860.

Corsetti, Giancarlo, Keith Kuester, André Meier, and Gernot J Müller (2014) “Sovereign risk and belief-driven fluctuations in the euro area,” *Journal of Monetary Economics*, 61, 53–73.

Davis, J Scott, Ippei Fujiwara, Kevin XD Huang, and Jiao Wang (2021) “Foreign exchange reserves as a tool for capital account management,” *Journal of Monetary Economics*, 117, 473–488.

De Bruyckere, Valerie, Maria Gerhardt, Glenn Schepens, and Rudi Vander Vennet (2013) “Bank/sovereign risk spillovers in the European debt crisis,” *Journal of Banking & Finance*, 37 (12), 4793–4809.

Degryse, Hans, Olivier De Jonghe, Sanja Jakovljević, Klaas Mulier, and Glenn Schepens (2019) “Identifying credit supply shocks with bank-firm data: Methods and applications,” *Journal of Financial Intermediation*, 40, 100813.

Devereux, Michael B, Charles Engel, and Giovanni Lombardo (2020) “Implementable rules for international monetary policy coordination,” *IMF Economic Review*, 68 (1), 108–162.

Devereux, Michael B and James Yetman (2014) “Globalisation, pass-through and the optimal policy response to exchange rates,” *Journal of International Money and Finance*, 49, 104–128.

Du, Wenxin and Jesse Schreger (2021) “Sovereign risk, currency risk, and corporate balance sheets,” *Review of Financial Studies* (Forthcoming).

Durbin, Erik and David Ng (2005) “The sovereign ceiling and emerging market corporate bond spreads,” *Journal of International Money and Finance*, 24 (4), 631–649.

Dvorkin, Maximiliano, Juan M Sanchez, Horacio Sapriza, and Emircan Yurdagul (2021) “Sovereign debt restructurings,” *American Economic Journal: Macroeconomics*, 13 (2), 26–77.

Eichengreen, Barry and Ricardo Hausmann (1999) “Exchange rates and financial fragility,” *National Bureau of Economic Research* (No. 7418).

Eichengreen, Barry, Ricardo Hausmann, and Ugo Panizza (2005) "The pain of original sin," *Other people's money: Debt denomination and financial instability in emerging market economies*, 13–47.

Eichengreen, Barry J, Ricardo Hausmann, and Ugo Panizza (2002) "Original sin: the pain, the mystery, and the road to redemption," *memo*.

Engel, Charles and JungJae Park (2018) "Debauchery and original sin: The currency composition of sovereign debt," *National Bureau of Economic Research* (No. w24671).

Gertler, Mark and Peter Karadi (2011) "A model of unconventional monetary policy," *Journal of Monetary Economics*, 58 (1), 17–34.

——— (2015) "Monetary policy surprises, credit costs, and economic activity," *American Economic Journal: Macroeconomics*, 7 (1), 44–76.

Gertler, Mark, Nobuhiro Kiyotaki et al. (2010) "Financial intermediation and credit policy in business cycle analysis," *Handbook of Monetary Economics*, 3 (3), 547–599.

Gopinath, Gita, Emine Boz, Camila Casas, Federico J Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller (2020) "Dominant currency paradigm," *American Economic Review*, 110 (3), 677–719.

Gourinchas, Pierre-Oliver (2018) "Monetary policy transmission in emerging markets: An application to Chile," *Series on Central Banking Analysis and Economic Policies no. 25*.

Hofmann, Boris, Ilhyock Shim, and Hyun Song Shin (2020a) "Bond risk premia and the exchange rate," *Journal of Money, Credit and Banking*, 52 (S2), 497–520.

——— (2020b) "Emerging market economy exchange rates and local currency bond markets amid the Covid-19 pandemic," *BIS Bulletin*, No 5.

Hofmann, Boris, Hyun Song Shin, and Mauricio Villamizar-Villegas (2019) "FX intervention and domestic credit: Evidence from high-frequency micro data," *BIS Working Papers* (No. 774).

Hördahl, Peter and Ilhyock Shim (2020) "EME bond portfolio flows and long-term interest rates during the Covid-19 pandemic," *BIS Bulletin No 18*.

Ivashina, Victoria, David S Scharfstein, and Jeremy C Stein (2015) "Dollar funding and the lending behavior of global banks," *The Quarterly Journal of Economics*, 130 (3), 1241–1281.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina (2012) "Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications," *American Economic Review*, 102 (5), 2301–26.

Kearns, Jonathan and Nikhil Patel (2016) "Does the financial channel of exchange rates offset the trade channel?" *BIS Quarterly Review, December 2016*.

Khwaja, Asim Ijaz and Atif Mian (2008) "Tracing the impact of bank liquidity shocks: Evidence from an emerging market," *American Economic Review*, 98 (4), 1413–42.

Kumhof, Michael and Douglas Laxton (2013) "Simple fiscal policy rules for small open economies," *Journal of International Economics*, 91 (1), 113–127.

McKinnon, Ronald I (2000) "Limiting moral hazard and reducing risk in international capital flows: the choice of an exchange rate regime," in *Global Financial Crises*, 159–176: Springer.

Mendoza, Enrique G and Eugenio Rojas (2019) "Positive and normative implications of liability dollarization for sudden stops models of macroprudential policy," *IMF Economic Review*, 67 (1), 174–214.

Mendoza, Enrique G and Vivian Z Yue (2012) "A general equilibrium model of sovereign default and business cycles," *The Quarterly Journal of Economics*, 127 (2), 889–946.

Morelli, Juan M, Pablo Ottonello, and Diego J Perez (2021) "Global banks and systemic debt crises," *National Bureau of Economic Research* (No. w28892).

Obstfeld, Maurice (2015) "Trilemmas and trade-offs: living with financial globalisation," *memo*.

Ottonello, Pablo and Diego J Perez (2019) "The currency composition of sovereign debt," *American Economic Journal: Macroeconomics*, 11 (3), 174–208.

Paravisini, Daniel (2008) "Local bank financial constraints and firm access to external finance," *The Journal of Finance*, 63 (5), 2161–2193.

Paravisini, Daniel, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon (2015) "Dissecting the effect of credit supply on trade: Evidence from matched credit-export data," *The Review of Economic Studies*, 82 (1), 333–359.

Rey, Hélène (2013) "Dilemma not Trilemma: The global financial cycle and monetary policy independence," *Jackson Hole Economic Symposium*.

Romer, Christina D and David H Romer (2004) "A new measure of monetary shocks: derivation and implications," *The American Economic Review*, 94 (4), 1055–1084.

Schmitt-Grohé, Stephanie and Martın Uribe (2003) "Closing small open economy models," *Journal of International Economics*, 61 (1), 163–185.

