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Global Financial Cycle and Liquidity Management*

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Abstract

We use a tractable model to show that emerging markets can protect themselves from the global financial cycle by expanding (rather than restricting) capital flows. This involves accumulating foreign liquid assets when global liquidity is high to then buy back domestic assets at a discount when global financial conditions tighten. Since the private sector does not internalize how this buffering mechanism reduces international borrowing costs, a social planner increases the size of capital flows relative to the laissez-faire equilibrium. The model also shows that foreign exchange interventions may be preferable to capital controls in less financially developed countries.

Keywords: capital flows, foreign exchange reserves, sudden stop, capital flow management, capital controls.

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1 Introduction

Emerging market (EM) economies are subject to large fluctuations in their access to foreign funds as a result of the global financial cycle.[1] Figure 1 shows that gross capital inflows to EMs increased more than three folds in the years prior to 2007 and then collapsed during the global financial crisis. The volatility of gross inflows has been largely absorbed through offsetting capital outflows which capture the purchase of foreign assets by EM residents. In other words, when foreign investors increase their holdings of EMs' assets, EM residents accumulate foreign assets and vice versa. To further smooth the domestic impact of fluctuations in capital inflows, EMs also employ several capital flow management policies such as capital controls or foreign exchange interventions.[2] Figure 1 shows, for example, that the public sector actively leans against fluctuations in capital inflows by accumulating official reserves when gross inflows increase and selling reserves when inflows recede.

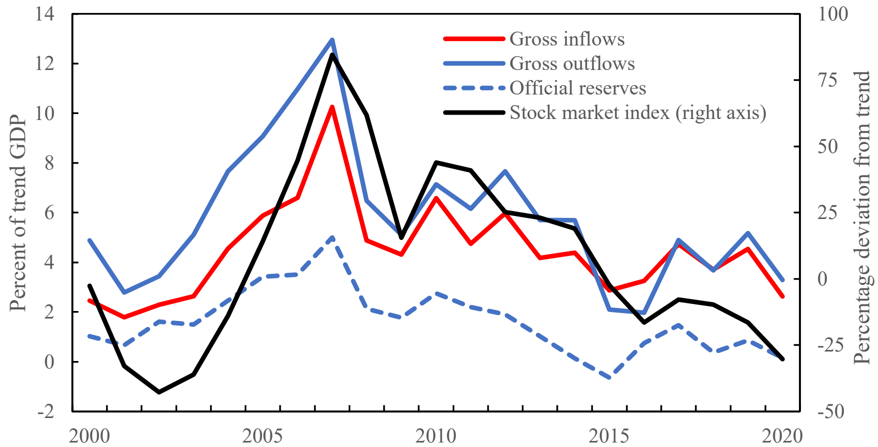
The chart also shows the evolution of the stock market's total-return index in EMs, expressed in deviation from trend. We see that in the years prior to the global financial crisis, stock prices in EMs rose rapidly above trend exactly when foreign investors increased their holdings of EM assets while EM residents brought their money abroad. The opposite dynamic took place post 2007 when EM stock prices plunged while gross capital flows declined sharply. This suggests that EM residents seize a trading advantage by buffering the volatility of gross capital inflows with gross outflows: they sell EM assets when prices are high and buy them back when prices decline.

This paper proposes a model that accounts for these facts and leads to novel normative implications for capital flow management. Our model features a three-period open economy representing an EM that is populated by a large number of private agents. In the first period, these agents issue long-term debt to foreign investors to finance an illiquid domestic investment and to accumulate liquid foreign assets. In the second period, there is a risk of an external financial tightening, whereby foreign investors withdraw their funds, leading to a fire sale of the outstanding stock of EM debt. More specifically, external financial tightening takes the form of deleveraging by foreign banks, in line with the evidence about the role of banking in the transmission of the global financial cycle (Miranda-Agrippino and Rey, 2020). When external financial conditions tighten, home

[1] See, for example, Rey (2015), Bruno and Shin (2015), Miranda-Agrippino and Rey (2020), Kalemli-Özcan (2019) and di Giovanni et al. (2021).

[2] Rey (2015), the IMF (2012), Ostry et al. (2011), Jeanne, Subramanian and Williamson (2012) and Basu et al. (2020) have advocated the use of such policies. The IMF has used the phrase *capital flow management* (CFM) policies to refer to capital controls. Here we will use the same phrase to mean both capital controls and foreign exchange interventions.

Figure 1: Gross capital flows and domestic stock prices, average across EMs



agents as well as foreign arbitrageurs use their liquidity to buy home debt. External financial tightening thus leads to a "retrenchment" (as defined by Forbes and Warnock, 2012) in which home agents repatriate foreign funds at the same time as foreigners sell home assets. In a decentralized equilibrium, home agents hold a level of liquidity such that the expected benefit from buying back domestic debt at the fire-sale price is exactly offset by the opportunity cost of carrying the liquidity.[3]

The model explains why the private sector of an open economy tends to build a large external balance sheet in which a large share of gross capital inflows is channeled into the purchase of liquid foreign assets rather than towards domestic physical investment. This might look like a diversion of capital flows away from their most productive use but the country's large external balance sheet in fact helps it to finance more investment at home. External liquidity reduces the country's cost of external borrowing and stimulates domestic productive investment.

It is in the normative area that our model has the most novel implications. The conventional wisdom and the existing literature hold that EMs should use policies to make capital flows less volatile. An example of such policies is the countercyclical tax on capital inflows used by Brazil in 2009-14 to mitigate capital inflow pressure. These views have been highly influential in policy circles, for example reshaping the IMF policy framework that now grants countries the ability of "pre-emptively curbing debt inflows to safeguard macroeconomic and financial stability" (Adrian et al., 2022). There are debates about the best instruments to achieve that goal but policymakers seem to have little doubt that the goal of capital flow management is to curb capital flow volatility.

[3]The opportunity cost of liquidity is measured as the spread between the interest rate on external debt and the return on liquidity, as in the literature on foreign exchange reserves (Rodrik, 2006).

Our model has the opposite implication. We find that a social planner maximizes the welfare of the small open economy by *increasing*, not reducing, the size and volatility of gross capital flows. As explained above, gross capital flow volatility is part of a process that reduces the volatility in home asset prices and thus the risk premia that they bear. The problem that the social planner has to solve is that the private sector under-invests in foreign liquidity because of a pecuniary externality. Private agents do not internalize the impact of their decisions on the price of domestic debt. Internalizing this externality means increasing the size and volatility of gross capital inflows and outflows.

The model also offers a novel interpretation of the role of foreign exchange intervention (FXI). Whereas the existing literature has focused on the impact of FXI on exchange rates, our model highlights its effect on domestic asset price volatility and risk premia.[4] We interpret FXI as the government using its own balance sheet to amplify the gross capital flows generated by the private sector. FXI has no impact in economies with a high level of financial development because of Ricardian equivalence but may benefit countries with an intermediate level of financial development. Furthermore, we show that in these countries FXI may have larger welfare benefits than capital controls.

