The original sin redux: a model based evaluation*

Boris Hofmann†
Nikhil Patel‡
Steve Pak Yeung Wu§

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Abstract

Several emerging markets (EMs) have graduated from the "original sin" and are able to borrow abroad in their local currency. Using a two-country model this paper shows that the shift from foreign currency to local currency debt can reduce the original sin concern, but does not eliminate it. Instead, it morphs the original sin into a "redux" (Carstens and Shin (2019)). As long as EMs rely on foreign intermediated funding, local currency borrowing shifts the currency mismatch problem to the balance sheet of financially constrained global lenders. As exchange rate movements significantly affect lenders' capacity to lend, this still leaves EMs vulnerable to sharp capital flow reversals, as in the original sin case. We document empirical evidence in favor of this prediction of the model using data on currency composition of external debt of EMs. We also use the model to show that a large domestic investor base is key to eliminating the original sin, and foreign exchange intervention proves to be a useful addition to the policy toolkit of central banks.

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†Bank for International Settlements. E-mail: Boris.Hofmann@bis.org.

‡Bank for International Settlements. E-mail: Nikhil.Patel@bis.org.

§University of British Columbia and University of California, San Diego. E-mail:stevepywu@gmail.com

1 Introduction

Emerging markets (EM) have historically been unable to borrow abroad in their domestic currency, a phenomenon termed as "original sin" (see for instance Eichengreen and Hausmann (1999), Eichengreen et al. (2002) and Eichengreen et al. (2005)). Since their assets are typically in local currency, borrowing in foreign currency induces a currency mismatch which makes them vulnerable to sudden depreciations of the exchange rate that raises the value of external liabilities compared to assets. This is exacerbated by the negative feedback loops between the exchange rate and financial conditions. Indeed, currency mismatches on borrowers' balance sheets is acknowledged to have played a critical role in many EM crises in the 1990s, most notably the Asian financial crisis, where several countries with debt in foreign currency suffered from a sudden and sharp depreciation of their exchange rate that led to or exacerbated the economic downturn.

In the aftermath of these crises, and with the adoption of inflation targeting regimes following the global trend, many EMs have succeeded in overcoming the original sin, and are able to borrow from abroad in their own currency, as documented in the next section. But this apparent overcoming of the original sin has not led to a "redemption" and eliminated the financial vulnerability of EMs entirely. For instance, during the "Taper Tantrum" episode as well as the recent Covid-19 induced selloff in global financial markets, EMs suffered much more from capital flow reversals than their advanced economy counterparts.

Carstens and Shin (2019) have termed this phenomenon the "original sin redux". They point out that local currency borrowing does not eliminate the currency mismatch, but migrates it from borrowers' to lenders' balance sheets. To the extent that these global lenders are financially constrained or remain risk averse with respect to their investments in EMs, the original sin problem is not eliminated, but instead reappears in the form of a redux. They argue that the causes of EM's vulnerability are deeper than the mere inability to issue debt in their domestic currency. In particular, the key source of vulnerability of EMs to external borrowing is the shallowness of financial markets and lack of a sizable domestic investor base, which makes them reliant on external borrowing (irrespective of the currency of denomination) in the first place, and makes it difficult for international lenders to hedge risks, in turn increasing their risk aversion towards EMs in times fo market stress.

This paper provides a model-based evaluation of this original sin redux hypothesis. To this end, it sets up a two-country New Keynesian DSGE model featuring a small open EM (the home country) and a large global economy (the United States). This is an important point of departure from the literature which has typically studied the implications of capital flows and financial frictions in a small open economy setting.[1] We show that a full dynamic and general equilibrium characterization of the balance sheet constraints of global lenders is critical to understand when and how the original sin can be eliminated or returns in the form of a redux.

In the model, EM firms borrow from domestic banks to finance investment. EM banks in turn obtain their funding from global banks and deposits from domestic households. Both domestic and foreign banks face a funding constraint that is governed by their net worth.[2] This presence of financial frictions on both lender (global economy) and borrower (EM) balance sheets allows us to study the impact of global shocks on EMs under different scenarios-namely foreign currency borrowing (original sin or OS) and local currency borrowing from foreign sources (original sin redux or OSR). When the EM currency depreciates, the value of loans, which are in local currency, declines relative to the value of the liabilities, which are in foreign currency. This leads to a drop in net worth for the EM bank in the case of the original sin, and for the global bank in the case of the original sin redux. In either case, there is a tightening in lending conditions that affects the real economy in EM. The effect is muted in the case of the original sin redux, since the exchange rate depreciation does not trigger a feedback loop on the balance sheet of the EM bank, hence preventing a further deterioration in financial conditions.

Using this framework, we highlight four findings. First, in the absence of financial frictions and leverage constraints on lenders' balance sheet, we show that local currency borrowing does indeed eliminate much of the vulnerability to external shocks in the EM. In this sense, local currency borrowing does lead to a "redemption", as would be concluded from small open economy models that do not model constraints of global lenders. The trade channel dominates in this case, and exchange rate depreciations imply that output rises in response to a foreign monetary contraction. On the other hand, with OS, the financial channel dominates and output falls.

Second, when financial frictions are present in both AE and EM, the financial channel is triggered, and output still falls, even when the EM borrows in local currency. This is because the shock which originates in the AE leads to a decline in the net worth of AE lenders, which limits their ability to lend. EM currency depreciation triggers further losses in the AE balance sheets and limits their lending capacity. This mirrors the exchange rate effect on EM balance

[1] See for instance Gabaix and Maggiori (2015), Adrian et al. (2020) and Basu et al. (2020).

[2] We focus on the currency mismatch problem in the banking sector, which is the focus in many recent capital flow studies, such as Bruno and Shin (2014) and 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 model to avoid any monetary commitment issue (inflating away local currency debt). That said, appendix **??** provides a simple extension of the model with sovereign debt.

sheets under the OS scenario, and challenges the traditional notion that local currency debt eliminates vulnerabilities in EMs.

Third, as hypothesized by Carstens and Shin (2019), we show that a large domestic investor base helps to further insulate the economy from external shocks, and reduces vulnerability to external shocks compared to both OS and OSR. Moreover, it increases the transmission of domestic monetary policy to the real economy, thus providing more leverage to policy makers in the face of adverse foreign shocks.

Fourth, we show that FX intervention that influences the balance sheet of affected domestic financial institutions can help mitigate the negative impact of external shocks via a "debt limit relaxation" channel. 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 show that it is not FX intervention per se, but rather central bank balance sheet policy, which proves to be a valuable tool for central banks.

Overall, the results highlight that while EMs may have reduced their vulnerability to external shocks by overcoming the original sin and borrowing in their domestic currency, the vulnerability is not eliminated due to the presence of financial frictions on AE lenders' balance sheet. This phenomenon of original sin redux shows the benefits of a large domestic investor base in reducing vulnerability to external shocks, as well as offering more policy space to EM central banks in the face of adverse external shocks. Furthermore, additional policy tools (beyond the policy rate) in the form of FX intervention can be useful for policy makers in dealing with external shocks.

The remainder of this paper is structured as follows. This section ends with a brief overview of the related literature. Section 2 presents two sets of stylized facts that motivate this paper. Section 3 presents the model. Section 4 discuss the main results and policy implications. Section 5 discusses empirical evidence that supports the main findings of the previous section. Section 6 discusses an extension of the model that allows for sovereign debt. 7 concludes.

Literature Review

The motivation of this paper and much of the literature around it comes from the extensive literature on the original sin, pioneered by Eichengreen et al. (2002) and Eichengreen et al. (2005). These papers emphasized the inability of emerging markets to issue external debt in domestic currency, and provided a rationale for why exchange rates do not play the stabilizing role as in the Mundell-Flemming framework. This in turn has been used as an explanation for why EMs continue to stay away from freely floating exchange rate regimes, a phenomena that Calvo and Reinhart (2000) term the "fear of floating". This motivated the first generation of models exploring the implications of debt dollarization for spillovers and monetary policy in EMs-see for instance Aghion et al. (2001), Céspedes et al. (2004) and Cook (2004). Post the great financial crisis, the literature moved towards understanding the implications of currency mismatches in the presence of financial amplifications mechanisms, giving rise to the now extensive literature on the financial channel of the exchange rate. These models combine the currency mismatch features of the previous generation of models with financial amplification mechanisms such as those in Bernanke et al. (1999) and Gertler et al. (2010). Prominent recent examples of this strand of the literature include Akinci and Queralto (2018) , Aoki et al. (2016) and Gourinchas (2018) . Akinci and Queralto (2018) consider a two country model with dollar invoicing and debt and show that these features imply large spillovers from US monetary policy on emerging markets. 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 the financial channel dominating the trade channel of exchange rates. 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 under the IMF's integrated policy framework also highlight the relevance of additional policy tools, including FX intervention, in the presence of capital inflows and the financial channel of the exchange rate (see for instance Basu et al. (2020) and Adrian et al. (2020)).These papers focus on financial frictions on the EM borrowers' (and not lenders') balance sheets. We contribute to the literature by analyzing the effect of financial friction on both EM borrowers and AE lenders, therefore allowing for a distinction between original sin and original sin redux.

Following Rey (2013) and the growing consensus in favor of the existence of a global financial cycle, several recent papers have popularized the shift in focus of financial frictions from borrowers' to lenders' balance sheets. Prominent examples include Morelli et al. (2019), Bruno and Shin (2014), and Banerjee et al. (2016). Among these, our framework is the closest to Banerjee et al. (2016), which in turn builds on the framework of banking frictions in Gertler and Karadi (2011). We show that in the present of lenders' balance sheets constraint, the distinction between local currency and foreign currency debt is less clear cut in understanding the spillover of AE shocks.

On the empirical front, the literature documenting the financial channel of exchange rate has grown sharply, especially on the back of a surge in dollar borrowing by EMs since the great financial crisis. 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 when restricting attention to exports where the impact of the trade channel is likely to be the strongest, the financial channel often tends to dominate the trade channel.Hofmann et al. (2019a) analyze the comovement of bond risk premia and exchange rates, and show that currency appreciations lead to a compression of bond spreads, even of local currency bonds. In a DSGE model, we provide support of these relationships and point to the critical role of balance sheet constraints on the lenders' side. 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.

Lastly, the paper also links to the literature evaluating the effectiveness of foreign exchange intervention in the presence of financial frictions-see for instance Cavallino (2019), Chang (2018), Hofmann et al. (2019b). Patel and Cavallino (2019) summarize a recent survey of EM central banks, and highlight that FX interventions are increasingly used to counter the financial, as opposed to the trade channel (price stability and competitiveness) of exchange rates. Consistent with Chang (2018) and Hofmann et al. (2019b), we highlight the role of FX intervention in relaxing domestic financial constraints. In our two-country model, it is an alternative to counteract the effects of financial frictions from the lenders' balance sheets.

2 Motivating stylized facts

This section highlights two sets of stylized facts that motivate key ingredients in the model and are critical for understanding the results. The first is the rising share of local currency borrowing from abroad, and the second is the shallowness of domestic financial markets in EMs.

Regarding the first, several emerging markets have made significant progress towards overcoming the original sin over the last two decades and are increasingly borrowing more from abroad in their local currency. Figure 1 shows the share of total external debt liabilities (across sectors) for a balanced sample of 14 EMs that are denominated in local currency. The median share has more than doubled since 2000, from under 0.1 back then to above 0.2 in 2017.

Since the data on foreign ownership and pricing in the sovereign debt market is more readily available than for loans and other sectors of the economy, the majority of attention in the literature has focussed on the high and rising share of foreign ownership and local currency in the sovereign debt market. That said, the phenomena is not limited to sovereign debt, and the share of local currency borrowing is high even in the non-financial corporate (NFC) sector, which will be the main focus of the model in this paper since compared to sovereign borrowing, it allows a more cleaner link between borrowing and real economic activity. In fact, as we show next, estimates of the share of local currency borrowing by NFCs in EMs is of a similar order of magnitude, if not even slightly higher, than in the sovereign bond market. [3]

As shown in Table 1, the foreign borrowing of NFCs can be split into three components.[4] The first is direct bond issuance by NFCs in international markets, which accounts for about 22% of the total. The second is direct cross-border bank loans from international banks, which accounts for about 36%. The third is termed indirect bank loans, and accounts for 38%. It captures the part of the cross-border borrowing of domestic banks in EMs that is used to finance their loans to domestic NFCs. The last column of Table 1 shows the share of local currency for each of these three components. It highlights that for indirect bank loans, which account for the highest share of total borrowing of NFCs from abroad, the share of local currency is fairly high, in excess of 50%. This motivates the indirect lending from aboard structure in our model, where domestic banks borrow from global banks in either local or foreign currency, and use the proceeds to make local currency loans to domestic firms.