Appendix

A Microfoundation for the time-varying leverage constraint (κ)

In this section, we provide a simple microfoundation of time varying κ in the paper. Suppose there is a continuum of sovereigns (indexed by i) that make up the mass n that represents the EM country in the main text ($\int idi = n$). All sovereigns are ex-ante identical. Each receives tax revenues $tax_{i,t}$ from the private economy and borrows from abroad an amount equal to $B^{Ge}_{i,t}(RER_{i,t})^{ldgovt}$ (fixed amount in local currency term, regardless of the currency denomination of the contract). Each period, a sovereign decides to default on its debt or not. When it defaults, it does not repay its debt, and receives a one-time value of default $\epsilon_{i,t}$. $\epsilon_{i,t}$ can be thought of as the sum of all default costs (political costs, sanctions, preference etc.).[26] We further assume that $\epsilon_{i,t}$ follows a persistent AR(1) process, such that $\epsilon_{i,t} = \alpha + \beta\epsilon_{i,t-1} + u_{i,t}$. The value to the sovereign under the repayment and default scenarios is given by

$$\text{value of repay: } tax_{i,t} - B^{Ge}_{i,t-1}(RER_{i,t})^{ldgovt} \text{ and value of default: } tax_{i,t} - \epsilon_{i,t} \tag{A.1}$$

The sovereign repays the debt if value of repay $\geq$ value of default.i.e.

$$\text{repay iff } \epsilon_{i,t} \geq R_{i,t-1}B^{Ge}_{i,t-1}(RER_{i,t})^{ldgovt} \tag{A.2}$$

We assume $\epsilon_{i,t}$ is a shock that has a cumulative distribution function $G(\epsilon_{i,t})$. One can think of $G(\epsilon_{i,t})$ as capturing variations along the political spectrum, and therefore the cost of default across countries. The $\epsilon_{i,t}$ shock is realized at the same time as other shocks in the model. At each point at time t, there is a cutoff $\bar{\epsilon}_t$ such that

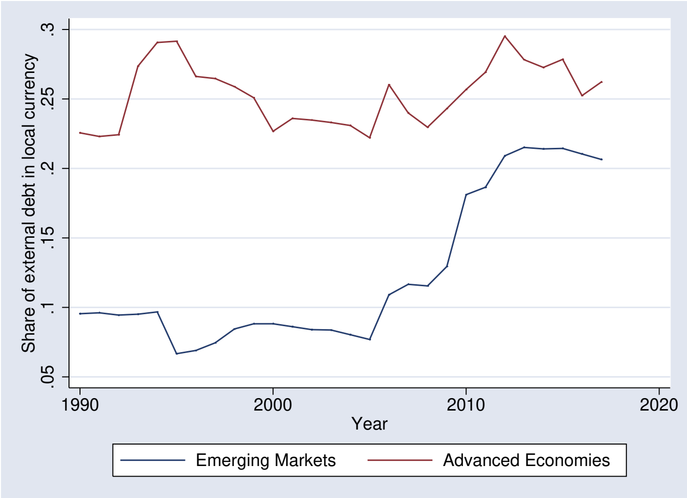
$$R_{i,t-1}B^{Ge}_{i,t-1}(RER_{i,t})^{ldgovt} = \bar{\epsilon}_{i,t} \tag{A.3}$$

A country i with $\epsilon_{i,t} > \bar{\epsilon}_t$ chooses to repay, whereas a country with $\epsilon_{i,t} \leq \bar{\epsilon}_t$ chooses to default. Therefore, a mass $1 - G(\bar{\epsilon}_t)$ of sovereigns repays their debt each period. Importantly, the size of debt repayment fluctuations move the threshold, according to equation A.3. For example, if $RER_{i,t}$ is high, it requires a higher threshold $\hat{\epsilon}_t \geq \bar{\epsilon}_t$ to commit to repay the debt. Under this setting, when the bankers abscond, the assets that lenders can take back becomes $1 - \kappa - E_tG(\bar{\epsilon}_{t+1}) \equiv 1 - \kappa^e_t$ in the main text. This gives rise to a time varying κ^e_t that depends on the debt repayment of the EM country.

[26] See Arellano et al. (2017), Arellano et al. (2020b), Arellano et al. (2020a) and Dvorkin et al. (2021).

List of Figures

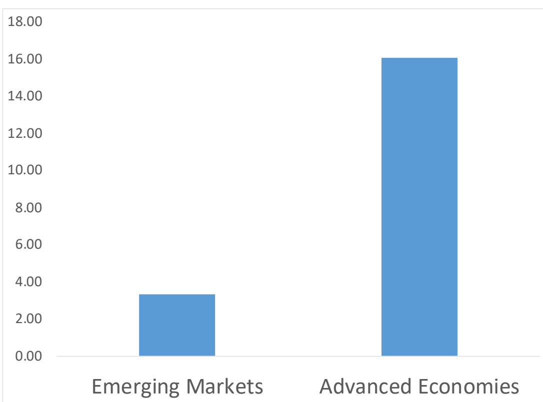
Figure 1 *– EMs are borrowing more from abroad in local currency*



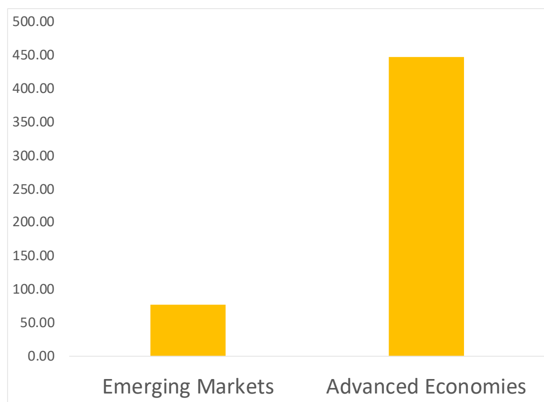
Notes: Share of external debt denominated in local currency. Median across a balanced sample of 14 EMs (CL, IN, KR, MY, CO, PE, CN, AR, HU, ID, BR, PL, PH, MX) and 8 AEs (DK,JP, CA,GB,AU,NO,NZ,CH). Source: Benetrix et al. (2019).