At a positive level, our model can explain why capital flows behave differently in advanced economies, emerging markets and low-income countries. Figure 2 compares the behavior of capital flows across countries with different levels of international financial integration. The sample of countries includes 104 countries across low-income countries, emerging markets, and advanced economies (AEs).[5] In the figure the countries are allocated to quartiles by increasing levels of international financial integration, as measured by the sum of foreign assets and liabilities in percent of GDP.

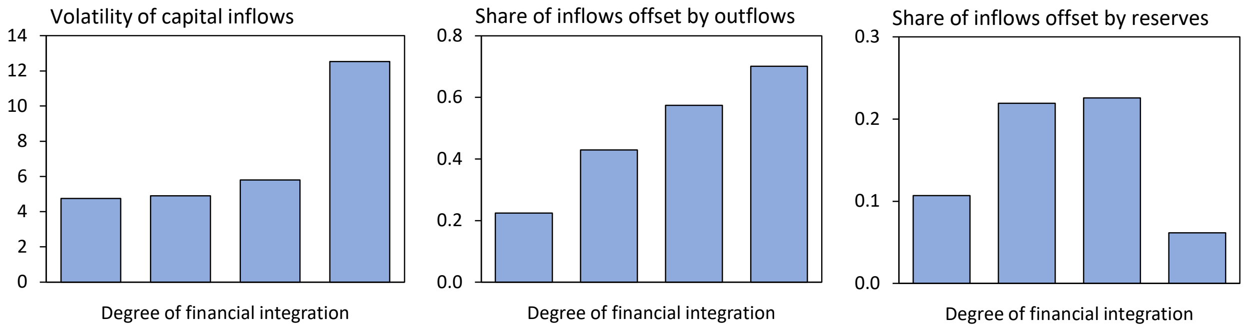
The left-hand side panel of Figure 2 shows that gross capital inflows are markedly more volatile in the most financially integrated countries. This fact is not surprising but it goes to show that AEs (which are predominantly in the top quartile) are not immune to capital flow volatility. There is a paradox (explained by our model) in the fact that capital flow management policies are being recommended to EMs, not AEs, even though the shocks that these policies are meant to smooth seem to be much larger for the latter than the former. What makes EMs special is not that they are hit by larger shocks but that they are less resilient to these shocks.

The middle panel gives a hint as to why this is the case. The chart shows the fraction of gross capital inflows that are offset by capital outflows, as measured by country regressions of outflows over inflows. We see that in more financially developed countries,

[4] There is no exchange rate in our one-good model.

[5] See Appendix B for the list of countries and the data sources.

Figure 2: International financial integration and capital flows



Notes: The figure uses data from the Balance of Payments and International Investment Position statistics between 2000 and 2020 for countries that report information on capital flows and external assets and liabilities for at least 10 years and have a population above 2 million. We exclude the United States and seven outlier countries whose external balance sheets exceed 6 times GDP, although the results are robust to their inclusion. The degree of financial integration is measured as the sum of foreign assets and foreign liabilities as a share of GDP. Countries are grouped into quartiles based on the size of their external balance sheets. The volatility of capital inflows is computed as the standard deviation of gross inflows normalized by GDP. The share of inflows offset by outflows (reserves) is obtained by regressing inflows over outflows (reserve outflows) for each country.

fluctuations in capital inflows are offset by opposite movements in outflows to a much larger degree. Importantly, this is not because more financially developed countries use more FXI. As shown in the third panel, FXI is used predominantly by countries at intermediate levels of international financial integration.

This set of facts is easy to interpret through the lens of the model. The model predicts that in more financially integrated countries the private sector uses its external balance sheet to smooth external financial shocks. In those countries, capital flow management policies tend to be less effective as well as less necessary because the private sector does a good job at offsetting the volatility in capital inflows, as shown by the middle panel of Figure 2. Hence countries with high levels of financial integration have little incentive to use capital flow management policies. By contrast, in countries at lower levels of financial development and integration, capital flow management policies are both more effective and more beneficial as the private sector is constrained by the smaller size of its balance sheet.[6] As described in the model, those countries tend to use FXI rather than capital controls because the former has larger welfare gains.

Relationship to the literature. Our paper is related to the literature that studies the behavior of gross capital flows in the global financial cycle. Broner et al. (2013) document that gross capital flows are much more volatile than net flows and are highly correlated. This correlation has increased over time in line with the process of global financial inte-

[6]This begs the question of why the relationship in the right-hand side panel has an inverted U shape, i.e., why the countries with the lowest level of financial integration tend to rely less on FXI. The model will explain that too, by the fact that countries with low levels of integration are less vulnerable to sudden stops.

gration, as described in Davis and van Wincoop (2018). Consistent with the predictions of our model, IMF (2013) finds that EM economies that exhibit stronger comovement between gross flows tend to be more resilient against fluctuations in global capital markets. Also consistent with our model is the fact that fluctuations in gross capital flows are primarily driven by global factors (Forbes and Warnock, 2012) and are shaped by the behavior of global banks (Forbes and Warnock, 2012; Bruno and Shin, 2015; Miranda-Agrippino and Rey, 2020; Avdjiev et al., 2022).

There is less literature explaining the comovements between gross inflows and gross outflows from a theoretical standpoint. Aguiar and Amador (2011) attribute this comovement to the fact that foreign assets constitute a collateral for a country's foreign liabilities. Davis and van Wincoop (2018) present a two-period portfolio model in which gross inflows and outflows are positively correlated in response to shocks in the cost of international portfolio diversification. In a contribution that is more closely related to ours and is discussed in more detail below, Caballero and Simsek (2020) present a model of gross capital flows in which capital flow surges and retrenchments are generated by fickle global investors.

Our contribution is normative more than positive. As noted earlier, most of the theoretical literature on capital flow management has focused on controls on capital inflows—see for example Ostry et al. (2012) and Korinek (2011). The rationale for policy intervention generally arises from pecuniary externalities associated with collateral constraints, as analyzed for example in Jeanne and Korinek (2010), Bianchi (2011), Benigno et al. (2016), Korinek and Sandri (2016), Schmitt-Grohé and Uribe (2017), and Korinek (2018). In these models, there is no meaningful separate role for the management of inflows and outflows.[7] What matters in a crisis is the net worth of indebted agents and it is irrelevant if net worth is increased by lowering external debt or increasing external assets. These papers have shown that controls on capital inflows should be used to reduce net capital inflows. The pecuniary externality at work in our model is different from that literature since it is distributive rather than collateral-based, to use the terminology in Davila and Korinek (2018).