Overall, the estimates in the table reveal that about 27% of NFC's total borrowing from abroad is in local currency. As shown in Figure 2, there is also significant cross country variation showing that it s higher in certain parts of the world (most notably Asia) than others (Latin America and Turkey)

While the share of local currency borrowing is high and rising in EMs, this is also the case for advanced economies. This raises the question of what are the distinguishing features of EMs, if any, which make the implications of this phenomena different for them compared to advanced economies. We argue that the answer to this question lies in the shallowness of financial markets in EMs compared to their advanced economy counterparts. Figure 3 illustrates this along two dimensions. Figure 3a shows that the size of the FX market for EM currencies is significantly small compared to AE currencies. This means that even if they borrow in their local currency and pass on the currency mismatch to global lenders who may be more financially capable of dealing with and hedging these exchange rate risk, opportunities to do so are limited even for them given the shallowess of the FX market for

[3]See also Hale et al. (2020) who document a sharp rise in local currency international bond issuance by corporates in emerging markets.

[4]For further details on this classification and related trends, see for instance Avdjiev et al. (2020)

EM currencies.

Figure 3b shows the size of domestic institutional investors (in relation to GDP). These investors, which include entities like pension funds and insurance companies, are a measure of the size of the domestic investor base in an economy. Given that this base is small in EMs, they are left more vulnerable to episodes when there is a pull-back and tightening in funding conditions from abroad. Advanced economies on the other hand are better able to deal with such scenarios given the availability of a large domestic investor base. This contrast in particularly stark in scenarios when there is global retrenchment in cross-border capital flows. While advanced economies can "fall back" on their domestic investor base to cushion the blow, this option is hardly available to EMs.

3 Model

The model is structured around the asymmetric two country model developed by BDL. Figure 4 provides a diagramatic representation of the setup. The two countries are Emerging Market (EM) and Advanced Economy (AE). Both economies include households, capital producers, production firms, banks (financial intermediaries)[5] and a monetary authority. The financial sector is modeled as in Gertler and Karadi (2011).

3.1 The Emerging Market setting

3.1.1 Household

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

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

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 household consumption on EM goods and AE goods. The consumption basket takes the following form:

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

[5]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. The non-bank finance sector are also subject to similar leveraged constraint. See for example, Morris et al. (2017).

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

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

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

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

where S_t is the exchange rate, which is price of AE currency in terms of the EM currency. An EM currency depreciation is an increase in S_t. B_t^e is the EM household holding of 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 into 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 household holding of AE risk-free bond and γ_B is a parameter that introduce a small convex transaction cost in international portfolio adjustment.

3.1.2 Capital goods producers

Capital producing firms in the EM buy back the 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:

$$\Gamma(I_t^e, I_{t-1}^e) = \varsigma(\frac{I_t^e}{I_{t-1}^e} - 1)^2 I_t^e \tag{3.5}$$

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

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

$$K_t^e = I_t^e + (1-\delta)K_{t-1}^e \tag{3.6}$$

3.1.3 Banks

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 the profits to households. The remaining θ continue 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. Banks are subject to an incentive constraint described below. The net worth of bank i is denoted as $N^e_{i,t}$.

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

$$N^e_{i,t} + (RER_t)^{ld} V^e_{i,t} + D^e_t = Q^e_t K^e_{i,t} + TB^e_t \tag{3.7}$$

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

$$N^e_{i,t} = R^e_{k,t} Q^e_{t-1} K^e_{i,t-1} - (RER_t)^{ld} \frac{R_{b,t-1}}{(\pi^c_t)^{ld} (\pi^e_t)^{1-ld}} V^e_{i,t-1} - \frac{R^e_{t-1}}{\pi^e_t} D^e_{t-1} \tag{3.8}$$

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

To motivate the financial friction, we follow Gertler and Karadi (2011) to model an incentive problem. Specifically, at the beginning of each period, the banker has the ability to abscond the a fraction κ^e of the assets. Therefore, no one will be willing to lend to the EM banks unless the following incentive compatibility constraint is satisfied.

$$J^e_{i,t} \geq \kappa^e Q^e_t K^e_{i,t} \tag{3.9}$$

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

Limitation of domestic deposit

To put the main focus on external capital flows, we limit the share of domestic deposit in the model, which can be thought as a form of financial sector under-development. Indeed, in many emerging countries households hold deposits in foreign currency. We assume that domestic deposits cannot be larger than $\frac{\varphi_D - 1}{\varphi_D}$ of total liabilites, where $\varphi_D \geq 1$ is an exogenous parameter. In equilibrium, deposits therefore amount to:

$$D^e_{i,t} = (\varphi_D - 1)RER^{ld}_t V^e_{i,t} \tag{3.10}$$

The maximization problem of EM banks is:

$$J^e_{i,t} = \max_{K^e_{i,t}, V^e_{i,t}, D^e_{i,t},} E_t \Lambda^e_{t+1|t}[(1-\theta)N^e_{i,t+1} + \theta J^e_{i,t+1}] \tag{3.11}$$

subject to 3.1.3, 3.1.3, 3.1.3 and 3.1.3. $\Lambda^e_{t+1|t} \equiv \beta(\frac{C^e_t}{C^e_{t-1}})^{-\sigma}$ is the stochastic discount factor of the household.

In aggregate, we can average the net worth across all EM banks. The aggregate net worth at any point of time is the sum of surviving banks and newly adjusted capital:

$$N^e_t \equiv \int N^e_{i,t} di = \theta[(R^e_{k,t} - (\frac{RER_t}{RER_{t-1}})^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D})Q^e_{t-1}K^e_{t-1} + (\frac{RER_t}{RER_{t-1}})^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D}(N^e_{t-1} - TB^e_{t-1})] + \delta_T Q^e_t K^e_{t-1} \tag{3.12}$$

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 good firms. A representative intermediate firm has the following production function:

$$Y^e_t = A^e_t (H^e_t)^{1-\alpha} (K^e_{t-1})^{\alpha} \tag{3.13}$$

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

$$R^e_{k,t} = \frac{R^e_{z,t} + (1-\delta)Q^e_t}{Q^e_{t-1}} \tag{3.14}$$

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 demands for capital and labor:

$$MC^e_t (1-\alpha) A^e_t (H^e_t)^{-\alpha} (K^e_{t-1})^{\alpha} = W^e_t \tag{3.15}$$

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

where MC_t^e is the real marginal cost of production, the price that intermediate goods firm sell their output.

The monopolistic final good firms buy goods from intermediate firms, re-package them to differentiated goods in a monopolistically competitive markets. They set prices subject to a Calvo (1983) type of friction. A random $1-\varsigma$ fraction of firms adjusts their prices each period. These assumptions generate a standard Phillips curves:

$$\pi_{e,t}^{*} = \frac{\sigma_p}{\sigma_p - 1}\frac{F_{e,t}}{G_{e,t}}\pi_{e,t}^{PPI} \tag{3.17}$$

$$F_{e,t} = Y_{e,t}MC_{e,t} + E_t[\beta\varsigma\Lambda_{t,t+1}^{e}(\pi_{e,t+1}^{PPI})^{\eta}F_{e,t+1}] \tag{3.18}$$

$$G_{e,t} = Y_{e,t}P_{e,t} + E_t[\beta\varsigma\Lambda_{t,t+1}^{e}(\pi_{e,t+1}^{PPI})^{-1+\eta}G_{e,t+1}] \tag{3.19}$$

$$(\pi_{e,t}^{PPI})^{1-\eta} = \varsigma + (1-\varsigma)(\pi_{i,e,t}^{*})^{1-\eta} \tag{3.20}$$

where $\pi_{i,e,t}^{*}$ is the optimal inflation rate for each firm i with price reset option. 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 policy

We focus on a simple Taylor rule type of monetary policy:

$$R_t^e = \lambda_r^e R_{t-1}^e + (1-\lambda_r^e)[\lambda_\pi^e(\pi_t^e - \pi_{ss}^e) + \lambda_y^e(Y_t^e - Y_{ss}^e)] + \epsilon_t^e \tag{3.21}$$

3.1.6 Foreign exchange intervention (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), in which the change in FX reserves are financed by a lump sum transfer. The two lump sum taxes to households and banks we described above serve this purpose:

$$\Delta FR_t = FR_t - R_{t-1}^c FR_{t-1} = (1-\Psi)T_t^e + \Psi TB_t^e \tag{3.22}$$

where FR_t is the 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 done by interaction with the households.

Denote RER_{SS} as the steady state RER. The monetary authority sets FX reserves response to the exchange rate with the following rule:

$$\Delta FR_t = (\frac{RER_t}{RER_{SS}})^{\chi} - 1 \tag{3.23}$$

where χ is a parameter that governs the strength of the intervention.

3.2 The Advanced Economy setting

The AE mass is $1-n$ of the world. AE variables are superscripted with c. The household, capital producer, production firm sectors and monetary policy in advanced economy are the same as the EM. The banking sector is different and is described below.

3.2.1 Banks

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

From the presentative AE bank j, the balance sheet accounting in real terms is:

$$N^c_{j,t} + D^c_{j,t} = Q^c_t K^c_{j,t} + V^e_{j,t}/(RER_t)^{1-ld} \tag{3.24}$$

where $N^c_{j,t}$ is the net worth, $D^c_{j,t}$ is the deposit from the domestic households in AE and $Q^c_t K^c_{j,t}$ is the investment in capital stock in AE.

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

$$N^c_{j,t} = R^c_{k,t} Q^c_{t-1} K^c_{i,t-1} + \frac{R_{b,t-1}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}} V^e_{i,t-1}/(RER_{t-1})^{1-ld} - \frac{R^c_{t-1}}{\pi^c_t} D^c_{t-1} \tag{3.25}$$

Incentive constraint

The AE banks face same type of incentive constraint so there could be financial friction in their banking sector:

$$J^c_{j,t} \geq \kappa^c_t (Q^c_t K^c_{j,t} + V^e_{j,t}/(RER_t)^{1-ld}) \tag{3.26}$$

The maximization problem of AE banks is:

$$J^c_{j,t} = \max_{K^c_{j,t}, V^e_{j,t}, D^c_{j,t},} E_t \Lambda^c_{t+1|t}[(1-\theta)N^c_{i,t+1} + \theta J^c_{i,t+1}] \tag{3.27}$$

subject to 3.24, 3.25 and 3.26.

Similar to 3.12, we can write the aggregate banking networth evolution as:

$$N^c_t \equiv \int N^c_{j,t} dj = \theta[(R^c_{k,t} - \frac{R^c_{t-1}}{\pi^c_t})Q^c_{t-1}K^c_{t-1} + \frac{n}{1-n}(\frac{R_{b,t-1}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}} - \frac{R^c_{t-1}}{\pi^c_t})(\frac{RER_{t-1}}{RER_t})^{1-ld}V^e_{t-1} + \frac{R^c_{t-1}}{\pi^c_t}N^c_{t-1}] \tag{3.28}$$

The first order condition of the AE bank decision w.r.t. $V^e_{j,t}$ is:

$$\Lambda^c_{t+1|t}[(1-\theta) + \theta J^{c'}_{j,t+1}][\frac{R_{b,t}}{(\pi^c_t)^{ld}(\pi^e_t)^{1-ld}}(\frac{RER_t}{RER_{t+1}})^{1-ld} - \frac{R^c_t}{\pi^c_{t+1}} + \vartheta_t] = \kappa^c_t \gamma^c_t \tag{3.29}$$

where γ^c_t is the Lagrangian multiplier associated with 3.26. ϑ_t introduces a stochastic component to the return of AE banks in investing in EM. This helps us to model capital inflow and outflow shock to the EM. χ_t can be interpreted as a preference or non-monetary return shock of investing in EM. [6]

3.3 Parameterization, shocks and regimes

We take parameters values from the literature that are in the standard range, closely following Banerjee et al. (2016) and Gertler and Karadi (2011). The model is parameterized to quarterly frequency. Table 2 reports the parameters used. The model is solved using log-linearization, assuming that the constraint is always binding, as in Gertler and Karadi (2011).

The main shock studied is a 100 basis points increase (tightening) in the advanced economy risk free rate. For robustness, we also study two additional foreign shocks- a capital outflow shock and a foreign financial shock (to the parameter κ^c) as in Gertler and Karadi (2011).