Figure 2 *– EM financial markets are shallower*

(a) Size of FX markets

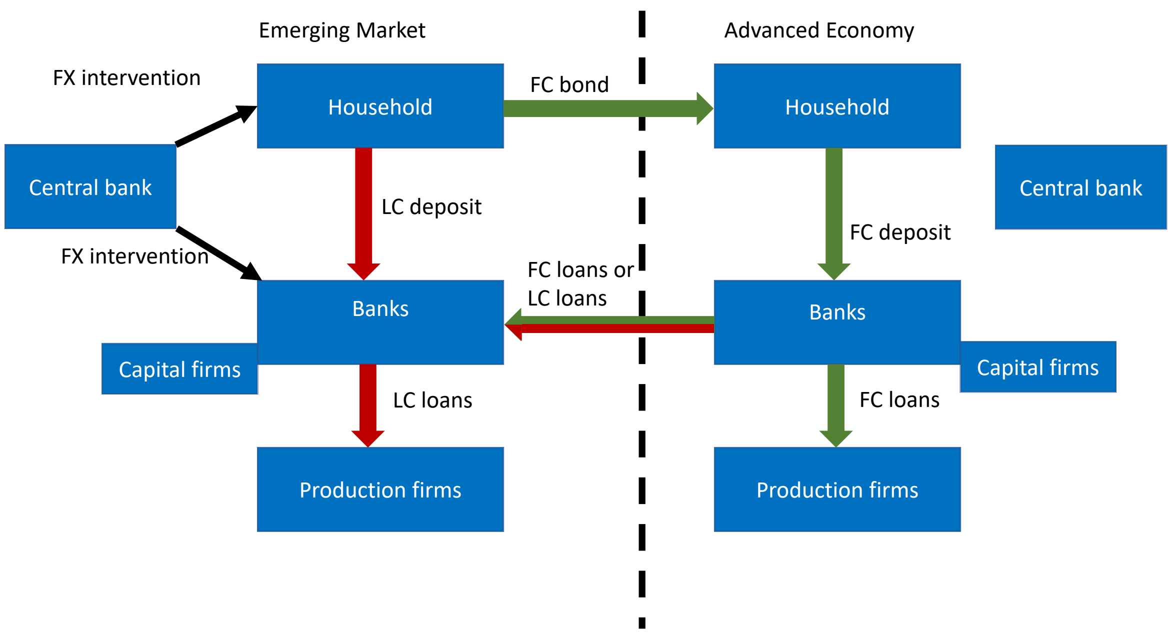


(b) Size of institutional investors



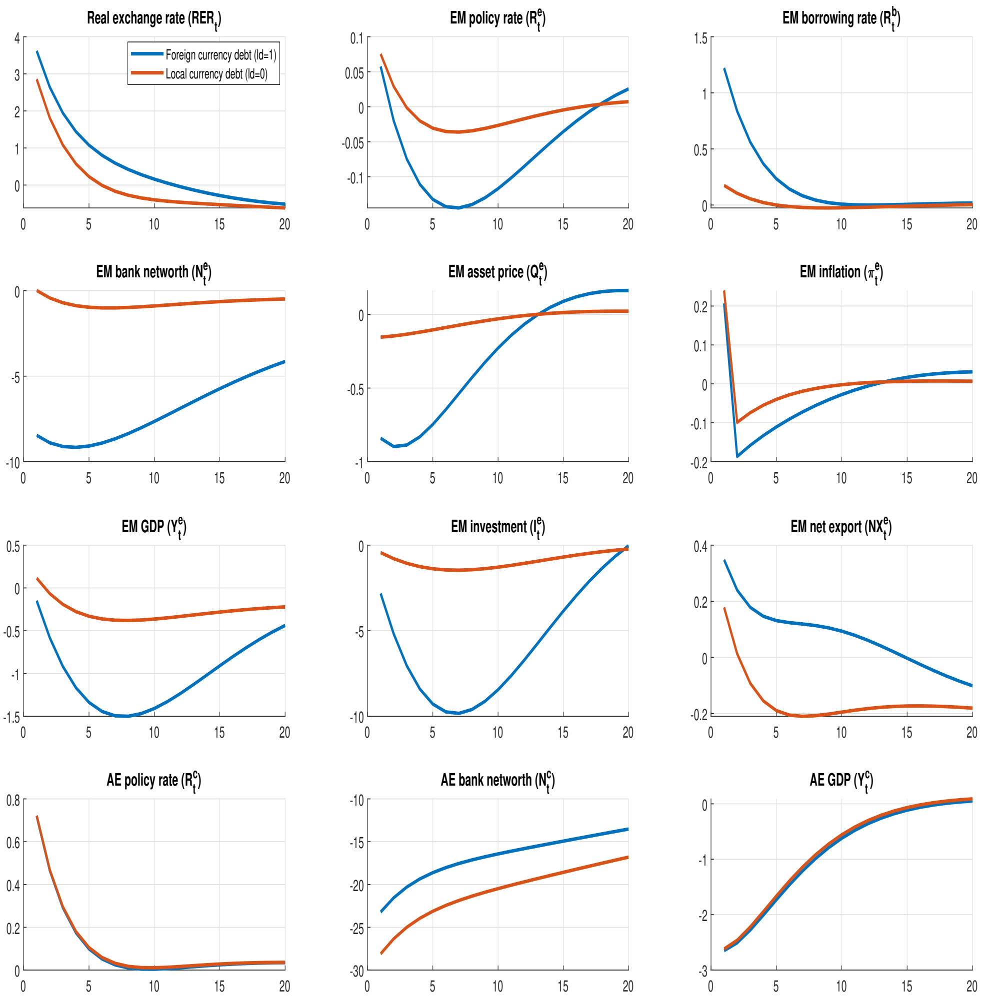
Notes: Panel (a): Average daily turnover in FX derivatives markets as a % of GDP. Medians based on a sample of 16 EM currencies (ZAR, HUF, TRY, CZK, MXN, PLN, KRW, BRL, CLP, RUB, THB. INR, COP, PHP, PEN, IDR) and 6 AE currencies (NZD, AUD, GBP, SEK, NOK, CAD). Source: BIS triennial survey, 2016. Panel (b): Assets of institutional investors as a % of GDP. Sample medians based on 8 EMs (TR, RU, IN, MX, BR, CL, KR, ZA) and 3 AEs (AU, CA, GB). Source: BIS (2019).