Our analysis shares several features with Caballero and Simsek (2020), in particular the association of capital flow retrenchments with fire sales. But there are also key differences. Caballero and Simsek assume that gross inflows are used exclusively to finance domestic investment. When capital inflows dry up, the country is forced to liquidate do-

[7] An exception is Arce, Bengui and Bianchi (2019), who show that the constrained efficient allocation can be achieved by government foreign exchange interventions that effectively push private agents against their credit constraint. The optimal management of gross capital flows is also analyzed by Aizenman (2011) in a context of a model where reserves are used to prevent contagion in the liquidation of domestic projects.

mestic capital at fire sale prices. This provides an incentive for a domestic social planner to restrict rather than expand gross inflows. In our model, gross inflows can instead be re-channeled abroad via the accumulation of liquid reserves. A second difference is that Caballero and Simsek emphasize the role of gross inflows in creating liquidity for the rest of the world whereas our analysis focuses on a small open economy.

The paper is also related to a theoretical literature on reserves accumulation and the role of foreign exchange intervention. Jeanne and Rancière (2011) present a model of the optimal level of reserves to deal with rollover risk in external debt. Reserves are modeled as an insurance contract that pays off conditional on the realization of a sudden stop, like in Caballero and Panageas (2008). Bianchi, Hatchondo and Martinez (2018) analyze a similar problem where reserves take the form of a noncontingent asset and can be financed by sovereign defaultable debt. Gourinchas, Rey and Govillot (2022) present a model in which EMs hold low-yielding US assets because they yield a higher return in bad times. In these models, there is no meaningful difference between reserves held by the government or by the private sector. Similar to our paper, Céspedes, Chang and Velasco (2017) and Céspedes and Chang (2020) analyze models in which official reserves are needed because the private sector does not internalize the beneficial effects of liquidity in periods of financial distress. Fanelli and Straub (2021) present a model in which foreign exchange interventions help to smooth the consumption of poor domestic agents. In Benigno, Fornaro and Wolf (2022), the government accumulates reserves to depreciate the currency and tilt production towards the tradable sector because it incorporates positive growth externalities.

A related line of empirical literature has pointed to the stabilizing benefits of reserves. Bussière et al. (2015), Ghosh, Ostry and Qureshi (2016), and Aizenman, Cheung and Ito (2015) found that countries with higher levels of reserves were less likely to suffer a crisis or fared better in crises. Blanchard, Adler and de Carvalho Filho (2015) show that countercyclical reserve interventions have stemmed exchange rate pressures from global capital flow shocks in emerging market economies. Closer to our paper, Avdjiev et al. (2022) show that in emerging market economies foreign exchange reserves tend to offset the volatility of gross inflows to the private sector.

The paper is structured as follows. The next section presents the model assumptions and section 3 characterizes the laissez-faire equilibrium. Section 4 looks at the impact of domestic financial development on capital flows. Section 5 analyzes optimal policies. Section 6 concludes.

2 Model

We consider an EM economy over three periods $t = 0, 1, 2$. The economy is populated by a unitary mass of atomistic identical agents who borrow from foreign investors in period 0. The borrowing proceeds are used to finance domestic investment projects as well as the accumulation of foreign assets. The domestic projects are illiquid in the sense that they pay off in period 2 and cannot be sold in period 1. The foreign assets are liquid and can be sold at any time. The global financial cycle is modeled by assuming that foreign investors' willingness to hold EM debt varies over time, in a sense to be made more precise below.

Agents do not consume in periods 0 and 1. The welfare of all agents (EM borrowers and foreign investors) is equal to their expected period-2 consumption. Figure 3 reports the timeline and the main assumptions, which we describe below in more detail.

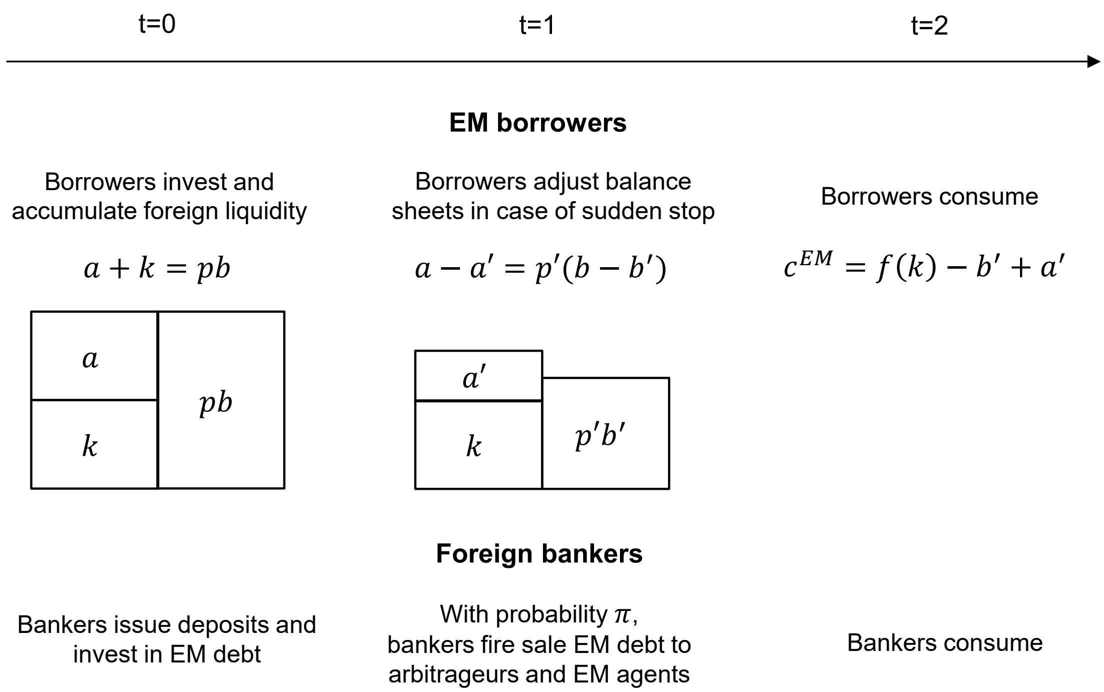


Figure 3: Model timeline

EM borrowers. The budget constraints of the representative EM borrower are,

$$k + a = pb, \tag{1}$$

$$a + p'b' = a' + p'b, \tag{2}$$

$$b' + c^{EM} = f(k) + a'. \tag{3}$$

In period 0 the representative EM agent finances an illiquid domestic investment k as well as liquid foreign assets a by issuing long-term bonds b at price p. The bonds are default-free and repaid in period 2. The domestic investment yields a payoff that is an increasing and concave function of k in period 2, when EM agents consume. The foreign assets are invested in cash, which is modeled as a zero-return storage technology. One may think of a as the foreign exchange reserves of the private sector (the case of public reserves will be considered in section 5). The representative EM borrower adjusts his balance sheet to external financial conditions by buying back a quantity of bonds $b - b'$ at price p' in period 1, after which he is left with a quantity of reserves a'. EM assets and liabilities are assumed to be non-negative.

Foreign investors. There is a large supply of funds ready to be invested at a zero expected return. The EM economy cannot tap this supply directly and must borrow from specialists. There are two classes of specialists, the bankers and the arbitrageurs.