We compare three benchmark 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 debt (original sin: $ld = 1$,$\varphi_D = 0$)

[6] This is isomorphic to an UIP shock in the exchange rate determination literature. See Kollmann (2001) Devereux and Engel (2002), Engel (2014), Itskhoki and Mukhin (2017) and Engel and Wu (2018).

- Local currency debt (original sin redemption/redux: $ld = 0$, $\varphi_D = 0$)
- Domestic deposits (50% domestic, 50% external local currency deposits: $ld = 0$, $\varphi_D = 0.5$)

In order to keep the model simple, we assume that all traded goods are invoices (and sticky) in the price of the producer (i.e producer currency pricing or PCP). However, as shown in appendix A, the results are robust to dollar invoicing, which some recent papers have argued is more in line with the data.

4 Results and policy implications

4.1 Absence of AE financial friction

We first investigate the effect of the currency of denomination of debt when there are no financial frictions in the AE banking sector, i.e. $\kappa_t^c = 0$. Figure 5 plots the IRFs (% deviation from the steady-state) for the case of loans from global banks in foreign currency (original sin, OS: $ld = 1$) and local currency (original sin redux, OSR: $ld = 0$) in response to a 100 basis point monetary tightening shock in the AE.

The monetary tightening in the AE causes the EM currency to depreciate. When loans are denominated in local currency, EM GDP increases relative to the steady-state level for a few periods. This is the conventional trade channel of exchange rates at work - the increase is mainly due to the expenditure switching effect that tends to increase EM net exports. The financial channel of exchange rate is largely muted. On the AE side, the AE GDP reduces due to a sharp contraction in aggregate demand caused by the monetary tightening. This leads to a significant reduction in AE banks' net worth. However, since there is no financial friction in the AE banking sector, the spread of the lending rate over the policy rate doesn't change (AE spreads). As a result, the borrowing rate faced by EM banks is effectively unchanged, because the increase in AE interest rate is compensated by the expected appreciation of the EM currency subsequently.

When the loans are denominated in foreign currency, EM GDP drops substantially. Looking at the GDP components, EM net export increases more compared to local currency debt. This can be partly attributed to the higher depreciation of the currency. The reduction in GDP is mainly driven by the drop in EM investment. The currency depreciation harms the EM banks' net worth and therefore limits capital investment. This illustrates the strong prevalence of the financial channel of exchange rates, which outweighs the trade channel of exchange rates.

To summarize, in the absence of financial frictions on AE balance sheets, local currency debt largely insulates the EM economy from the financial channel by removing the exchange rate movements on the balance sheet of the financially constrained banking sector. This brings a more stable financial sector, which is consistent with policy prescriptions after the Asian financial crisis that advocated the development of local currency bond markets.

4.2 Presence of AE financial friction

We now turn to 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 6 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 in both AE and EM. 1) $ld = 1$ (OS) and 2) $ld = 0$ (OSR), the local (EM) currency debt or "original sin redux" case.

The blue line in Figure 6, which represents the "original sin" case, behaves similar to the blue line in Figure 5. It features a strong reduction in EM GDP that is driven by a reduction in EM investment.

More importantly, the IRFs of the "original sin redux" case behaves very differently from the case when there is no AE financial friction. EM GDP drops significantly in this case, driven again by the dynamics of investment. The contraction of investment is due to the rise of lending rate offered by the AE banks. The unexpected EM currency depreciation erodes the local currency loan return for AE banks, as shown in the first period of "windchill",[7] which impairs the AE banks' net worth and therefore the lending rate to EM banks. For the subsequent periods, the AE banks charge a higher than steady state lending rate. The high funding cost then affects the EM banks net worth, which creates dynamics similar to the original sin case. In other words, rather than a direct valuation change due to exchange rate fluctuations on EM bank balance sheets, the exchange rate fluctuations that are costly for AE bank balance sheets feeds back to the EM indirectly through a "price effect". The positive correlation between the EM financing cost (either in local or foreign currency) and EM currency depreciation driven by AE monetary shock period is consistent with the empirical findings in Hofmann et al. (2019a).[8]

The important message is that once we fully consider the implications of local currency borrowing in a general equilibrium setting, the prescription of local currency bond markets

[7] Carstens and Shin (2019) describe a loss in the local currency return as the "temperature effect" , which is compounded by an additional "windchill" effect if local currency depreciates at the same time, leading to a double hit for AE investors who evaluate returns in foreign currency.

[8] In Hofmann et al. (2019a), the AE monetary shock is identified through high frequency identification on key FOMC announcement dates.

may not be as ideal as one may have thought, and may not imply a redemption from the original sin. One way or the other, the exchange rate mismatch problem remains, either on the lenders' or on borrowers' balance sheets.

4.3 Policy prescription 1: Domestic investor base

A notable observation is that the AE financial constraint is a restriction on the banking sector net worth, evaluated in the AE currency. Therefore, the exchange rate fluctuations affect the net worth when loans are denominated in EM currency. As hypothesized by Carstens and Shin (2019), this hints that increasing domestic investor base, which evaluates returns in local currency and therefore does not suffer from currency mismatches, can ease the friction and transmission of shocks.

In figure 7 we compare the effect of an AE monetary tightening shock (100 basis point) in the original sin redux case above to the original sin redux with 50% of the EM bank funds sourced from domestic deposits ($\varphi_D = 1$). In both cases, the AE GDP and banks' net worth reduction are similar. However, the borrowing rate that the EM can obtain is much lower in the case with domestic deposits. There are two reasons for this difference. First, compared to the AE bank loan offer rate, the domestic deposit is less sensitive to a change in AE interest rate. Second, domestic deposits that are sourced from EM households are not subject to the incentive constraint. The smaller increase in the borrowing cost translates to a small reduction of EM banks' net worth and investment, resulting in a smaller drop in EM GDP.

A large domestic investor base not only makes the economy less vulnerable to foreign shocks, it also increases the transmission of domestic monetary policy. This is due to the fact that with a larger domestic investor base, a larger fraction of EM banks' funding is linked directly to, and can be influenced strongly by the changes in the policy rate. This provides more policy space to the central bank in the face of external financial shocks. Figure 8 illustrates this for the case of a domestic monetary policy cut.

A large domestic investor base helps reduce the vulnerability of EMs to foreign shocks via two channels. First, domestic investors evaluate their returns in the domestic currency. As a result, the financial intermediation from domestic investors to domestic firms is free from the 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 fractions, namely those involving the domestic banks. On the other hand, lending from foreign investors is subject to two layers of financial frictions-those involving global and domestic banks respectively. Reducing or eliminating one of these features would reduce the benefits provided by a large domestic investor base. On the other hand, allowing for financial frictions being more stringent in international borrowing as opposed to domestic borrowing (as assumed by Akinci and Queralto (2018)) would further increase the benefits of a domestic investor base, since currently the model assumes that the leverage constraint inherently does not distinguish between domestic and foreign sources of funding.

4.4 Policy prescription 2: FX intervention

Deepening the domestic investor base is a long process with involvement of institutional and structural changes. Potentially a more feasible alternative in the short run could come from the ability to stabilize exchange rate movements. We analyze the case of sterilized FX intervention in this subsection.

We consider two types of FX interventions. The case when the sterilization bonds go to the household ($\Psi = 0$) and when the sterilization bond go to the banking sector ($\Psi = 1$). Figure 9 shows the IRFs for the case of AE monetary tightening shock. When the intervention comes with sterilization bond going to the household sector, the intervention is almost ineffective. This is consistent with the finding of Backus and Kehoe (1989) in which FX intervention is ineffective in a frictionless portfolio market.[9]

The effect of intervention increases substantially when sterilization bonds go to the banking sector. The GDP reduction is significantly less. The intervention is successful in the sense that the equilibrium exchange rates depreciates less than the no intervention case. The less depreciated exchange rate helps with stablizing the net worth change in the AE bank but the effect is fairly limited. The reduction in AE banking net worth results in a higher EM borrowing rate. On the other hand, the FX intervention improves the EM banking balance sheets. The sterilized FX intervention involves selling foreign reserves and purchase of sterilization bond. This frees up resources for the banking sector to undertake more private lending and buffer the reduction of net worth. The FX intervention is effective here as it relaxes the more binding constraint when the AE tighten the monetary policy rate. The smaller reduction in banking net worth reduces the investment and GDP drop. This "debt limit channel" of FX intervention is also discussed in Chang and Velasco (2017), Chang (2018) and Hofmann et al. (2019b).

FX intervention is often considered as a possible solution to capital outflows. In the following exercise in Figure 10, we consider a capital outflow shock ϑ_t with a magnitude that is same as the steady-state EM borrowing rate (1.2%). The shock introduces a non-monetary return to AE assets relative to a loan to EM, inducing capital outflow. In response to the shock, the equilibrium EM borrowing rate increases, as AE banks require a higher

[9]The household portfolio market is not exactly frictionless in our model, but it has a very small portfolio adjustment cost.

monetary return to compensate. Again, in this scenario, the intervention that involves the household sector is almost ineffective. On the other hand, the FX intervention with purchase of sterilization bond from the banking sector significantly eases the banking sector constraint, as observed by the slower increase in the shadow value of wealth. This results in a smaller and flatter reduction in banking net worth, therefore smaller reduction in EM investment and less depreciated currency. Such leaning against the wind of capital flow using FX intervention has been recently advocated by Diamond et al. (2020) and Cavallino (2019). In our model, the policy is effective because it stabilizes the credit creation ability of the banking system.

5 Empirical evidence

A key ingredient in the model is the significance of constraints on advanced economy lenders in affecting financial conditions in EMs. In Appendix B, we provide motivating empirical evidence for this phenomenon by documenting the rise in EM local currency spreads in response to a tightening in global financial conditions, highlighting in particular how the rise in spreads is more pronounced in EMs that have a larger presence of foreign lenders.

In this section, we focus on testing the main prediction of the model in terms of the macroeconomic implications of foreign shocks. Our results suggest that in response to a US monetary tightening, GDP and investment in EMs contracts most under the original sin regime, somewhat less under the original sin redux regime, and least when they rely more on domestic sources of funding. We use cross-country data on investment and external borrowing by currency to test this prediction. As shown in the simulation results, the key variable which captures the mechanism in the model is investment. Motivated by this, we look at the response of investment to an external (US monetary policy) shock, with proxies for both original sin and the original sin redux.

More specifically, the model that we estimate is as follows:

$$y_{i,t+4} - y_{i,t-1} = \alpha_y \triangle y_{i,t-1} + \alpha_{os} os_{it-1} + \alpha_{osr} osr_{i,t-1} + \beta_r \triangle r_{t-1} + \beta_\pi \pi_{t-1} \tag{5.1}$$

$$\beta_{os} * \triangle r^{us}_{t-1} * os_{it-1} + \beta_{osr} \triangle r^{us}_{t-1} * osr_{it-1} + \beta_X \triangle X_{i,t-1} + \alpha_t + \alpha_i + \epsilon_{i,t} \tag{5.2}$$

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 original sin and original sin redux respectively. We use data on currency composition of external debt liabilities from Benetrix et al. (2019) measure os as the ratio of external debt liabilities in USD to GDP, while osr is measured as the ratio of non-USD external debt liabilities to GDP, the bulk of which are in local currency. Given the relatively high unconditional correlation between os and osr, we conduct a first stage regression of osr on os, and include the residuals from this first stage when estimating equation 5.2. $\triangle r_{t-1}$ 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).[10] $X_{i,t-1}$ includes additional country level controls including lagged inflation and policy rate.

Our theoretical results would suggest that both $\beta_{os} < 0$ and $\beta_{osr} < 0$, and than $\beta_{osr} > \beta_{os}$. Table 3 presents the estimates. The estimates reported in Column 1 and 1.1 correspond to a simple OLS regression (with clustered standard errors by country), for EM and advanced economies respectively. The subsequent two columns present estimates from models with richer specifications, including country fixed effects (Column 2) and country and time fixed effects (Column 3). Lastly, Column 4 presents estimates based on the an estimator that allows cross-sectional clustering (Driscoll and Kraay (1998)).

Overall, the results for EMs are consistent with the predictions of the model, i.e $\beta_{os} < 0$ and $\beta_{osr} < 0$, and than $\beta_{osr} > \beta_{os}$. The results for advanced economies (Column 1.1) on the other hand are more mixed, in line with the observation made earlier that deep financial markets in these economies reduces the vulnerability to external shocks.