Figure 3 – *Schematic representation of the model*



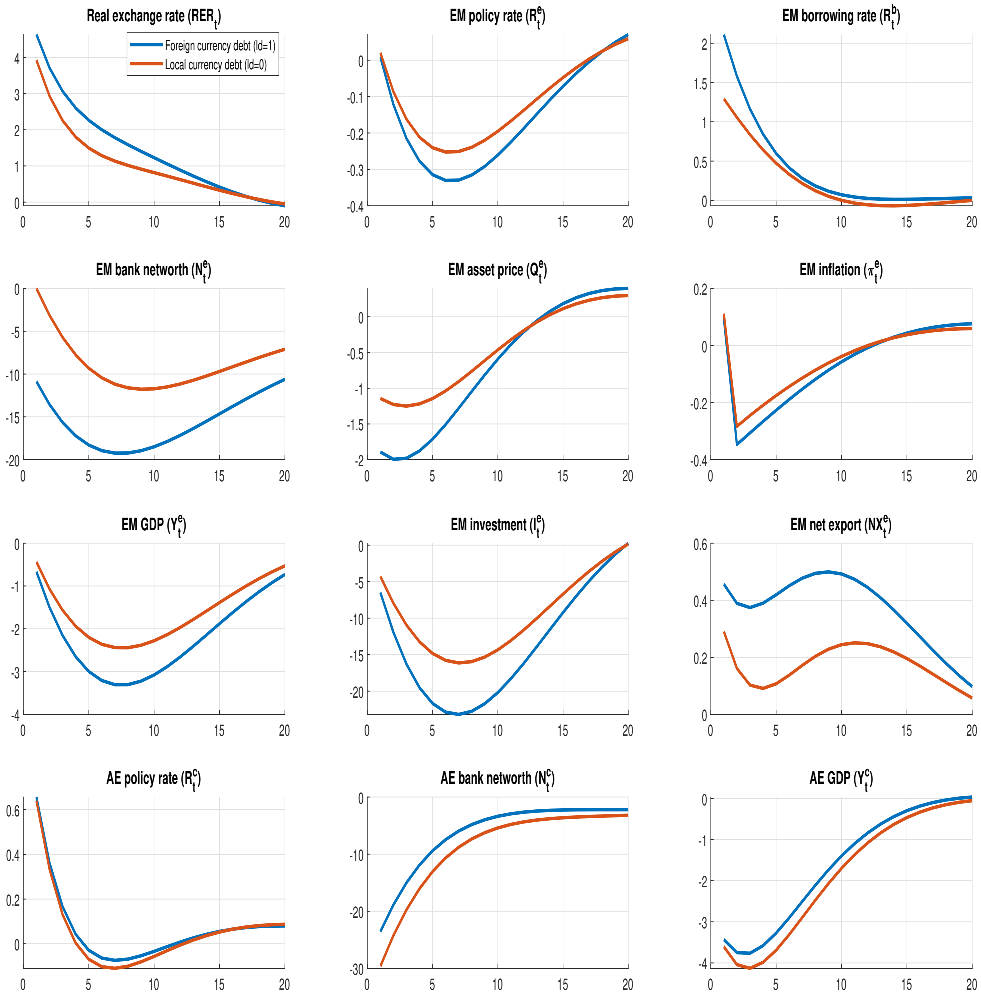
Notes: FC = foreign currency, LC = local currency

Figure 4 – *Advanced economy monetary tightening without global lender financial friction*



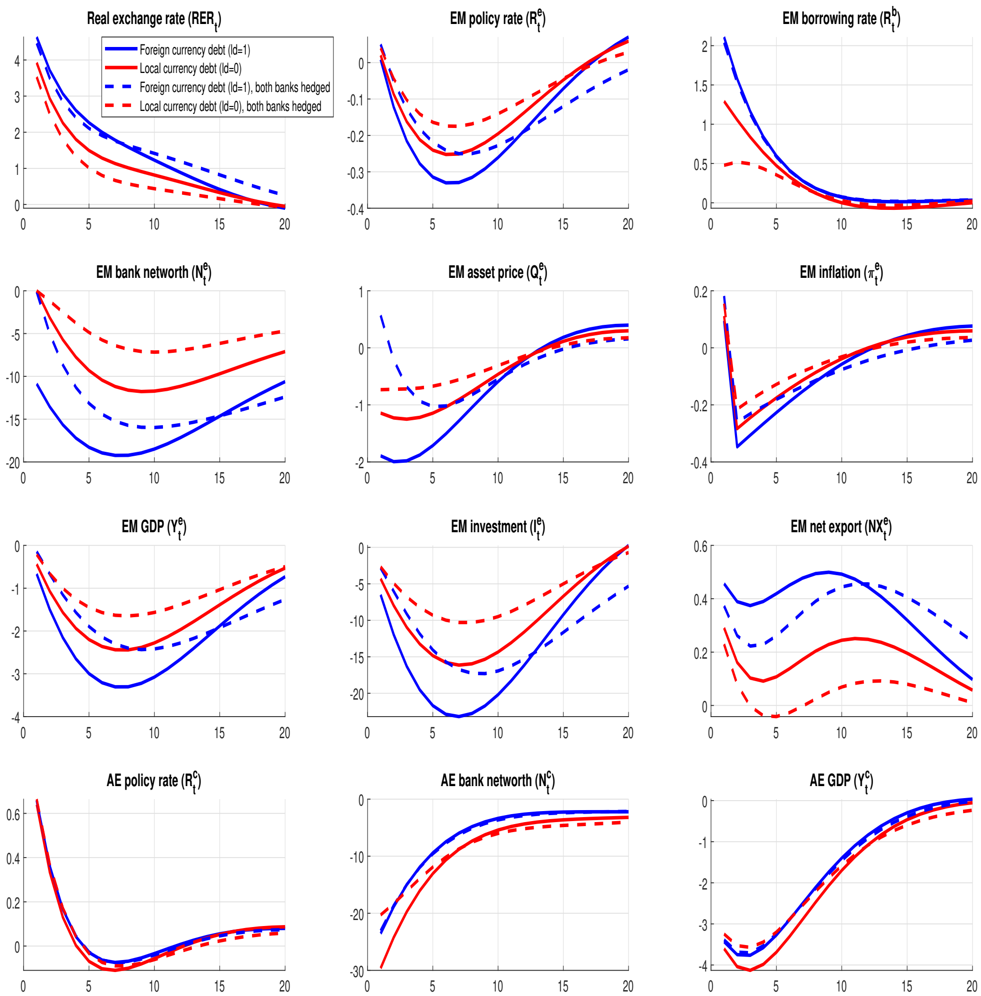
Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state.

Figure 5 – *Advanced economy monetary tightening with global lender financial friction*