There is a unitary mass of atomistic *bankers*. They have no funds of their own and lend to EM borrowers by issuing safe deposits in period 0. The period-0 budget constraint of bankers is,

$$pb = d,$$

where pb is the value of EM bonds purchased by bankers and d is the quantity of deposits.[8] Bankers also have κ units of legacy assets that generate $R\kappa$ units of output if held until maturity at time 2, with $R > 1$. These assets can be liquidated at time 1 and their liquidation value is denoted by κ. The legacy asset is in sufficient quantity to guarantee the repayment of all deposits.

We assume that the deposits are demandable in period 1 and that depositors demand early repayment with probability π.[9] The early withdrawal of deposits is an exogenous event reflecting the "fickleness" of foreign investors. Thus, there are two states in period 1: the normal state (denoted by N), in which depositors are repaid d in period 2, and the "sudden stop" state (denoted by S), in which the depositors demand early repayment. In the normal state the period-1 price of EM debt is equal to 1. We denote by q the price of EM debt in the sudden stop state.

In the normal state, the period-2 consumption of bankers is equal to the payoff on the unliquidated legacy asset plus the profit that bankers make from the spread on long-term

[8] Bankers are assumed to invest only in EM long-term debt. Nothing of substance is changed if we allow bankers to invest in cash.

[9] Demandable deposit contracts are a standard feature in the banking literature. Deposits could be demandable to give appropriate incentives to bankers or to protect depositors against the risk of a sudden loss in bankers' income pledgeability.

EM debt,

$$c_N^B = R\kappa + b - d = R\kappa + (1-p)\,b. \tag{4}$$

In a sudden stop, bankers repay the deposits by selling EM debt and possibly liquidating their legacy assets. If $q > p$ the bankers make a profit $(q-p)\,b$ on their EM debt holdings. If $q \leq p$ the bankers make a loss $(p-q)\,b$ and liquidate an equivalent quantity of legacy assets to repay all the depositors. The bankers' consumption in the sudden stop state is thus given by,

$$c_S^B = \begin{cases} R\kappa + (q-p)\,b & \text{if } q \geq p, \\ R\kappa - R\,(p-q)\,b & \text{if } q \leq p. \end{cases} \tag{5}$$

Observe that since $R > 1$, the disutility of bank losses is larger than the utility of bank profits, making bankers effectively risk averse.

EM debt can also be sold to *arbitrageurs* in period 1. The arbitrageurs are endowed with ϕ in period 1 which they can invest in cash or EM debt. Their final consumption is equal to the payoff from investing ϕ in EM bonds (or in cash if $p' = 1$) in period 1,

$$c^A = \frac{\phi}{p'}, \tag{6}$$

where p' is equal to 1 in state N and to q in state S.

This setup captures the key frictions at work in conventional accounts of the global financial cycle. EM economies obtain funds from specialized investors who are sometimes under pressure to sell EM assets. The selling pressure, in our model, comes from the fact that the bankers have to deleverage.[10] This selling pressure would not depress the price of EM debt if arbitrageurs had enough resources. A key assumption is that the arbitrageurs' resources ϕ are not large enough to prevent a fire sale discount in the price of EM debt.

Unconstrained first best. We characterize the unconstrained first-best allocation as a benchmark for the rest of the analysis. The first-best allocation is achieved if EM borrowers can bypass the intermediation of specialists and borrow directly from non-specialist foreign investors at a zero interest rate. EM physical investment then satisfies,

$$f'\left(k^{FB}\right) = 1. \tag{7}$$

[10]Alternatively, we could assume that the bankers are self-funded but have access to an alternative investment with gross return R between periods 1 and 2 with probability π. In this case, the selling pressure comes from the fact that bankers want to disinvest from the EM economy to take advantage of a higher return.

The level of foreign liquidity a is indeterminate and irrelevant for welfare in the first-best allocation.

3 Laissez-faire

We now solve for the laissez-faire equilibrium in which: (i) EM borrowers set the levels of k, a, and b to maximize their utility $E_0\left(c^{EM}\right)$ subject to the budget constraints (1)-(3) and taking the prices p and p' as given; and (ii) the prices p and p' clear the market for EM debt in periods 0 and 1. The equilibrium from period 1 onwards is contingent on the state (N or S). We derive the laissez-faire equilibrium by proceeding backwards, starting with period 1.

Period-1 equilibrium. In the normal state, the period-1 price of EM debt is $p' = 1$. In the sudden stop state, the bankers sell their holdings of EM debt to the arbitrageurs and the EM residents. The price of debt is then determined by a cash-in-the-market pricing formula (Allen and Gale, 1994). The debt price that equalizes demand and supply is such that $a + \phi = qb$ unless there is enough cash in the market to buy the debt at price 1 ($a + \phi \geq b$). The fire-sale price of debt is thus given by,

$$q = \min\left(1, \frac{a + \phi}{b}\right). \tag{8}$$

Period-0 demand for EM debt. In period 0 the foreign bankers maximize their utility $U_0^B = E_0\left(c^B\right) = (1-\pi)c_N^B + \pi c_S^B$ where c_N^B and c_S^B are respectively given by (4) and (5). If $q > p$, the bankers' demand for EM debt is infinite since they make a strictly positive profit on each unit of EM debt purchased in period 0 irrespective of the state. This cannot be true in equilibrium, so that q must be equal to or lower than p. Using (4) and (5), the banker's welfare is then given by,

$$U_0^B = R\kappa + (1 - \pi + \pi R q - R^e p)\, b, \tag{9}$$

where $R^e \equiv 1 - \pi + \pi R$ is the expected return on period-1 liquidity for bankers.

Bankers maximize their utility (9) subject to the constraint that the legacy asset is large enough to cover their loss, $(p - q)\, b \leq \kappa$. We assume that κ is large enough that this constraint is not binding.[11] Hence bankers' demand for EM debt is non-zero and finite if

[11] A condition involving the exogenous parameters is derived at the end of this section.

and only if,

$$p = \frac{1 - \pi + \pi R q}{R^e}. \tag{10}$$

The price of EM debt is lowered by a pure risk premium. To see this, observe that equation (10) can be re-written as

$$p = E_0(p') - \pi(1-\pi)\frac{R-1}{R^e}(1-q), \tag{11}$$

where $E_0(p') = 1 - \pi + \pi q$ is the expected price of EM debt. The second term on the right-hand side of (11) is a pure risk premium discount reflecting the fact that the price of EM debt falls when the value of liquidity increases for bankers. The risk premium is decreasing with the fire sale price of EM debt.

Solving for b in equations (1), (8) and (10) gives the period-0 and -1 prices of EM debt in terms of physical investment k and reserves a. The following lemma describes how p and q vary with k and a.

Lemma 1. *The period-*0 *price of EM debt is a function of the EM agents' investment in physical capital k and foreign liquidity a*

$$p(k,a) = \frac{1 - \pi + \pi R q(k,a)}{R^e}, \tag{12}$$

where the fire-sale price of EM debt is given by

$$q(k,a) = \left[1 + \frac{R^e}{1-\pi}\frac{(k-\phi)^+}{a+\phi}\right]^{-1}. \tag{13}$$

(using the conventional notation $x^+ = \max(x,0)$).