6 Extension: The original sin and its redux in a model with sovereign debt

Our main model illustrated the original sin and its redux when borrowing is used by the private sector of the economy to finance real investment. This provides a clear link between borrowing and the real economy. In addition to private borrowing though, the share of sovereign borrowing in local currency has also been high and rising, as shown in Figure 11. In this section, we consider an extension of the model to allow for sovereign borrowing from abroad, in both local and foreign currency, and reexamine the consequences of foreign shocks on domestic financial conditions and output.

To simplify the analysis and focus on highlighting the key mechanisms, we abstract of endogenous fiscal policy shifts and fiscal rules, and consider a case where the government

[10]The narrative approach uses the the Federal Reserve's Greenbook forecast which is 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.

raises a fixed amount (in local currency) of debt from foreign banks each period, in either local or foreign currency.[11]

We study the implications of currency of denomination of sovereign debt under two scenarios. First, as a benchmark we consider a set up where there is no direct feedback between private and sovereign borrowing conditions in the EM. Second, in line with empirical evidence, we relax this assumption and allow for either unidirectional (from sovereign to private) or bidirectional (from sovereign to private and vice versa) feedback in funding conditions.

6.1 Sovereign debt without feedback between private and sovereign borrowing conditions

Figure 12 shows the impulse response to a foreign monetary tightening in this benchmark case where government debt is risk free and has no direct effect on private funding conditions. Note that the net worth of global banks falls more when they lend to the 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 for currency mismatch when borrowing in dollars are negligible for the government, since unlike the EM banks, they are not financially constrained.

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 appreciation of the EM exchange rate starting in the period after the shock makes global banks willing to lend to government in local currency at a lower rate.[12]

[11] We assume this fixed amount to be equal to the steady state value of the debt of domestic banks. Note that this makes government borrowing countercyclical, as the share of external debt to GDP rises during downturns. This counter-cyclicality however is not critical to the main results. In terms of link to the data, while fiscal policy in emerging markets has historically been fairly procyclical, this trend has reversed to a large extent since the early 2000s (see for instance Frankel et al. (2011)).

[12] See appendix B and Hofmann et al. (2019a) for empirical evidence on the impact of global financial conditions on local currency sovereign spreads in EMs

6.2 Sovereign debt with feedback between private and sovereign borrowing

The ability to impose taxes and transfers on different agents of an economy gives the sovereign sector, at least in principle, the unique ability to divert resources from other parts of the economy to cover their fiscal needs. As a result, sovereign funding conditions can be expected to have a a significant bearing on the outlook and funding conditions in the private sector. For instance, if the sovereign debt increases, the risk of higher taxes as well as explicit and implicit expropriation of resources from the private sector would imply that higher costs of sovereign borrowing would spill over to other parts of the economy as well.

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[13]. While most studies have focussed on unidirectional link (from sovereign to private-see for instance Panetta et al. (2011)), a subset of the studies including Alter and Schüler (2012) have also documented the link from banks to sovereign spreads.

Motivated by this literature on sovereign-bank funding interactions, we modify the benchmark specification of by allowing either unidirectional or bidirectional interactions between the sovereign and EM banks. In the unidirectional feedback model, the sovereign's financial health affects corporate borrowing spreads, while in the bidirectional set up, both sovereign and corporate financial healths affect each other.

Note that the repayment burden of the sovereign to the foreign bank in each period is give by:

$$Repayment_t^{govt} = (RER_t)^{OS_{govt}} \frac{R_{bgovt,t-1}}{(\pi_t^c)^{OSgovt}(\pi_t^e)^{1-OSgovt}} V^e_{govt,t-1} \tag{6.1}$$

Here os_{govt} is a dummy variable which takes the value 1 if the sovereign debt is denominated in dollars, and 0 if it is denominated in the EM currency. We now assume that the economy wide stringency of the financial constraint, κ_t^e, which was taken as a constant parameter so far, increases with the rise in the governments debt repayment as a fraction of GDP compared to its steady state value.

[13] See for instance De Bruyckere et al. (2013),Alter and Beyer (2014)

$$\kappa_t^e = F\left[\left(\frac{Repayment_t^{govt}}{Y_t^e}\right) - \left(\frac{Repayment^{govt}}{Y^e}\right)_{ss}\right] \tag{6.2}$$

There are several possible explanations for why κ_t^e could be an increasing function of the debt repayment obligation of the government relative to output. For example, the Gertler and Karadi (2011) constraint is motivated by the incentive of the borrower to abscond with the borrowed funds. This incentive is likely to be higher when the debt repayment is higher. Another interpretation of the parameter κ^e is the legal costs associated with recovering the proceeds from a defaulting borrower. This interpretation also supports that κ^e being an increasing function of the debt repayment to GDP ratio, since legal costs can be assumed to be convex, and will typically be higher during bad times when bankruptcies and restructurings are higher.

Figure 13 shows the response of a US monetary tightening when κ_t^e is endogenous and moves according to 6.2. Note that as before, that 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 (equation 6.1) rises much more when debt is denominated in foreign currency(since $OS_{govt} = 1$ and RER_t increases). Consequently, κ_t^e rises much more sharply in this case, leading to a sharper decline in credit, investment and hence output.

Figure 14 shows that the sharper decline of GDP under foreign currency debt is also obtained if we allow for a more general bidirectional interaction between sovereign and private borrowing conditions, by assuming that the economy wide κ_t^e evolves according to:

$$\kappa_t^e = \left[\left(\frac{Repayment_t^{govt} + Repayment_t^{private}}{Y_t^e}\right) - \left(\frac{Repayment^{govt} + Repayment^{private}}{Y^e}\right)_{ss}\right] \tag{6.3}$$

In this case, κ_t^e depends not only on the government's debt repayment burden, but also its private counterpart. As such, an increase in either relative to steady state leads to an increase in the tightness of financial conditions for both the sovereign and the private sectors.

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". But this has not eliminated their financial vulnerability entirely. EMs still rely heavily on foreign sources of funding, albeit in local currency, as their debt markets have a less developed base of domestic institutional investors. This leaves them vulnerable to capital flow reversals on account of currency mismatches on the balance sheets of global lenders, and has given rise to the phenomenon of "original sin redux" (Carstens and Shin (2019)). This paper presents a model-based evaluation of the original sin redux and the vulnerability of EMs to foreign and domestic shocks using a two country new Keynesian DSGE model where financial frictions are present on both lenders' and borrowers' balance sheet.

The main takeaways from the analysis can be summarized as follows. First, while the original sin redux reduces the vulnerability of EMs to global shocks compared with original sin, it falls short of matching the benefits that ensue from a large domestic investor base. Second, a large domestic investor base also increases the transmission of domestic monetary policy, thus providing more ammunition to EM central banks in the face of external shocks. Third, foreign exchange intervention that eases constraints on the balance sheet of the affected financial institutions can mitigate the impact of external shocks, and thus proves to be a valuable addition to the policy toolkit of central banks.

The paper focuses on the simplest possible general equilibrium framework to highlight the role of frictions that give rise to differences across regimes. As such, it leaves open several avenues for future research and exploration. For instance, the regimes (OS, ORS and DD) are fixed exogenously throughout the analysis, and banks are not allowed to adjust the share 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 are sticky, especially at business cycle frequencies considered in this paper.[14] Nevertheless, extending the model to allow for endogenous switching between sourced of funding would be an interesting extension to establish the robustness of the results uncovered here.

Lastly, the focus of the paper is primarily positive, and we abstract from issues relating to optimal policy as well as the scope for coordination of policies across countries (as in Banerjee et al. (2016)). An extension to characterize to optimal policy in the presence of two instruments (namely FX intervention and monetary policy) is likely to be particularly informative in the context of most EMs adopting monetary policy frameworks that employ additional tools and serve objectives beyond inflation targeting such as financial stability (BIS (2019))

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

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Appendix

A A model with dollar invoicing

Several recent papers have emphasized the role of dollar invoicing in understanding the transmission of shocks across countries.[15] While our baseline model assumed producer currency pricing, this section shows that the main results are robust to the alternate assumption of dollar invoicing of international trade.

Unlike in the baseline model where monopolistic firms set a single price (in the producer currency) for both domestic and forign markets, they now set two prices, one for the domestic market (in their own currency) and one for foreign markets in the global currency (dollar). Each of these prices are subject to the staggered setting in Calvo (1983), and the same random fraction $1-\varsigma$ fraction of firms adjusts their prices each period for both currencies. These now generate two phillips curves, one for the domestic price $((\pi_{e,t}^{PPI})$, and one for exports $(\pi_t^{*ec}))$.

$$\pi_{e,t}^{*} = \frac{\sigma_p}{\sigma_p - 1}\frac{F_{e,t}}{G_{e,t}}\pi_{e,t}^{PPI} \tag{A.1}$$

$$F_{e,t} = Y_{e,t}MC_{e,t} + E_t[\beta\varsigma\Lambda_{t,t+1}^{e}(\pi_{e,t+1}^{PPI})^{\eta}F_{e,t+1}] \tag{A.2}$$

$$G_{e,t} = Y_{,t}^{ee}P_{,t}^{ee} + E_t[\beta\varsigma\Lambda_{t,t+1}^{e}(\pi_{e,t+1}^{PPI})^{-1+\eta}G_{e,t+1}] \tag{A.3}$$

$$(\pi_{e,t}^{PPI})^{1-\eta} = \varsigma + (1-\varsigma)(\pi_{e,t}^{*})^{1-\eta} \tag{A.4}$$

$$\pi_t^{*e,c} = \frac{\sigma_p}{\sigma_p - 1}\frac{F_t^{e,c}}{G_t^{e,c}} \tag{A.5}$$

$$F_t^{e,c} = Y_t^{ec}MC_t^{e} + E_t\left[\zeta\Lambda_{t+1}^{e}\pi_{t+1}^{ec}F_{t+1}^{ec}\right] \tag{A.6}$$

$$G_t^{ec} = Y_t^{ec}P_t^{ec}RER + E_t\left[\zeta\Lambda_{t+1}^{e}\pi_{t+1}^{ec\,(\sigma_p-1)}G_{t+1}^{ec}\right] \tag{A.7}$$

$$(\pi_{,t}^{ec})^{1-\eta} = \varsigma + (1-\varsigma)(\pi_{,t}^{*ec})^{1-\eta} \tag{A.8}$$

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

[15] See for instance Akinci and Queralto (2018) and Cook and Patel (2020).

Figure 15 shows a comparison of impulse response of EM GDP to a foreign monetary tighening under producer currency pricing (PCP) and dominant currency (dollar) pricing (DCP). It highlights that while the magnitudes are different, the odering between the three regimes-original sin, local currency debt, and domestic deposits, is the same across the two pricing assumptions, showing that the main results are robust to alternatie pricing assumptions. The fact EM GDP falls more under each regime in DCP is on account of the weaker influence of the trade channel of the exchange rate. In particular, since exports in the DCP case are priced in dollars, their demand is boosted less than in the PCP case when the EM exchange rate depreciates.

B Global financial constraints and EM local currency sovereign spreads

We specify the following empirical model measuring the impact of foreign constraints and ownership on spreads in local currency sovereign yields in EMs as follows:

$$Spread_{i,t} = \alpha_i + \beta_1 FO_t + \beta_2 Contraint_t + \beta_3 FO_t * Contraint_t + controls + \epsilon_{i,t}$$

Here, *Spread* denotes the spread (over US treasury) of EM local currency sovereign bonds. FO is the share of foreign ownership of local currency sovereign bonds. $Contraint$ denotes the tightness of advanced economy financial constraints. We use two measures to quantify this tightness. The first is an index capturing the leverage of 24 major US primary dealers.[16] As a second measure, we use the VIX index from CBOE.

The main coefficient of interest is β_3. Our predicts that a tightening of financial constraints in AEs leads to an increase in local currency sovereign spreads in EMEs. Furthermore, the impact should be higher if foreign ownership in the domestic sovereign bond market is high. This implies that the coefficient on the interaction terms between the two measures should be positive, i.e $\beta_3 > 0$. This is confirmed with the estimates as shown in Table 4.

[16] This set includes major banks such as Goldman Sachs, JP Morgan and HSBC.