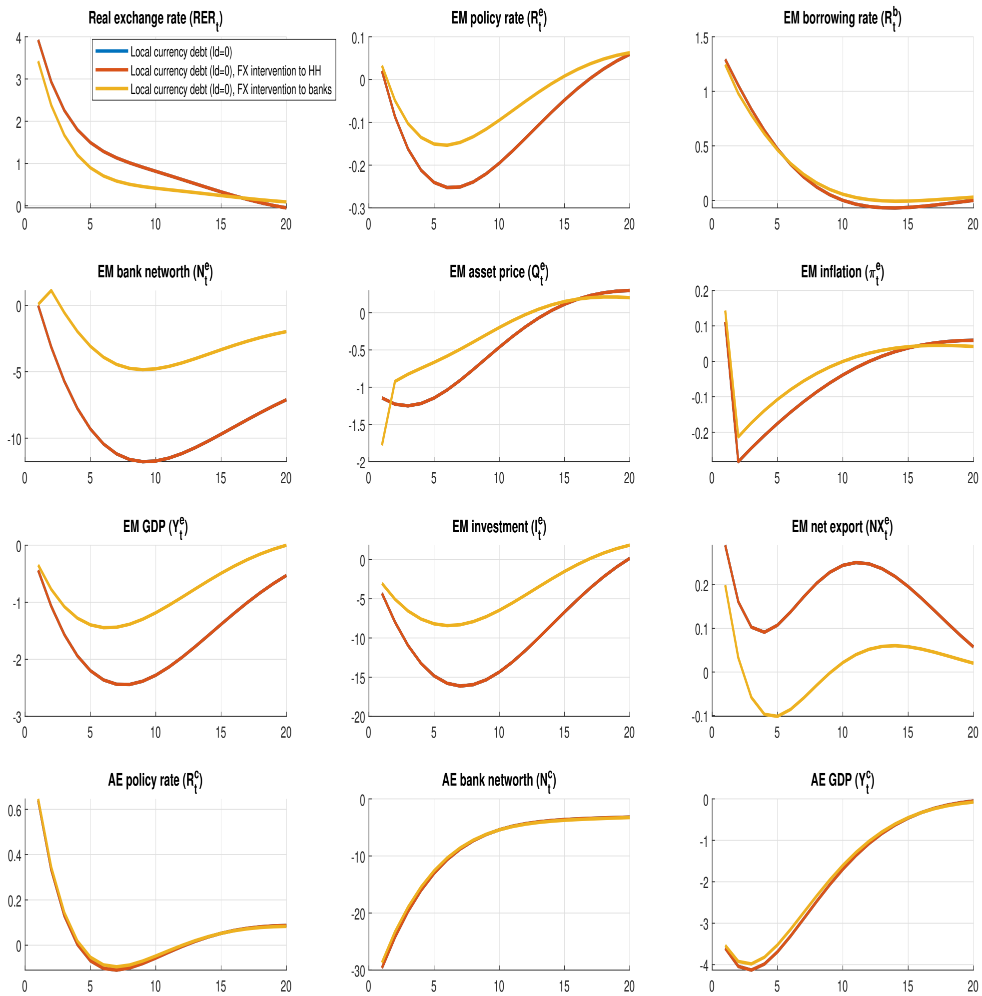
Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state.

Figure 6 *– Advanced economy monetary tightening: the role of financial exchange rate amplification effects*



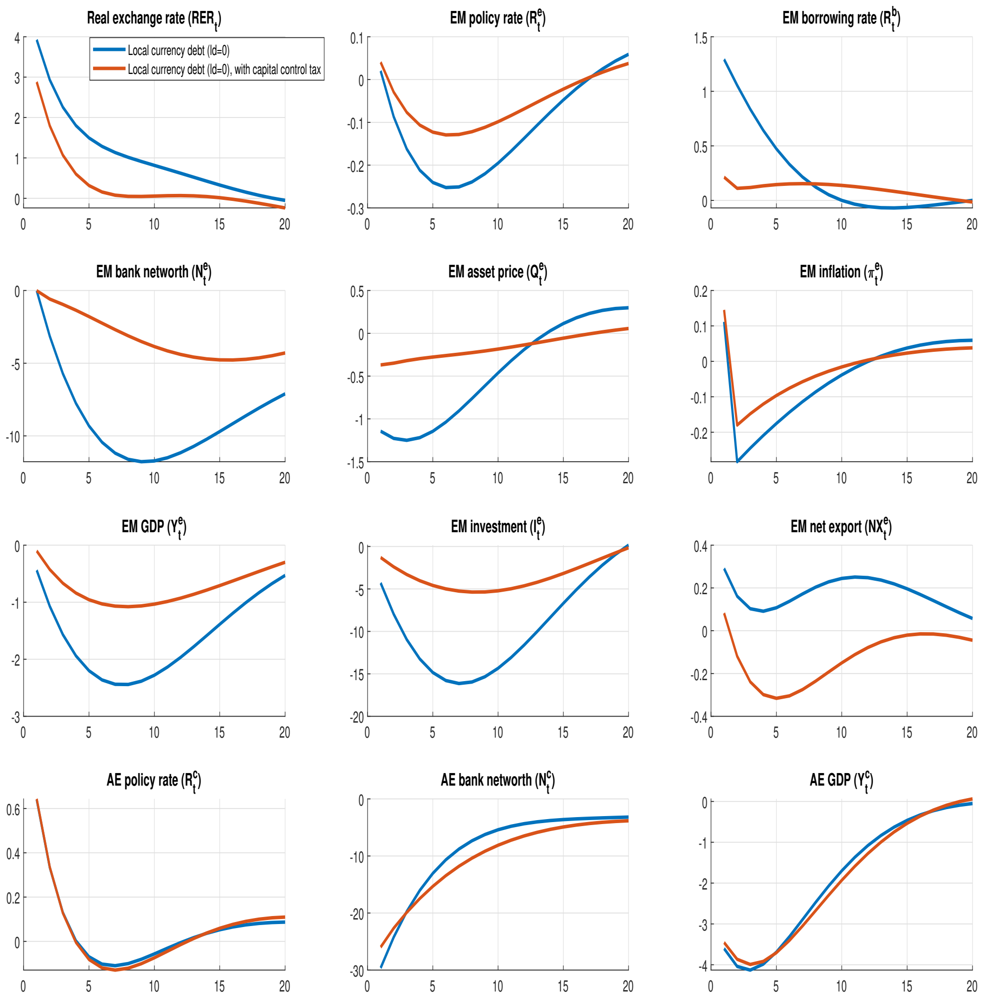
Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state.

Figure 7 – *Advanced economy monetary tightening: the role of sterilized FX intervention*