Proof. See Appendix A.1. ∎

Equations (12) and (13) give the price of debt as a function of the allocation of capital inflows between the physical asset and foreign liquidity. In both equations, the amount of debt b is endogenous and left implicit. These equations show how the price of EM debt depends on what it finances in aggregate.

Several observations follow from equations (12) and (13). First, $q(k,a) = p(k,a) = 1$ if $k \leq \phi$. If arbitrageurs have enough liquidity to buy k without a discount, the price of debt is not affected by a sudden stop so that debt can be sold to bankers for $p = 1$ in period 0 .

Second, if $k > \phi$, q and p are both strictly smaller than 1 because a sudden stop leads to a fire sale. In this case, the price of EM debt is decreasing in physical investment and increasing in liquidity,

$$\left.\frac{\partial p}{\partial k}\right|_a < 0, \quad \left.\frac{\partial p}{\partial a}\right|_k > 0.$$

On one hand, higher investment k is financed by issuing more debt b, which depresses the fire-sale price of debt. On the other hand, issuing debt in order to accumulate liquidity raises the fire-sale price of debt. To understand this result one can substitute out a from (8) using (1), which gives

$$q = p - \frac{k - \phi}{b}.$$

Given p and k, the EM agents raise the fire-sale price of debt by increasing b, i.e., by accumulating debt-financed liquidity. This in turn increases the ex-ante price of debt p.

Period-0 reserves. Next, consider the problem of EM agents in period 0. EM agents' welfare can be computed by assuming that they spend all their liquidity to buy back EM debt in period 1 irrespective of the state.[12] Using $a' = 0$ and the budget constraints (1)-(3) to substitute out k and c^{EM}, the representative borrower's welfare can be written,

$$U_0^{EM} = f(k) - b + aE_0\left(\frac{1}{p'}\right), \tag{14}$$

$$= f(k) - \frac{k}{p} + a\left[E_0\left(\frac{1}{p'}\right) - \frac{1}{p}\right]. \tag{15}$$

The representative EM agent maximizes his welfare taking the prices p and p' as given. The first-order condition for k equates the marginal cost of issuing bonds to the marginal return on capital,

$$f'(k) = \frac{1}{p}. \tag{16}$$

In an equilibrium where EM borrowers hold foreign assets (i.e., in which the constraint $a \geq 0$ is not binding) the first-order condition for a is

$$E_0\left(\frac{1}{p'}\right) - \frac{1}{p} = 0. \tag{17}$$

Issuing bonds at price p in period 0 to invest in liquidity and buy back EM debt at price p' in period 1 must yield a zero expected profit in equilibrium.

It is then possible to show the following result.

Lemma 2. *If $k^{FB} > \phi$ the representative EM agent holds a strictly positive level of foreign*

[12] If $p' < 1$ they do so in equilibrium. If $p' = 1$, their purchase of EM debt is indeterminate but their welfare is the same as if they spent all their liquidity on EM debt.

liquidity if and only if $q = 1/R$.

Proof. See Appendix A.1. ■

The inverse of the fire-sale price, $1/q$, is the value of liquidity for EM agents in the sudden stop state, whereas R is the value of liquidity for bankers. The Lemma states that the value of period-1 liquidity must be the same for bankers and EM agents in equilibrium. This is because bankers and EM residents trade period-1 liquidity with each other through the debt and deposit markets. If q were lower than $1/R$, EM residents would strictly benefit from issuing more debt to accumulate liquidity, which would raise q. Conversely, if $q > 1/R$, EM residents benefit from reducing their debt-financed liquidity.

Period-0 equilibrium. Putting things together, the equilibrium level of capital and price of debt are determined as in Figure 4. The upward-sloping curve corresponds to the EM demand for funds, equation (16). The other curve represents the foreign investors' supply of funds, equation (12), taking into account the endogeneity of a to the fire-sale price. When k exceeds ϕ, the fire-sale price q falls below 1 but as long as q is larger than $1/R$, EM residents do not invest in liquidity (by Lemma 2) so that p is equal to $p(k,0)$. When the fire-sale price reaches $1/R$ (point B), EM residents start to accumulate liquidity so that the fire-sale price remains equal to $1/R$, and p to $1/R^e$. EM agents start accumulating liquidity when $q(k,0) \leq 1/R$, which using (13) is equivalent to $k \geq \phi R/R^e$.

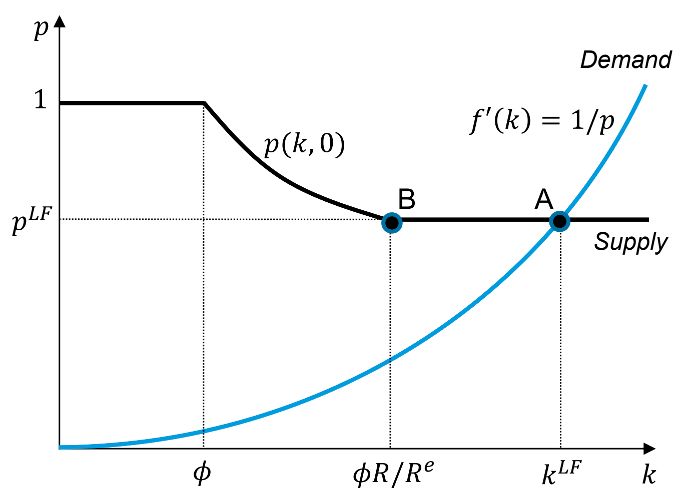


Figure 4: Laissez-faire equilibrium

Figure 4 shows an equilibrium (point A) where EM agents accumulate a positive level of liquidity. The following Proposition characterizes such equilibria in general.

Proposition 3. *(Laissez-faire equilibrium) The EM agents hold a strictly positive level of foreign liquidity in the laissez-faire equilibrium if and only if*

$$f'\left(\phi\frac{R}{R^e}\right) > R^e. \tag{18}$$

In this equilibrium, the price of EM debt is equal to $1/R^e$ *in period* 0 *and falls to* $1/R$ *in period* 1 *if there is a sudden stop. The period-*0 *level of physical investment satisfies*

$$f'\left(k^{LF}\right) = R^e, \tag{19}$$

and the EM country's external balance sheet is given by

$$b^{LF} = \frac{k^{LF}-\phi}{1/R^e - 1/R}, \tag{20}$$

$$a^{LF} = \frac{k^{LF}-\phi R/R^e}{R/R^e - 1}. \tag{21}$$

Proof. See Appendix A.1. ■

Proposition 3 calls for several observations. First, equation (18) implies that EM residents accumulate liquidity if and only if the arbitrageurs' resources ϕ are small enough. Second, equation (19) implies that $k^{LF} < k^{FB}$ if $\pi > 0$, i.e., the level of physical capital falls short of the unconstrained first best if there is a risk of sudden stop. This is because of the risk premium in the cost of borrowing from foreign bankers.