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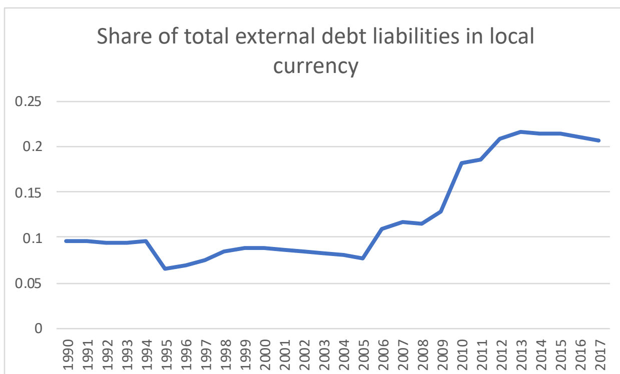
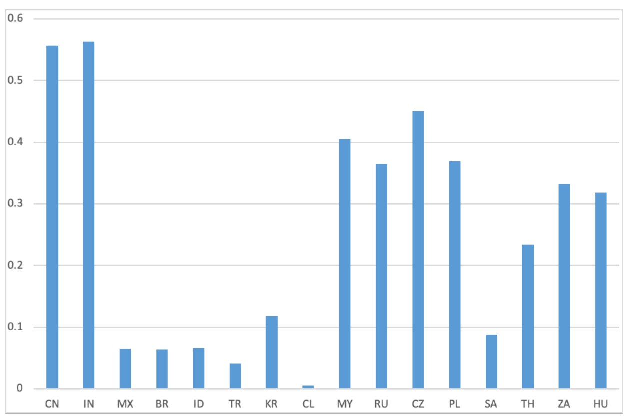
Figure 1 *– EMs are borrowing more from abroad in local currency*



Notes: median across a balanced sample of 14 emerging markets: CL, IN, KR, MY, CO, PE, CN, AR, HU, ID, BR, PL, PH, MX; Source: Benetrix et al. (2019).

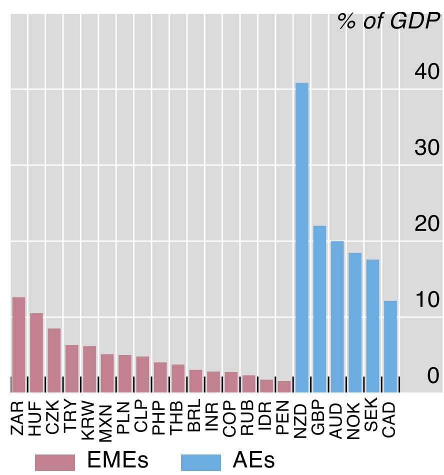
Figure 2 *– Share of local currency in NFC's indirect borrowing from abroad in emerging markets*



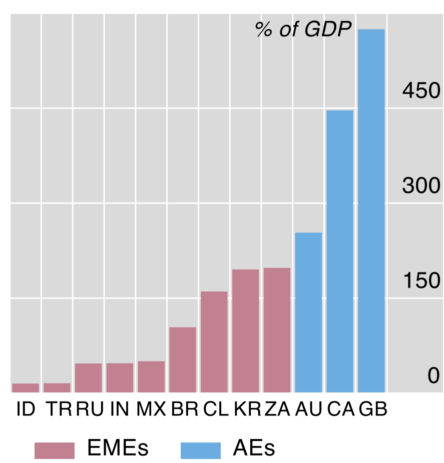
Source: BIS International banking and financial statistics (IBFS).

Figure 3 *– Financial markets in emerging markets remain shallow compared to advanced economies*

(a) Average daily turnover in FX derivative markets



(b) Size of institutional investors



Notes: EMEs: emerging market economies. AEs: advanced economies. Source: BIS (2019)

Figure 4 – *Schematic representation of the model*

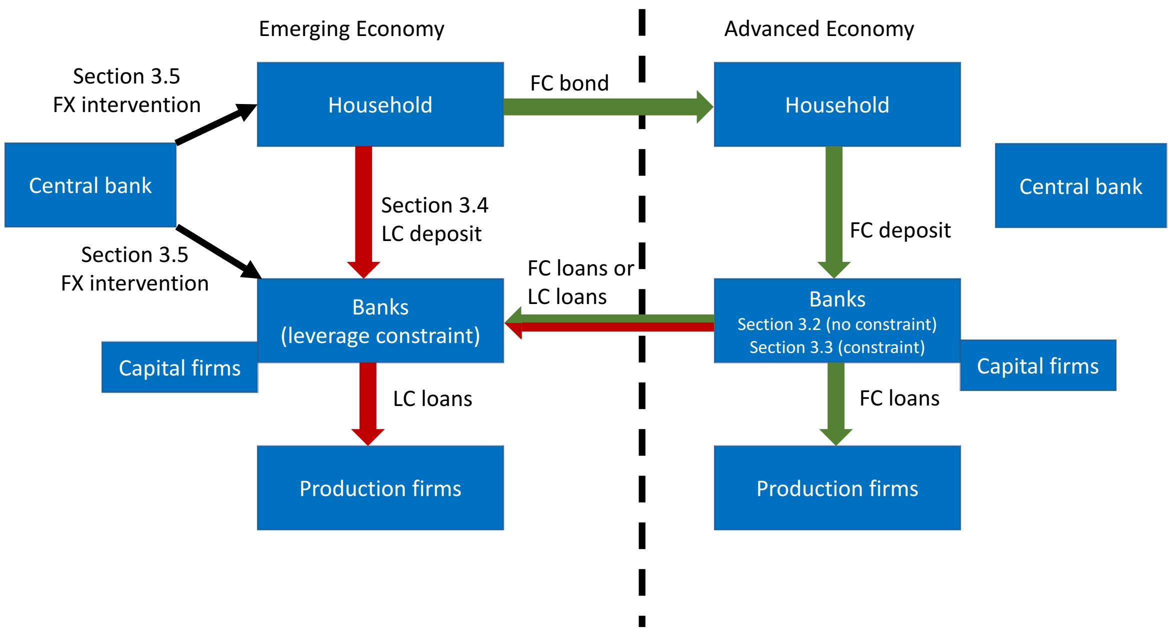


Figure 5 *– Advanced economy monetary tightening, absence of AE financial friction*

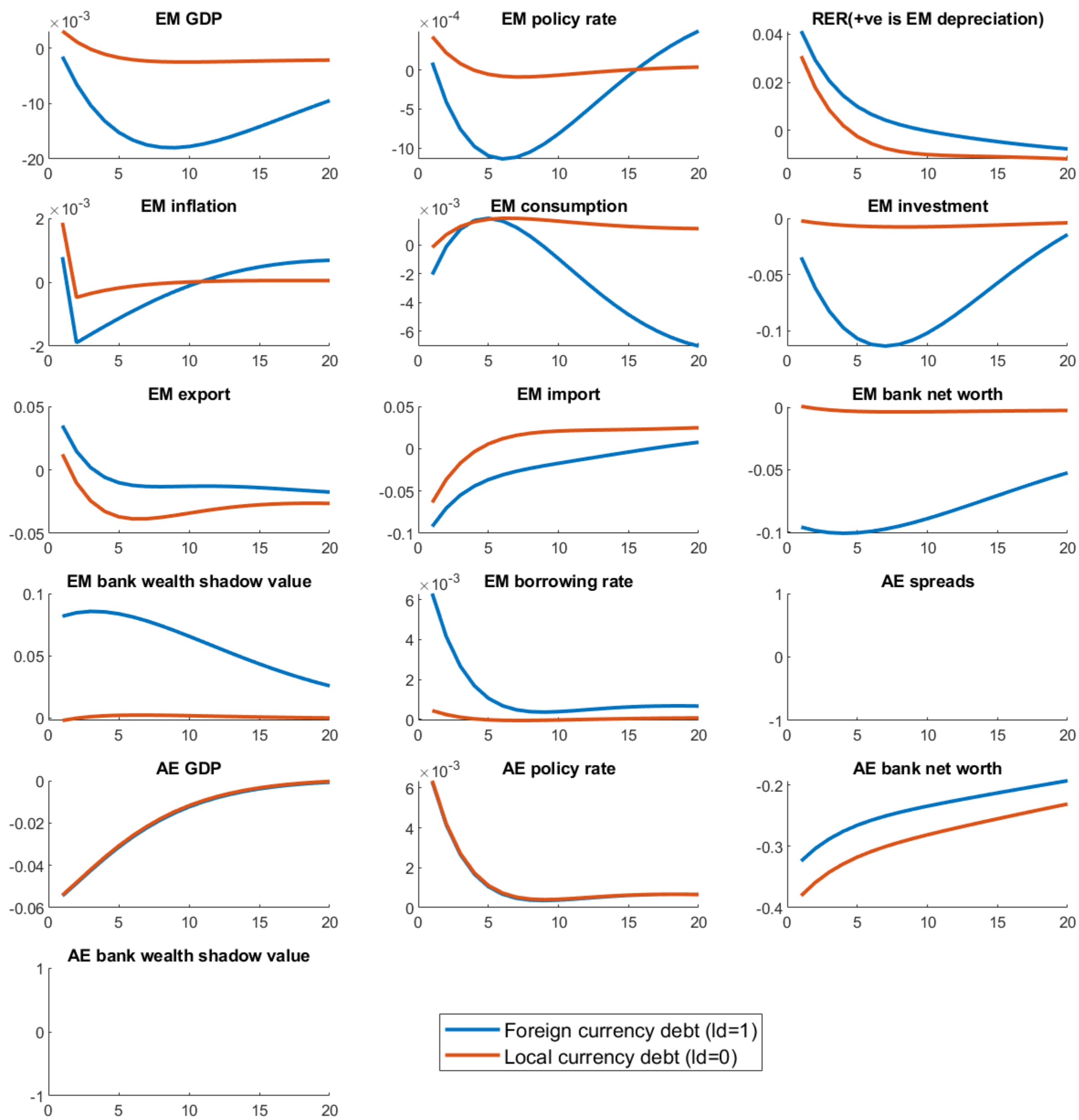
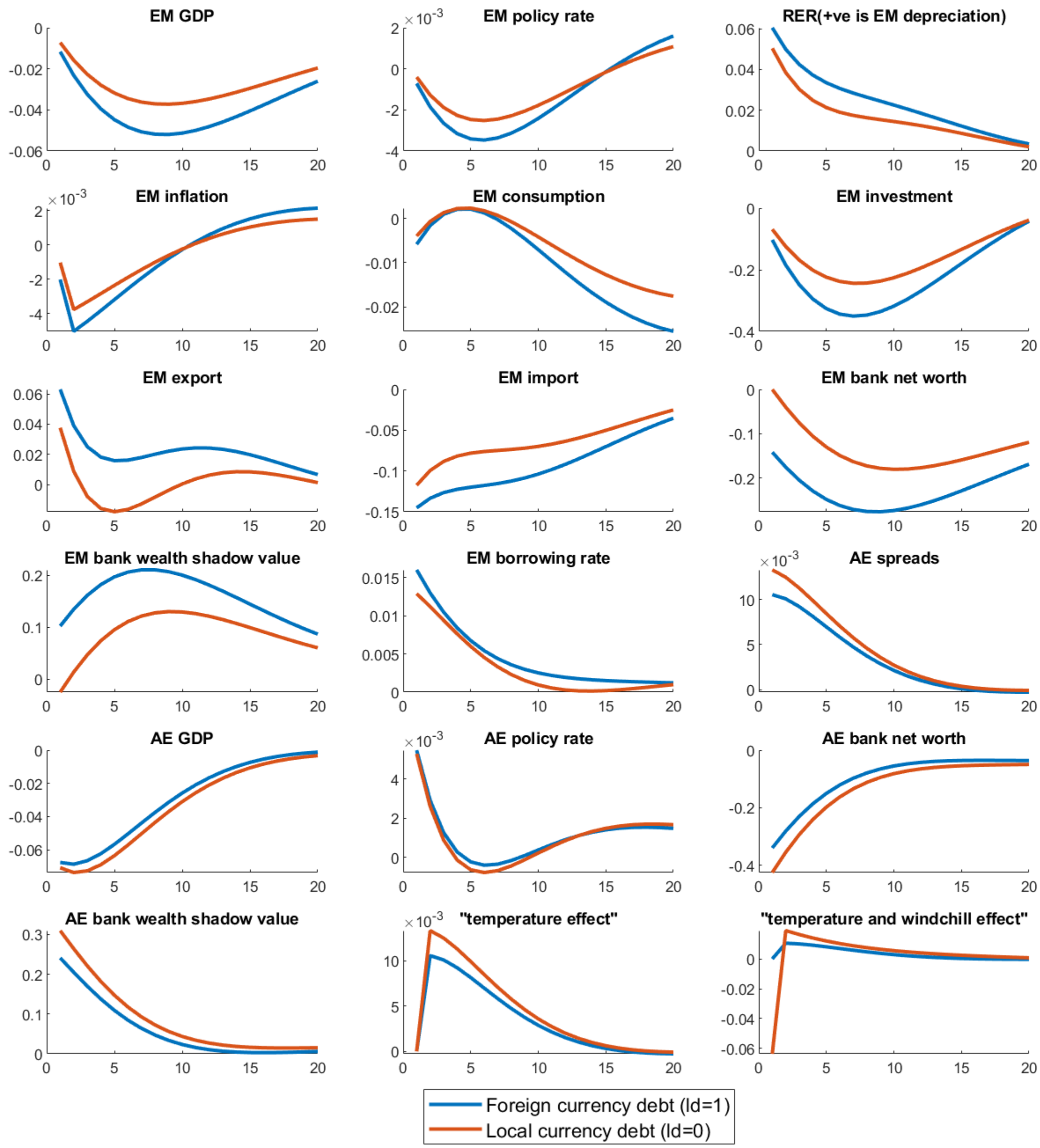
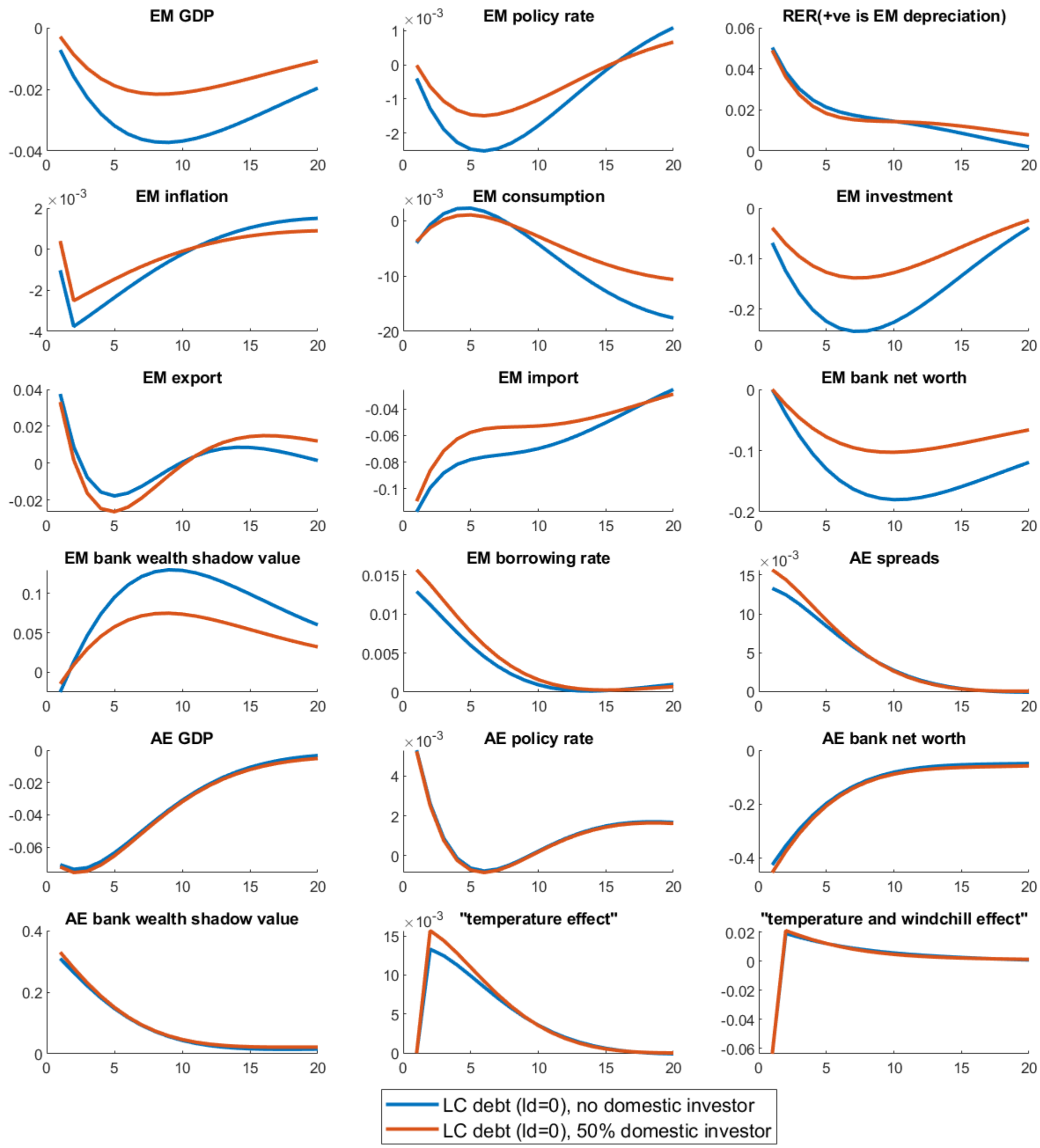