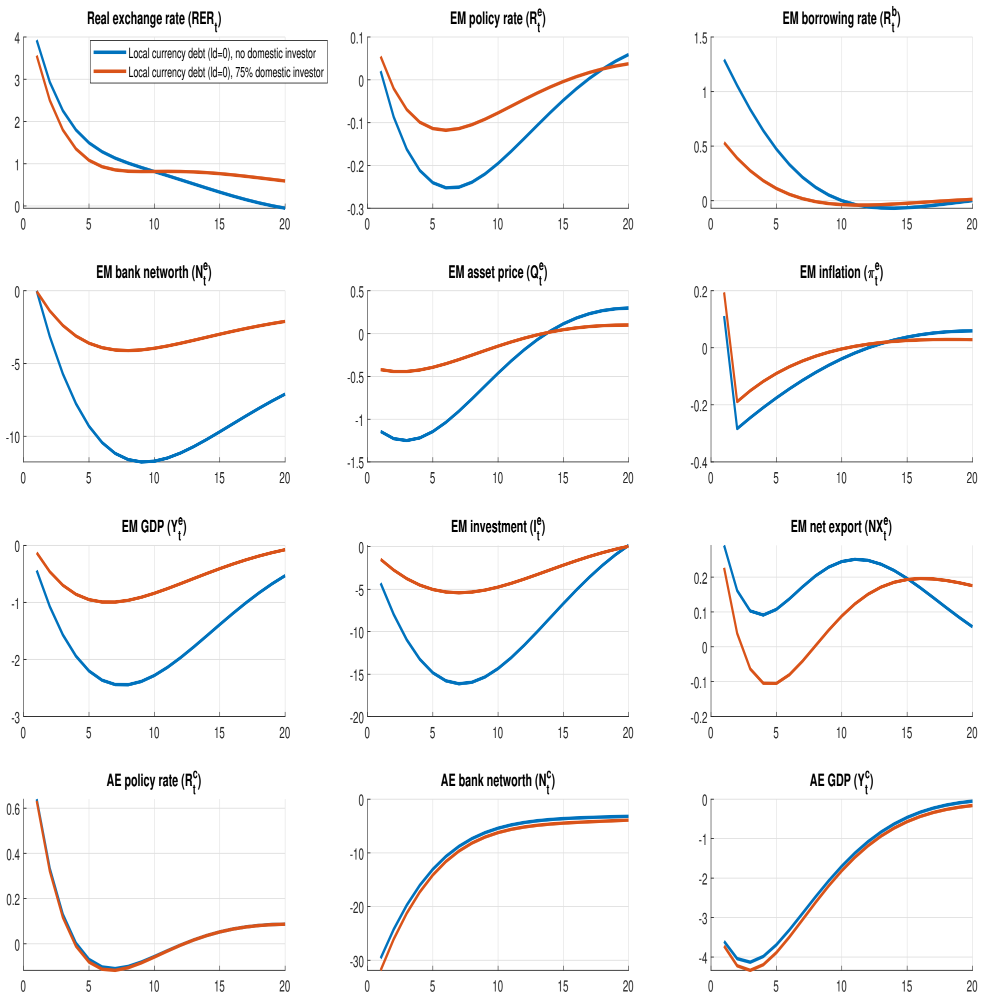
Notes: Impulse responses to a 100 basis points increase in the AE risk-free rate. Percentage deviations from steady state.

Figure 8 *– Advanced economy monetary tightening: the role of capital flow tax*



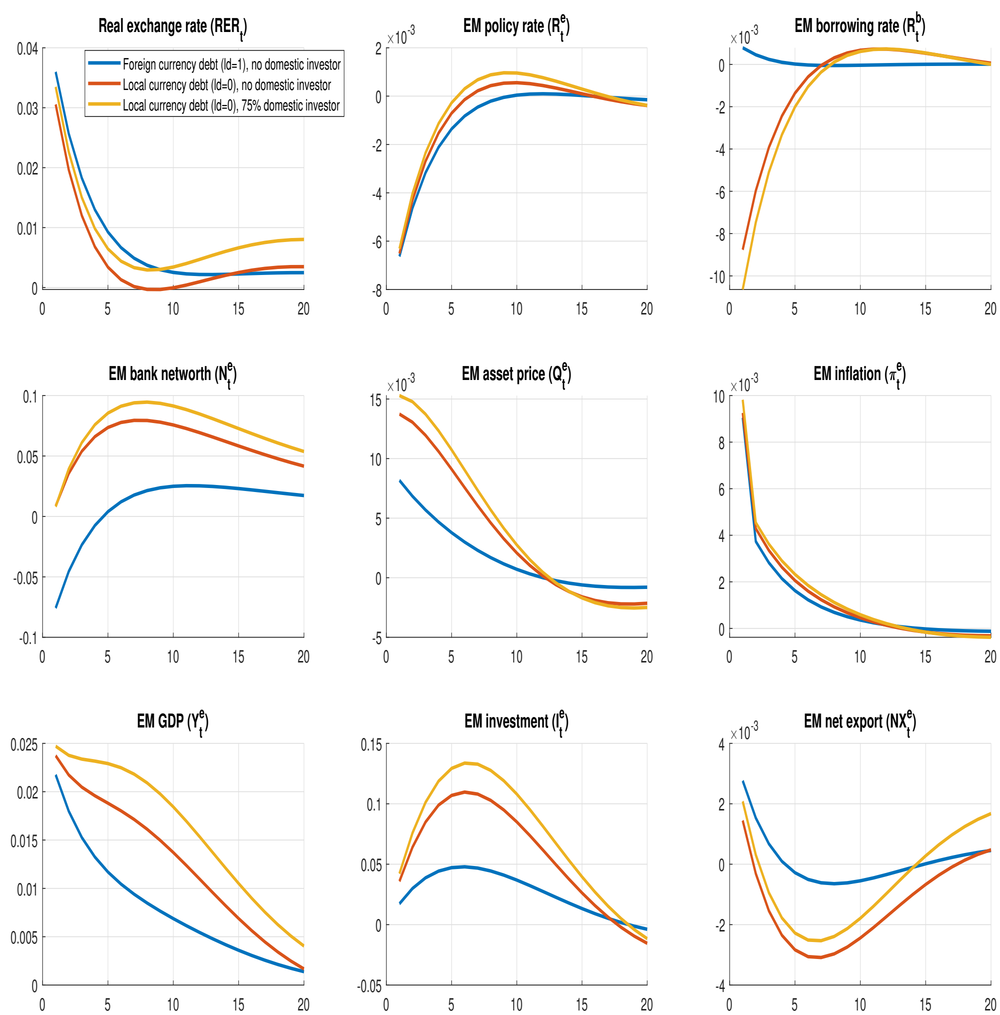
Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state.

Figure 9 – *Advanced economy monetary tightening: the role of the domestic investor base*



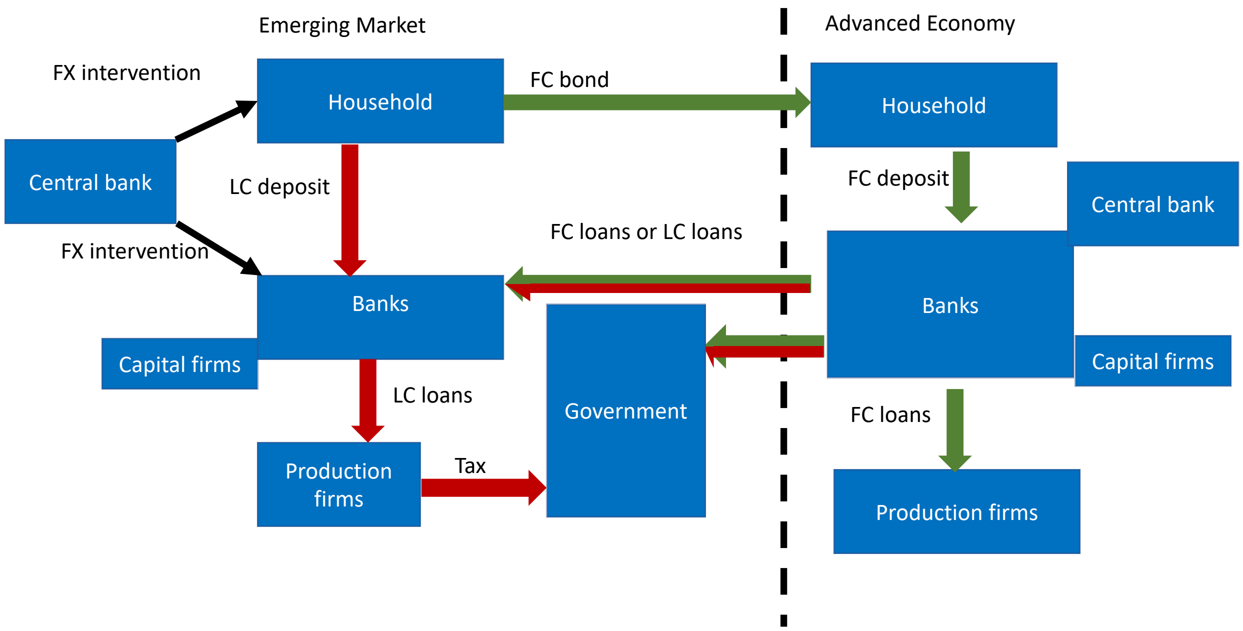
Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state.