Third, the level of physical investment and the debt prices p and p' do not depend on the foreign arbitrageurs' resources ϕ. Changes in ϕ are endogenously offset by changes in the EM balance sheet that leave the price of EM debt the same. For example, a lower level of arbitrageur resources induces EM residents to increase their holdings of debt-financed liquidity one for one.

Finally, this equilibrium was derived under the assumption that bankers have enough legacy asset to pay for their losses in a sudden stop, $\kappa \geq (p-q)b$. Using the values given in Proposition 3 this condition becomes $\kappa \geq k^{LF} - \phi$ which we assume to be satisfied in the rest of the paper.

Links to the evidence. The model can be used to interpret some of the stylized facts discussed in the introduction. A sudden stop in period 1 can be interpreted as a tightening of the global financial cycle. The model explains why a capital flight (the sale of EM assets by foreigners) is associated with a retrenchment (the sale of foreign assets by EM residents) as well as with a fall in in the price of EM debt. By contrast, period 0 can be interpreted as a loose phase of the global financial cycle, when EM agents can sell their debt at a high price and their balance sheets expand. Thus, the model explains why EM gross capital inflows and outflows are positively correlated with each other, and with the price of EM assets.

The model as it stands however does not help us to understand the differences between countries at different levels of financial development and international financial integration. We turn our attention to this question in the following section.

4 Financial development and capital flows

In the previous section, we assumed that EM agents were unconstrained in the amount of debt that they could issue. We now relax this assumption and assume that domestic agents can issue a limited amount of debt because of a *domestic* financial friction. The question is how domestic financial development affects capital flows, and in particular the allocation of capital inflows between physical investment and liquidity.

We assume that a financial friction limits the borrowing capacity of EM agents. As a result EM borrowers are subject to the credit constraint,

$$pb \leq \beta, \tag{22}$$

where β is an exogenous parameter. Several microfoundations for such a constraint can be found in the literature.[13] Parameter β may reflect the strength of creditor rights, the strength of their enforcement, or the creditors' ability to monitor the borrowers' actions. We will interpret this variable as the country's level of financial development. Increased financial development allows EM agents to produce more financial assets that can be sold to foreign investors. Constraint (22) is binding if and only if β is smaller than the economy's unconstrained level of foreign borrowing, $k^{LF} + a^{LF} = \left(k^{LF} - \phi\right)/(1 - R^e/R)$.

We study how the country's external balance sheet, a and b, investment k, and debt prices, p and q, depend on the level of domestic financial development β. The constraint $a \geq 0$ is binding if and only if the marginal return on capital is larger than the marginal return on liquidity, i.e.

$$f'(k) \geq 1 - \pi + \frac{\pi}{q(k, 0)}. \tag{23}$$

[13] For example, assume the collateral constraint $pb \leq \alpha + \gamma(a + k)$, where γ is a coefficient lower than one. The r.h.s. is the amount of good that foreign creditors can recover in a default. If this constraint were violated, the borrower could make a take-or-leave offer to reduce her debt to that amount in period 0, which the creditors would accept. Using (1) to substitute out $a + k$, this credit constraint can be rewritten as (22) with $\beta = \alpha/(1 - \gamma)$.

The left-hand side and right-hand side of this inequality are respectively decreasing and increasing in k. Thus (23) is satisfied if and only if k is lower than the level $\hat{k}$ for which it holds as an equality. The threshold $\hat{k}$ is between ϕ and k^{LF} because $k = \phi$ satisfies (23) but k^{LF} does not.[14]

Having defined the threshold $\hat{k}$ in this way, we can distinguish between three stages of financial development.

1. Low financial development. For $\beta \leq \hat{k}$, EM agents borrow β and invest the proceeds in illiquid domestic capital: $k = \beta$. Constraint (22) is binding because β is lower than $k^{LF} + a^{LF}$ and EM agents do not invest in foreign assets because (23) is satisfied.

2. Intermediate financial development. For $\beta \in \left[\hat{k}, k^{LF} + a^{LF}\right]$, constraint (22) is still binding, but EM borrowers now invest a share of capital inflows in foreign liquidity.

3. High financial development. For $\beta > k^{LF} + a^{LF}$, constraint (22) is no longer binding so that further financial development does not affect capital flows.

The most interesting development stage is the intermediate one because it may be interpreted as capturing the situation of emerging markets (whereas low-income countries and AEs would correspond to the first and third stages respectively). The impact of financial development on capital flows in that case is characterized in the following proposition.

Proposition 4. *(Impact of financial development on capital flows) EM borrowers hold a positive level of reserves and their external borrowing is constrained if and only if the level of domestic financial development is intermediate, $\beta \in \left[\hat{k}, k^{LF} + a^{LF}\right]$. In this case domestic financial development (an increase in β) raises physical investment k and reserves a as well as the price of EM debt,*

$$\frac{\partial k}{\partial \beta} > 0, \ \frac{\partial a}{\partial \beta} > 0 \text{ and } \frac{\partial p}{\partial \beta} > 0.$$

Proof. See Appendix A.1. ■

Financial development leads to gross capital inflows that finance increments in both physical capital and foreign liquid assets. Both capital and liquidity increase at the margin because domestic agents equate the returns on both types of assets. The return on liquidity falls because the fire-sale price of EM debt increases with the level of liquidity.

[14]For $k = \phi$ this is an implication of $q(\phi, 0) = 1$ and $\phi < k^{FB}$. For $k = k^{LF}$ note that since $a^{LF} > 0$, $f'\left(k^{LF}\right) = 1 - \pi + \pi / q\left(k^{LF}, a^{LF}\right) < 1 - \pi + \pi / q\left(k^{LF}, 0\right)$.

Figure 5 illustrates the impact of financial development on the main endogenous variables.[15] The left-hand side and right-hand panels respectively show the impact of financial development on gross capital flows and the price of EM debt. For $\beta < \hat{k}$, the capital inflows allowed by financial development finance only physical capital and no foreign liquidity is accumulated. If $\beta < \phi$, larger debt inflows do not reduce the price of debt because foreign arbitrageurs have enough resources to buy back all the debt in a sudden stop. When $\beta > \phi$ the price of debt initially falls sharply with the level of borrowing because capital inflows do not finance liquidity. The response of the debt price to gross inflows is reversed when $\beta > \hat{k}$. The capital inflows allowed by financial development then finance mostly the accumulation of foreign liquidity, which raises the price of EM debt.

Links to the evidence. The model explains why increased financial integration leads to better offsetting of capital inflows by outflows (which is true in the data as shown in Figure 2). In period 0 a larger fraction of gross inflows finances outflows in countries with a larger level of β. Similarly, a larger β implies that in a sudden stop a larger fraction of negative gross inflows by non-residents is covered by negative gross outflows by residents.