Figure 6 – *Advanced economy monetary tightening, with AE financial friction*



Notes: The "temperature effect" is the ex-post nominal investment return over the risk-free rate of the currency of denomination. The "temperature and windchill effect" is the temperature effect plus ex-post change in nominal exchange rate.

Figure 7 – *Advanced economy monetary tightening, with domestic investor base*



Notes: The "temperature effect" is the ex-post nominal investment return over the risk-free rate of the currency of denomination. The "temperature and windchill effect" is the temperature effect plus ex-post change in nominal exchange rate.

Figure 8 – *Emerging market economy monetary loosening*

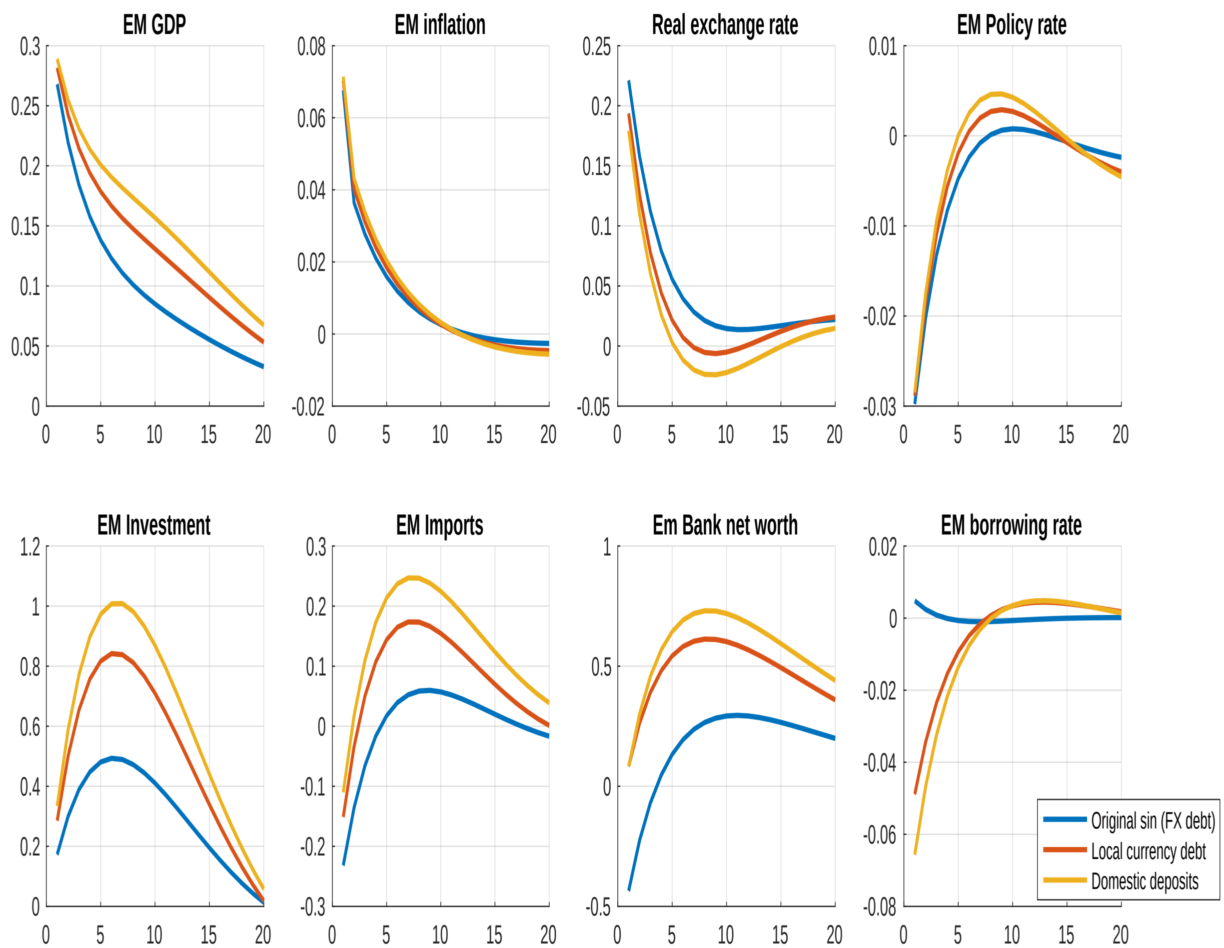
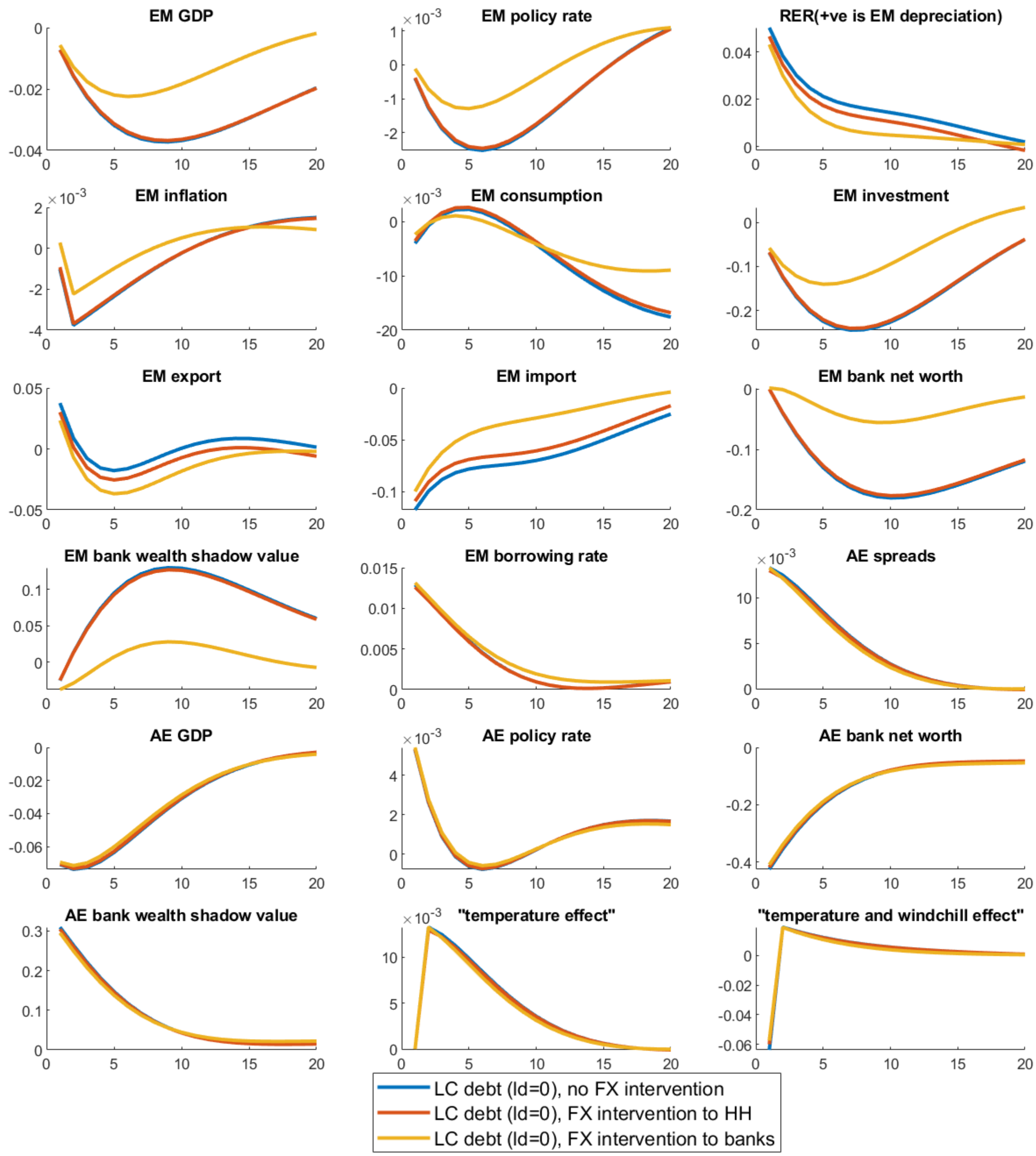
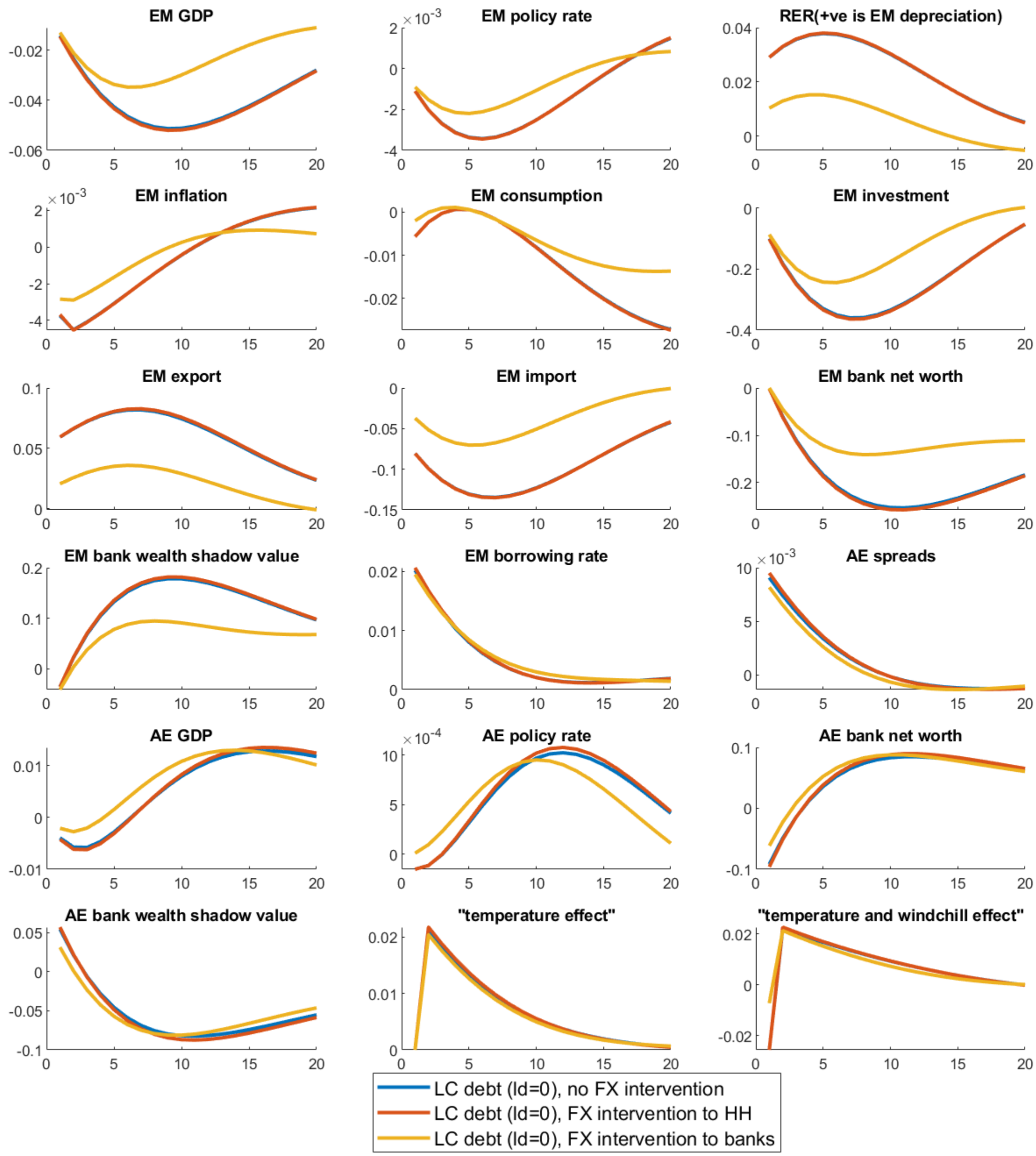