Figure 10 *– Emerging market monetary loosening*



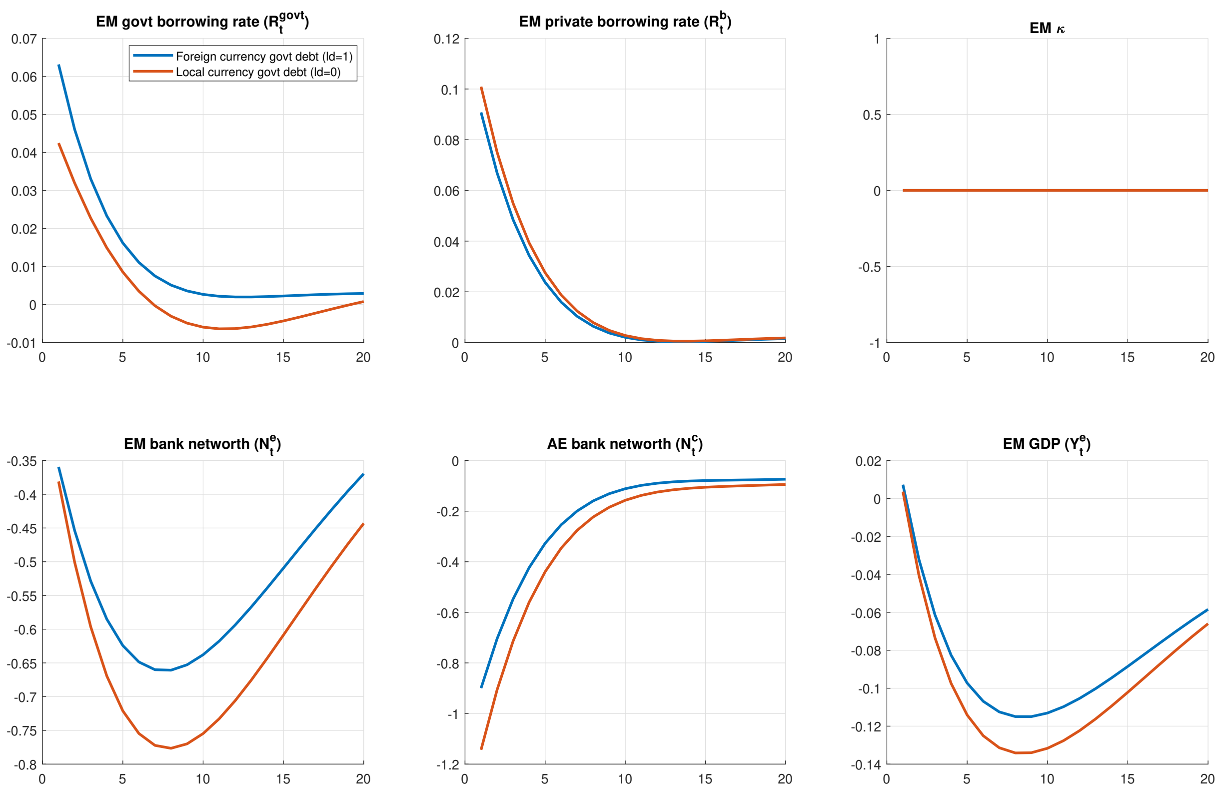
Notes: Impulse responses to a 100 basis points decrease in the emerging market risk-free rate. Percentage deviations from steady state.

Figure 11 – *Schematic representation of the model with sovereign debt*



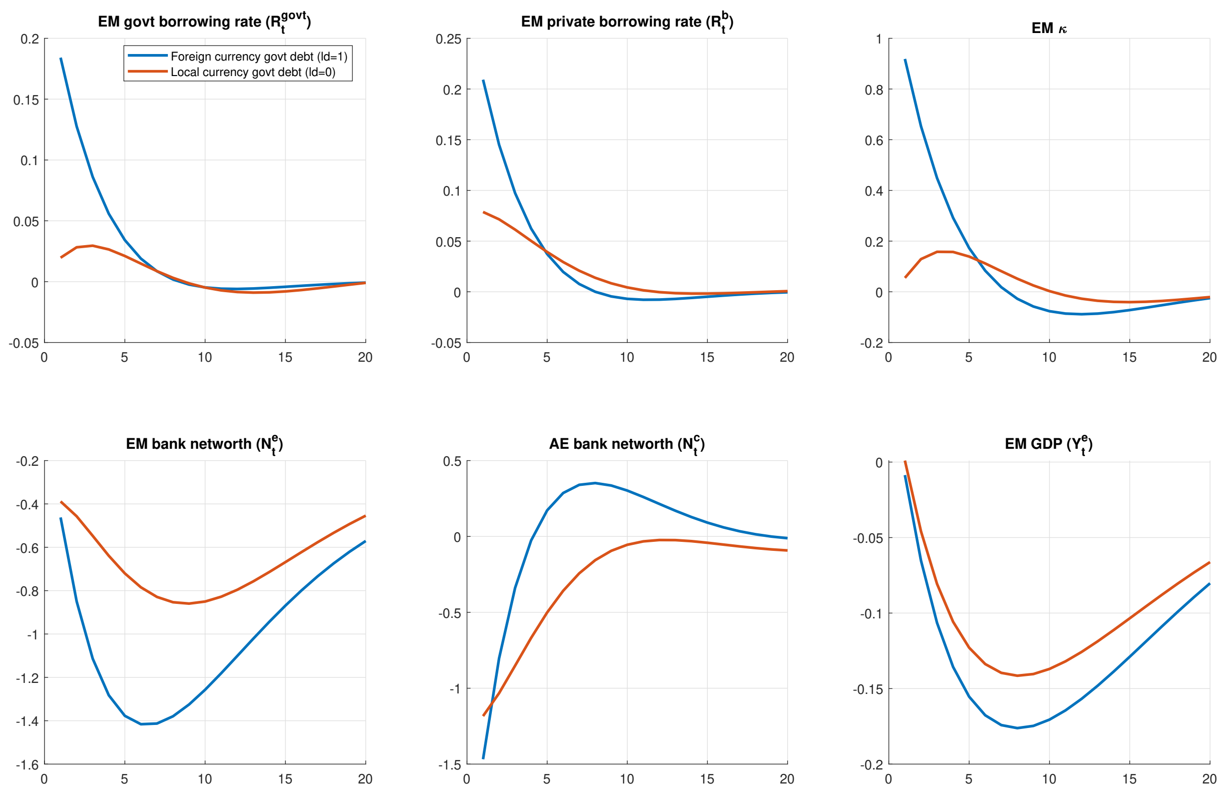
Notes: FC = foreign currency; LC = local currency