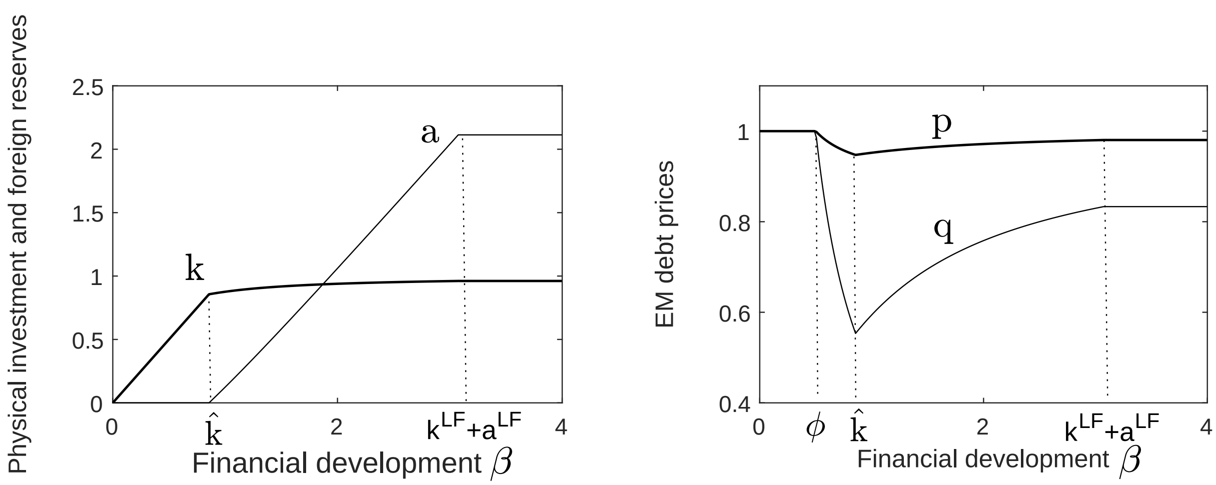


Figure 5: Financial development, EM balance sheet, and debt prices

[15]We use the following model specification and calibration: $f(k) = 2\sqrt{k}$, $\phi = 0.5$, $\pi = 0.1$ and $R = 1.2$. The numerical illustrations presented in the rest of the paper will be based on the same parameter values.

5 Policies

We now turn to the normative part of our analysis. Section 5.1 characterizes the allocation chosen by a social planner who maximizes EM welfare. Section 5.2 shows how the social planner allocation can be implemented with capital controls or domestic financial regulation. Section 5.3 compares the EM social planner allocation with that chosen by a global social planner. Finally, 5.4 looks at the role of sterilized foreign exchange intervention.

We limit our attention to ex-ante policy interventions in period 0 and assume that the social planner commits not to interfere with the decentralized allocation ex post (in period 1). It is possible to show that such a commitment is optimal. Some form of commitment is necessary—otherwise the social planner would simply expropriate foreign bankers in $t = 1$ and the bankers would not lend in $t = 0$, i.e., we would have $\beta = 0$. We show in Appendix A.2 that EM welfare is not strictly increased if the EM social planner can commit to state-contingent debt taxation or liquidity hoarding policies.

5.1 EM social planner allocation

We consider a constrained-efficient social planner who sets a and b in period 0 so as to maximize the welfare of EM residents subject to the same constraints as private agents. The wedge between the private and social impacts of changing the EM balance sheet comes from a pecuniary externality. The social planner takes into account the impact of changing the EM's balance sheet on debt prices whereas private borrowers do not. As explained above we assume that the social planner intervenes only ex ante (in period 0).

The social planner exploits the fact that the EM country is a monopolist in the market for its own debt. Which way the social planner wants to move debt prices is not obvious a priori because EM agents are both sellers and buyers in their debt market. In period 0 EM agents sell debt and benefit from a higher price p but in a sudden stop the same agents buy back debt and benefit from a lower price q.

In order to understand the EM social planner allocation it is useful to take a detour through global welfare. Global welfare is the sum of the welfare of EM residents, foreign bankers and foreign arbitrageurs,[16]

$$U_0^W = U_0^{EM} + U_0^B + U_0^A,$$

[16] We do not include the welfare of bank depositors, which is simply equal to their endowments.

where the welfare of the three types of agents is given by,

$$U_0^{EM} = f(k) - b + a\left(1 - \pi + \frac{\pi}{q}\right), \tag{24}$$

$$U_0^B = R\kappa, \tag{25}$$

$$U_0^A = E_0\left(c^A\right) = \phi\left(1 - \pi + \frac{\pi}{q}\right). \tag{26}$$

These expressions come from equations (6), (9), (10), (14) and using the fact that p' is equal to 1 with probability $1-\pi$ and to q with probability π. Observe that bankers receive their reservation value, which is equal to the payoff on their unliquidated legacy asset. Summing up (24), (25) and (26) and using $q = (a+\phi)/b$ we have,

$$U_0^W = R\kappa + f(k) - (1-\pi)(b - a - \phi).$$

Then using (10) and $q = (a+\phi)/b$ to substitute out p from (1) gives $(1-\pi)(b-a-\phi) = R^e(k-\phi)$ so that the expression above can be re-written,

$$U_0^W = R\kappa + R^e\phi + f(k) - R^e k. \tag{27}$$

Global welfare is equal to the payoff on the bankers' unliquidated legacy asset, plus the value of the foreign arbitrageurs' endowment invested at R^e, plus the welfare surplus from the EM physical investment assuming a cost of funds of R^e. Importantly, global welfare is constant given k and does not depend on the EM external balance sheet. Hence, the effect of changes in the EM balance sheet, if any, is to redistribute welfare between the EM economy and the rest of the world. That is, the pecuniary externality is entirely redistributive.

To understand this externality, let us use (27) to rewrite EM welfare as,

$$U_0^{EM} = U_0^W - U_0^A - U_0^B = f(k) - R^e k + \pi\phi\left(R - \frac{1}{q}\right). \tag{28}$$

As can be seen from this equation and (26), changes in the EM balance sheet redistribute welfare between EM agents and foreign arbitrageurs. Furthermore, EM agents always benefit from an increase in the fire sale price of debt q which raises the ex-ante price p. Increasing the ex-ante price of EM debt comes at the cost of lower profits for foreign arbitrageurs and the two welfare effects exactly offset each other, leaving global welfare unchanged.

The fire sale price of debt is too low in the laissez-faire allocation where $q = 1/R$. This suggests that EM welfare would be increased by making the EM external balance sheet larger than under laissez-faire. The EM social planner allocation is characterized in the following proposition.