Figure 9 – *Advanced economy monetary tightening, with FX intervention*



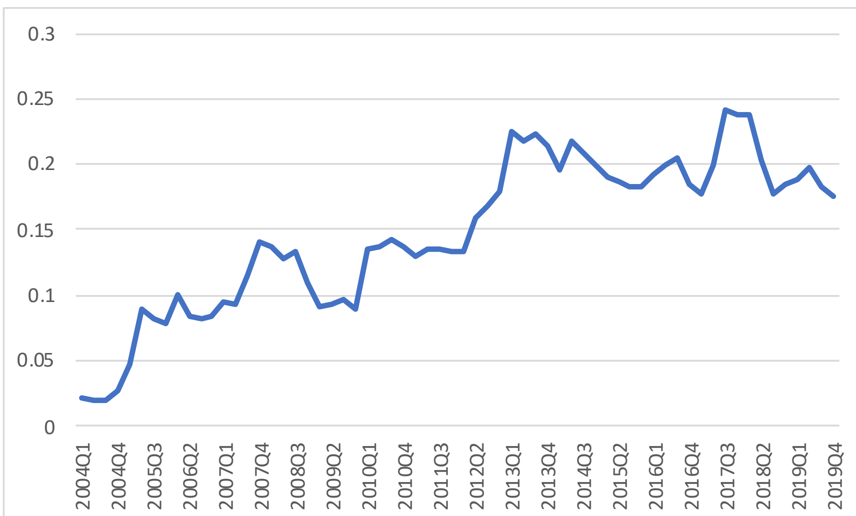
Notes: The "temperature effect" is the ex-post nominal investment return over the risk-free rate of the currency of denomination. The "temperature and windchill effect" is the temperature effect plus ex-post change in nominal exchange rate.

Figure 10 *– Capital outflow shock, with FX intervention*



Notes: The "temperature effect" is the ex-post nominal investment return over the risk-free rate of the currency of denomination. The "temperature and windchill effect" is the temperature effect plus ex-post change in nominal exchange rate.

Figure 11 – *Foreign Holdings of local currency EM government debt (share)*



Notes: median across a balanced sample of 15 emerging markets: AR, CN, EG, HU, IN, ID, LI, MY, MX, PE, PH, PO, RY, TH, TR; Source: Arslanalp and Tsuda (2014).

Figure 12 – *Impulse response to foreign monetary tightening in the absence of direct feedback between corporate and sovereign borrowing conditions*

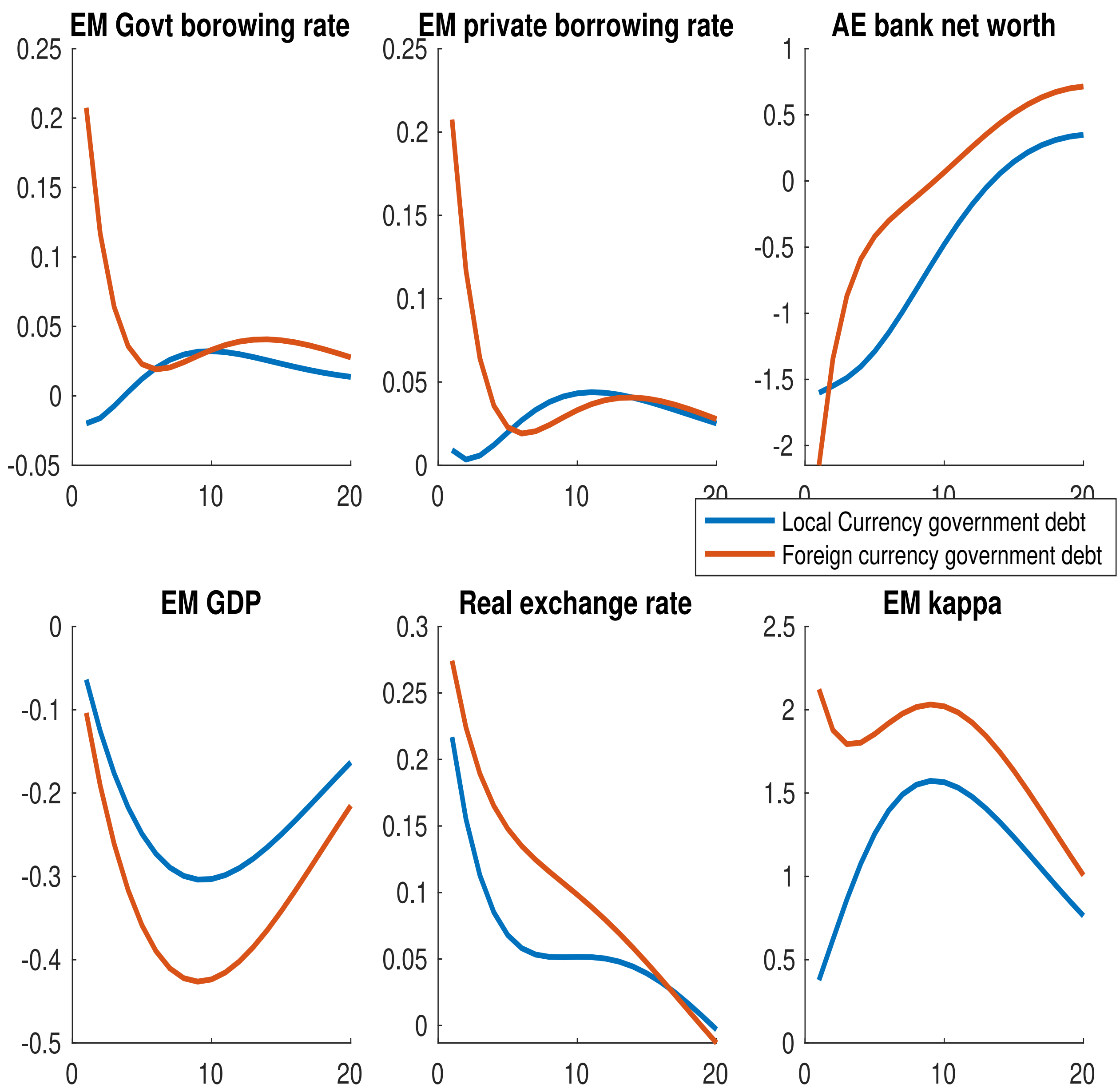


Figure 13 – *Impulse response to foreign monetary tightening with feedback from sovereign to private borrowing conditions*

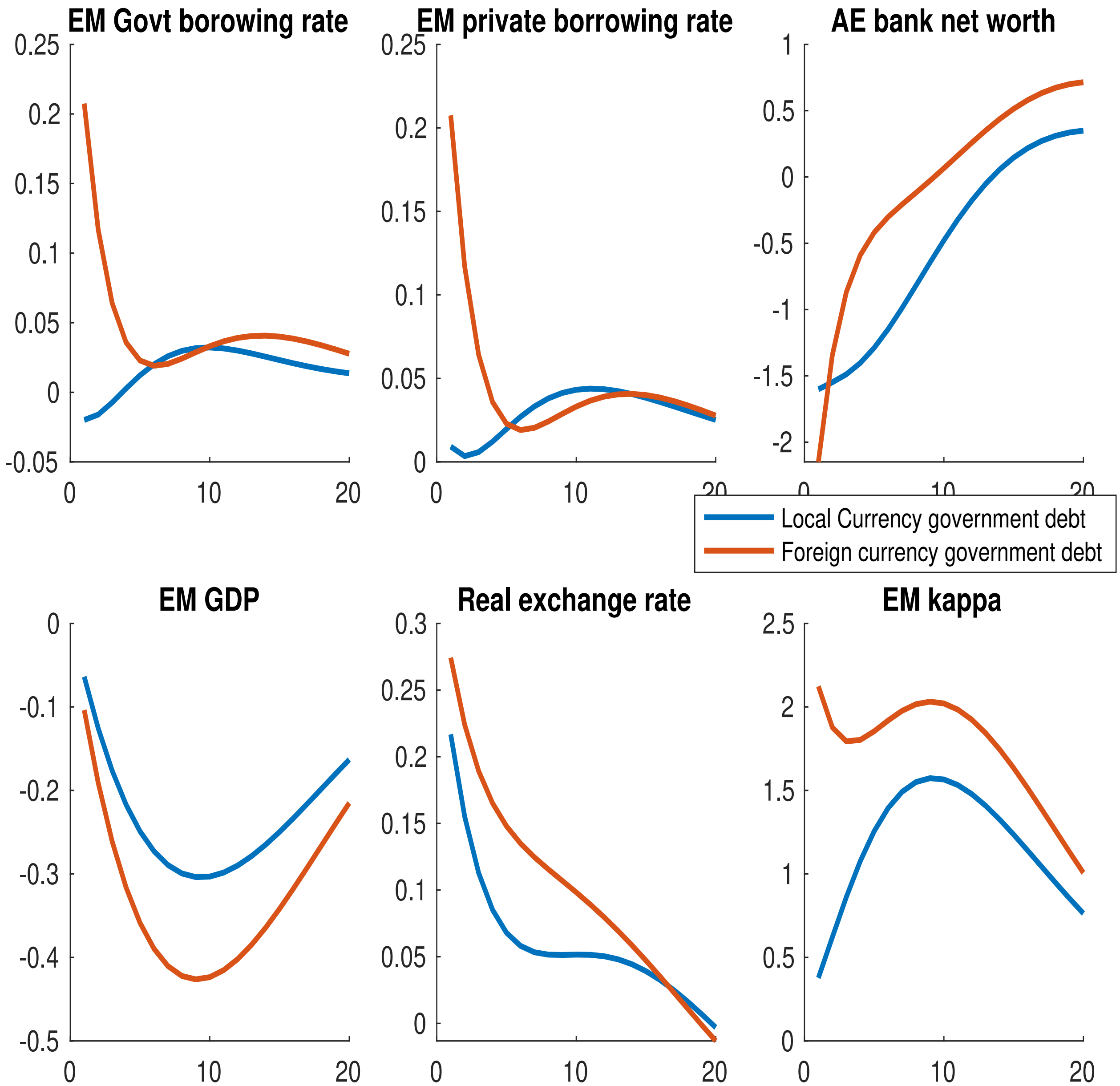


Figure 14 – *Impulse response to foreign monetary tightening with feedback from sovereign to private borrowing conditions*