Figure 12 *– Advanced economy monetary tightening without feedback from sovereign to private borrowing conditions*



Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state. The private sector is assumed to borrow in foreign currency in both cases, only the sovereign debt currency denomination is changing.

Figure 13 – *Advanced economy monetary tightening with feedback from sovereign to private borrowing conditions*



Notes: Impulse responses to a 100 basis points increase in the advanced economy risk-free rate. Percentage deviations from steady state. The private sector is assumed to borrow in foreign currency in both cases, only the sovereign debt currency denomination is changing.

List of Tables

Table 1 – *Response of investment to US monetary policy shocks*

	(1.1)	(1.2)	(2)	(3)
Sample	EM	AE	EM	EM
β_{osr}	-0.098***	-0.010	-0.093***	-0.099***
	(0.026)	(0.0083)	(0.025)	(0.023)
β_{os}	-0.28***	0.012	-0.23**	-0.18*
	(0.079)	(0.013)	(0.082)	(0.094)
P value $F(\beta_{os} = \beta_{osr})$	0.02**	0.12	0.08*	0.31
Observations	235	350	235	235
R-squared	0.169	0.412	0.175	0.327
Sample	EM	AE	EM	EM
Country FE	NO	NO	YES	YES
Time FE	NO	NO	NO	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Estimates based on 2.1 for a 100 basis points increase in the US policy rate. For columns 1.1, 2 and 3: Unbalanced panel of 16 EMs (AR, BR, CL, CN, CO, CZ, HU, ID, IN, KR, MX, MY, PE, PH, PL, RU). For column 1.2: 8 AEs (DK, JP, CA, GB, AU, NO, NZ, CH). Source: Benetrix et al. (2019) (annual data from 1990-2007, interpolated linearly to quarterly frequency), IMF International Financial Statistics.

Table 2 *– Impact of foreign monetary contraction on EM GDP: Key model mechanisms*

(1) Trade channel		(2) Financial channel		
(1a) Aggregate demand	(1b) EM depreciation	(2a) Credit Supply	(2b) EM Depreciation	
EM GDP↓	EM GDP↑	EM GDP↓	EM GDP↓	
			Original Sin	Original Sin Redux
Mechanism				
Import demand↓	Import price↑	Foreign Net worth↓	EM Net worth↓	Foreign Net worth↓
	Import demand↓	Credit Supply↓	Borrowing rate↑	Borrowing rate↑
	Export price↓	Borrowing rate↑	Investment↓	Investment↓
	Export demand↑	Investment↓		
	CPI inflation↑			

Notes: The table summarizes the different channels through which a foreign monetary contraction affects EM GDP in the model.

Table 3 *– Model calibration*

Variable	Definition	Value
Household		
σ	Household risk aversion	2
$\nu^e = \nu^c$	Trade openness	0.95
β	Discount factor	0.99
ψ	Inverse of Frisch elasticity	0.276
γ_B	Portfolio adjustment cost	0.0001
φ_D	Deposit size*	0 or 4 (=75% of liabilty)
Trade / goods markets		
n	Size of EM	0.2
ς	Prob. of price fixed (Calvo pricing)	0.85
η	Cross-country elasticity	2
σ_p	Domestic cross-good elasticity	6
Banking sector		
θ	Bank survival rate	0.97
δ_T	Bank capital injection share	0.004
$\kappa^e = \kappa^c$	Divertable fraction*	0.38
Capital producer		
ς	Capital adjustment cost	1.728
δ	Capital depreciation	0.025
Monetary authority		
$\lambda_r^e = \lambda_r^c$	Monetary policy persistence	0.85
$\lambda_\pi^e = \lambda_\pi^c$	Taylor coefficient on inflation	2
$\lambda_y^e = \lambda_y^c$	Taylor coefficient on output gap	0.2
χ	Foreign reserve response to exchange rate*	0 or 1

*Notes: These parameters change across exercises.

Previous volumes in this series

1003 February 2022	Global production linkages and stock market co-movement	Raphael Auer, Bruce Muneaki Iwadate, Andreas Schrimpf and Alexander Wagner
1002 February 2022	Exorbitant privilege? Quantitative easing and the bond market subsidy of prospective fallen angels	Viral V Acharya, Ryan Banerjee, Matteo Crosignani, Tim Eisert and Renée Spigt
1001 February 2022	Unequal expenditure switching: Evidence from Switzerland	Raphael Auer, Ariel Burstein, Sarah Lein and Jonathan Vogel
1000 February 2022	Dollar beta and stock returns	Valentina Bruno, Ilhyock Shim and Hyun Song Shin
999 February 2022	Shadow loans and regulatory arbitrage: evidence from China	Amanda Liu, Jing Liu and Ilhyock Shim
998 February 2022	Does IT help? Information technology in banking and entrepreneurship	Toni Ahnert, Sebastian Doerr, Nicola Pierri and Yannick Timmer
997 February 2022	Money markets, collateral and monetary policy	Fiorella De Fiore, Marie Hoerova and Harald Uhlig
996 January 2022	Monetary policy expectation errors	Maik Schmeling, Andreas Schrimpf and Sigurd A M Steffensen
995 January 2022	When uncertainty decouples expected and unexpected losses	Mikael Juselius and Nikola Tarashev
994 January 2022	Capital flows and institutions	Deniz Igan, Alexandre R Lauwers and Damien Puy
993 January 2022	Term premium dynamics and its determinants: the Mexican case	Ana Aguilar-Argaez, María Diego-Fernández, Rocio Elizondo and Jessica Roldán-Peña
992 January 2022	Bank opacity - patterns and implications	Stefan Avdjiev and Maximilian Jager
991 January 2022	Monetary policy and endogenous financial crises	Frederic Boissay, Fabrice Collard, Jordi Galí and Cristina Manea
990 January 2022	Informational switching costs, bank competition, and the cost of finance	José Renato Haas Ornelas, Marcos Soares da Silva and Bernardus F Nazar Van Doornik

All volumes are available on our website www.bis.org.