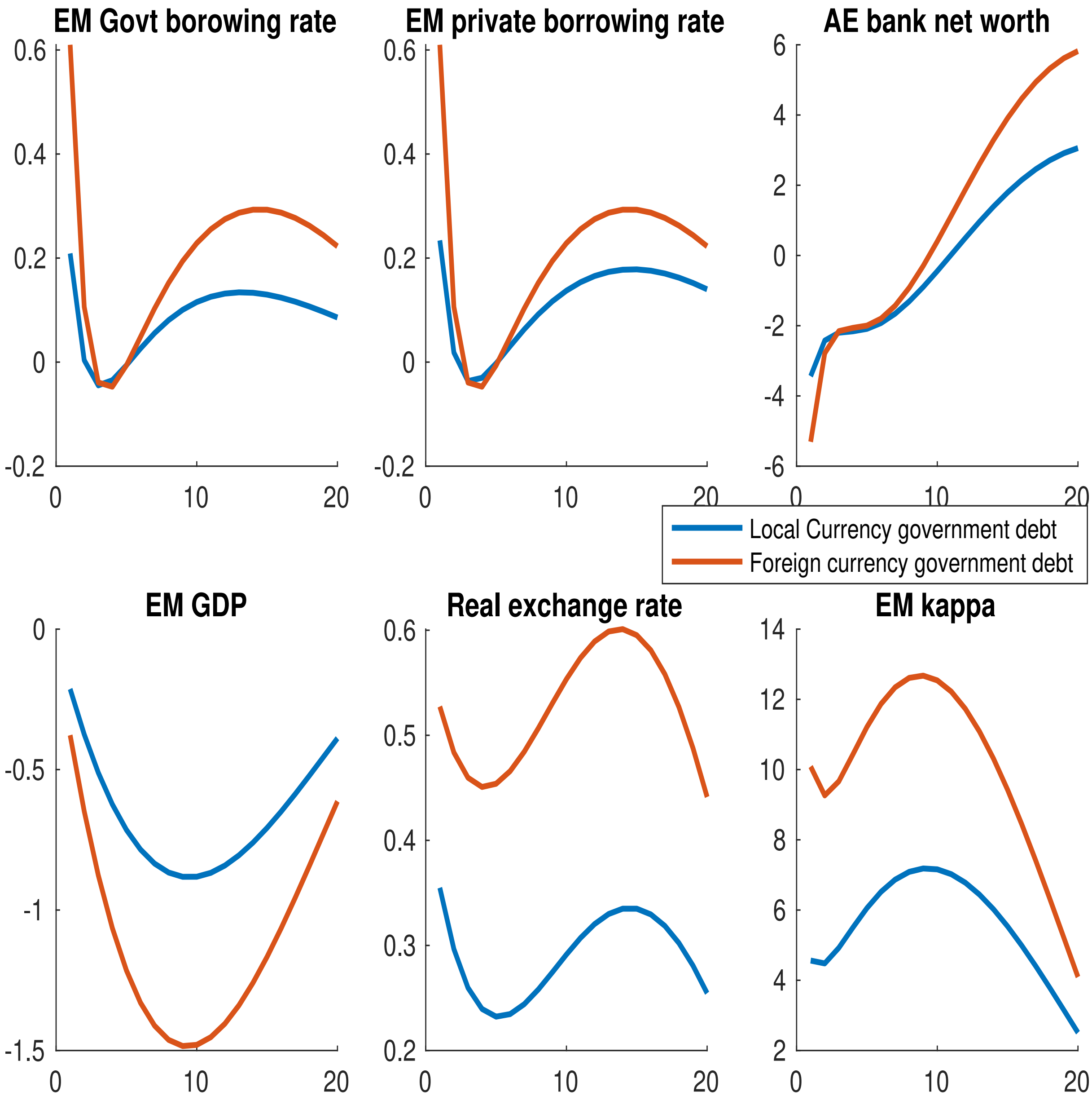
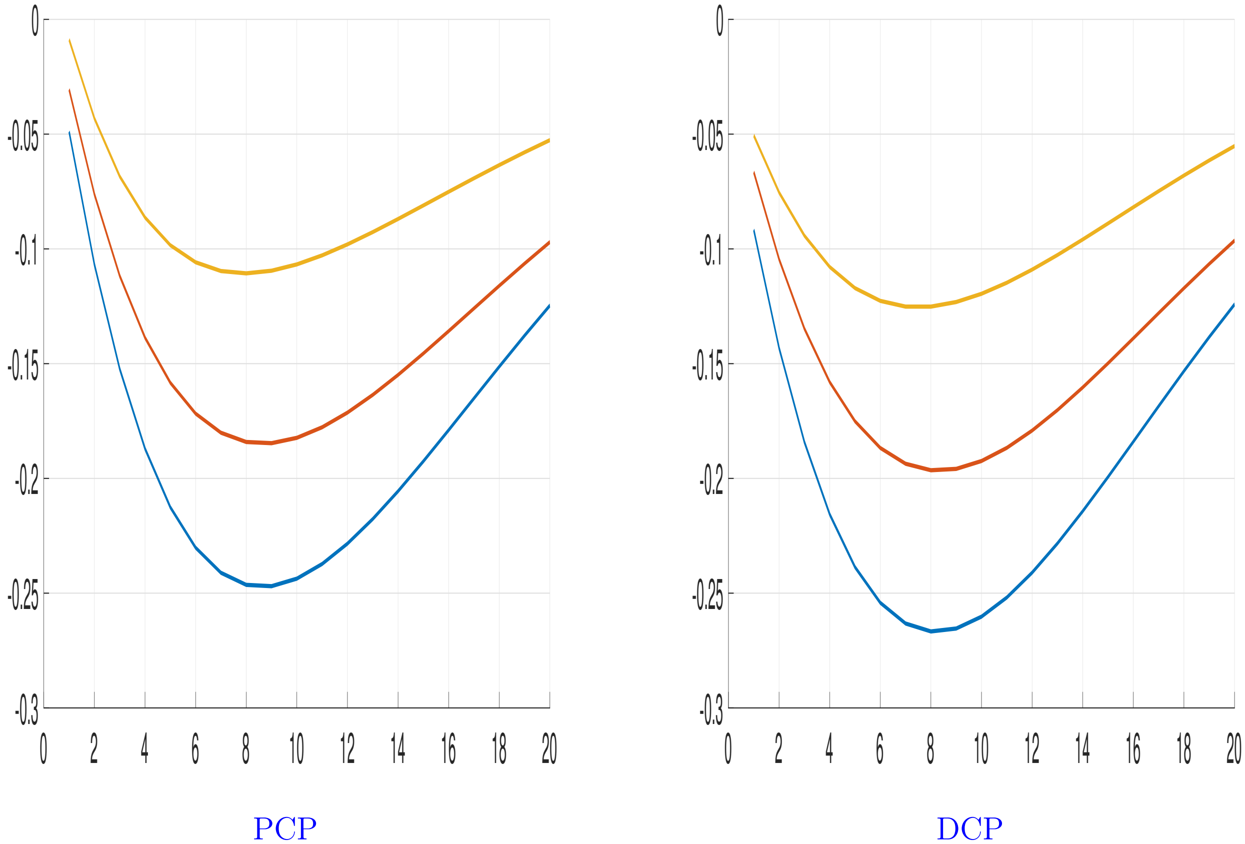


__Figure 15__ – Response of EM GDP to a foreign monetary tightening



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Notes: Comparison of impulse response of EM GDP to a foreign monetary tighening under producer currency pricing (PCP) and dominant currency (dollar) pricing (DCP).

List of Tables

Table 1 *– Currency composition of Non financial corporate (NFC) sector's foreign borrowing*

		% of total (median)	% in local currency*
1	International bond issuance	22%	<1%
2	Direct cross border bank loans	36%	7%
3	Indirect bank loans	38%	54%
	Total		**27%**

Notes: Median across a sample of 16 EMs in 2019: CN, IN, MX, BR, ID, TR, KR, CL, MY, RU, CZ, PL, SA, TH, ZA, HU. Source: BIS International banking and financial statistics (IBFS).

Table 2 – *Parameterization*

Variable	Definition	Value
Household		
σ	Household risk aversion	1.02
$\nu^e = \nu^c$	Trade openness	0.97
β	Discount factor	0.99
ψ	Inverse of Frisch elasticity	0.276
γ_B	Portfolio adjustment cost	0.0001
Trade / goods markets		
n	Size of EM	0.2
ς	Prob. of price fixed (Calvo pricing)	0.85
η	Cross-country elasticity	2
σ	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	0.0025
Monetary authority		
$\lambda_r^e = \lambda_r^c$	Monetary policy persistence	0.85
$\lambda_\pi^e = \lambda_\pi^c$	Taylor coefficient on inflation	1.2
$\lambda_y^e = \lambda_y^c$	Taylor coefficient on output gap	0.2
χ	Foreign reserve response to exchange rate*	0

*Notes: These parameters change across exercises.

Table 3

	(1)	(1.1)	(2)	(3)	(4)
Sample	EM	AE	EM	EM	EM
β_{osr}	-0.098***	-0.010	-0.093***	-0.099***	-0.099**
	(0.026)	(0.0083)	(0.025)	(0.023)	(0.040)
β_{os}	-0.28***	0.012	-0.23**	-0.18*	-0.18
	(0.079)	(0.013)	(0.082)	(0.094)	(0.15)
Observations	235	350	235	235	235
R-squared	0.169	0.412	0.175	0.327	
Sample	EM	AE	EM	EM	EM
Country FE	NO	NO	YES	YES	NO
Time FE	NO	NO	NO	YES	NO

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

Notes:Sample: Unbalanced panel of 16 EMs (AR, BR, CL, CN, CO, CZ, HU, ID, IN, KR, MX, MY, PE, PH, PL, RU). Benetrix et al. (2019), annual data from 1990-2007, interpolated linearly to quarterly frequency.

Table 4 – *Response of Local currency sovereign yields to global conditions and foreign ownership*

	AE constraint measure	
	Log(intermediary leverage)^	Log (VIX)
Foreign holding of LC debt	-15.49**	-12.53**
	(6.28)	(4.86)
AE constraint	2.61***	1.88***
	(0.39)	(0.34)
Foreign holding of LC debt*AE constraint	4.52**	4.83***
	(2.04)	(1.77)
Log(total debt to GDP)	2.86***	2.74***
	(0.27)	(0.25)
Log(reserve to GDP)	-1.90***	-1.80***
	(0.41)	(0.38)
GDP growth	0.01	-0.36
	(0.84)	(1.04)
_cons	-14.39***	-12.27***
	(1.49)	(1.49)
N	628	628
Country	16	16
Within R^2	0.295	0.290

Standard errors clustered by time in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Notes: Left hand side variable is the spread on the five year local currency sovereign yield (relative to US treasuries). Standard errors clustered by time in parenthesis.