Proposition 5. *(EM social planner allocation) Assume $\beta > k^{LF} + a^{LF}$ so that the constraint $bp \leq \beta$ is not binding under laissez-faire. Consider a social planner who sets capital flows in period 0 so as to maximize EM welfare subject to $bp \leq \beta$. Then the EM social planner maximizes the volume of capital inflows, i.e., makes the constraint $pb \leq \beta$ binding. In the social planner allocation the level of foreign liquidity is higher, and the level of physical capital lower, than under laissez-faire: $a^{SP} > a^{LF}$ and $k^{SP} < k^{LF}$.*

Proof. See Appendix A.1. ■

The social planner maximizes capital inflows in period 0, and so also the outflow of foreign capital in period 1 if there is a sudden stop. This result runs counter to the idea that gross capital flows are excessively large and volatile under laissez-faire. The problem is actually the opposite: gross flows are not large enough in the decentralized equilibrium. Gross capital flows play a stabilizing role in our model because they reduce the volatility in the price of domestic debt ex post (in period 1) and thus the risk premium that the country has to pay ex ante (in period 0). This is in marked contrast with the literature on pecuniary externalities based on a collateral constraint, in which the social planner allocation involves smaller and less volatile net capital flows than under laissez-faire (Jeanne and Korinek, 2010; Bianchi, 2011; Benigno et al., 2016; Schmitt-Grohé and Uribe, 2017; Korinek, 2018). The nature of the pecuniary externality in our model is not the same as in that literature.

The social planner lowers the ex-ante cost of borrowing for private agents but does not raise k—instead she decreases it below the laissez-faire level, which itself was lower than the unconstrained first-best level given by (7). This is because like private agents, the social planner is constrained by the fact that external finance comes from leveraged bankers who demand a compensation for the risk of having to liquidate legacy assets.

5.2 Implementation

This section discusses the implementation of the social planner allocation with capital controls or financial regulation.

Capital controls. The social planner allocation can be implemented with taxes on gross capital inflows and outflows. Let us assume that the purchase of EM bonds by foreign bankers and the accumulation of foreign liquidity by EM residents are taxed at rates τ_b and τ_a respectively. The period-0 budget constraint of EM agents becomes

$$k + (1 + \tau_a)a = \frac{pb}{1 + \tau_b} + z, \tag{29}$$

where z is the lump-sum rebate of the taxes.

It turns out that the social planner allocation can always be implemented with one instrument, a subsidy on foreign liquidity, as stated in the following proposition.

Proposition 6. *The social planner allocation discussed in Proposition 5 can be implemented with a subsidy on foreign liquidity ($\tau_a \leq 0$ and $\tau_b = 0$).*

Proof. See Appendix A.1. ■

The subsidy on foreign liquidity expands the level of capital inflows all the way to the upper bound β, and then tilts the composition of the assets towards foreign liquidity.

Domestic financial regulation. The model as it stands does not separate the real sector from the financial sector in the EM economy. One could separate the two sectors by assuming that the EM agents who invest in physical capital k do not invest in foreign liquidity a, and that the investment in a is instead done by debt-issuing home financial institutions. In this case, the first category of agents (the real sector) issues just the debt they need to finance physical investment. We sketch out some properties of this two-sector model in the rest of this section.

The modified model with a real and a financial sector implies the same equilibrium allocations as our baseline model. Under laissez-faire, the EM financial institutions issue long-term debt to finance liquidity in aggregate quantities that satisfy the same first-order conditions as in section 3. The EM financial sector would endogenously finance foreign liquidity by issuing long-term debt.

In this two-sector model the social planner allocation could be implemented by domestic financial regulation rather than capital controls. The social planner can use liquidity regulation to induce home financial institutions to expand their balance sheets and hold more foreign liquidity than they would under laissez-faire. This policy would impose some costs on the financial sector, but these costs would be more than offset by the gains from a lower cost of external borrowing.

One could also introduce in this model EM unleveraged investors that can be interpreted as pension funds or insurance companies. These investors would be endowed with an exogenous level of equity in period 0 to be invested in home long-term debt or foreign liquidity. The existence of such investors increases the welfare of the EM economy because it reduces the amount of debt that the EM real sector needs to sell to fickle foreign investors. If the balance sheet of leveraged institutions is constrained by frictions or by regulation, it would be optimal to induce the unleveraged financial sector to invest more resources in foreign liquidity.

The general principle underpinning government interventions is that they should boost the accumulation of foreign liquidity, even when this liquidity is financed by long-term borrowing abroad. This can be achieved most directly by a subsidy on foreign liquidity holding. Liquidity regulation of the financial sector can also be used to this end if foreign liquidity is held primarily by the home financial sector.

5.3 Global vs. local social planner

The intervention by the EM social planner is not Pareto-optimal from a global perspective since it comes at the cost of foreign arbitrageurs' welfare. In fact, no global Pareto improvement is possible starting from laissez-faire. Any Pareto improvement would have to increase global welfare, but global welfare is already at its maximum level under laissez-faire since (27) is maximized for $f'(k) = R^e$. Thus, a constrained-efficient global social planner applying the Pareto criterion would not see the need to change anything to the laissez-faire allocation.

However, the global Pareto criterion does not seem appropriate in the context of this model. Foreign arbitrageurs receive a rent from the existence of sudden stops and the Pareto criterion implies the preservation of their rent. In particular, reducing the probability of sudden stop π is not Pareto-improving from a global perspective. If it were possible to remove sudden stops by waving a magic wand, the global Pareto criterion would preclude it.

This begs the question of which welfare criteria would make more sense than constrained-efficient global Pareto optimality. We make two proposals below and show that they lead to the same implications for capital flows. The first welfare criterion postulates that it is desirable to bring the *distribution* of welfare closer to the unconstrained first best provided that global welfare is not reduced. In more formal terms, we define an allocation that minimizes the distance to the unconstrained first best as one that solves the following problem (P),

$$\min \omega^{EM} \left| U_0^{EM} - U_0^{EM,FB} \right| + \omega^A \left| U_0^A - U_0^{A,FB} \right|$$

subject to

$$U_0^{EM} + U_0^A \geq U_0^{EM,LF} + U_0^{A,LF}$$

where $U_0^{EM,FB}$ and $U_0^{A,FB}$ are the levels of welfare of EM agents and arbitrageurs in the unconstrained first-best allocation analyzed at the end of section 2, and ω^{EM} and ω^{A} are arbitrary weights put on the welfare of these agents.

It is easy to see that problem (P) is solved by leaving capital at the laissez-faire level ($k = k^{LF}$) and maximizing capital flows ($pb = \beta$). The first condition is necessary for global welfare not to decrease. The second condition comes from the fact that arbitrageurs receive zero rent in the unconstrained first best. Hence, given k, increasing gross capital flows raises EM welfare and decreases arbitrageurs' welfare toward their unconstrained first best levels.

In our second welfare criterion international policy is motivated by concerns about inequality. Because utility is linear in our model, the income inequality between EM borrowers and foreign investors is not a source of global welfare loss. Redistributing income from richer foreign arbitrageurs to poorer EM borrowers would increase global welfare if utility were concave. One may capture this idea in a simple way by assuming that the global social planner puts a lower weight $1-\omega$ on the welfare of foreign arbitrageurs than on the welfare of EM residents. The objective function of the global social planner would then be

$$\begin{aligned} U_0^{GSP} &= U_0^{EM} + (1-\omega)\, U_0^{A}, \\ &= f(k) - R^e(k-\phi) - \omega\phi\left(1 - \pi + \frac{\pi}{q(k,a)}\right). \end{aligned} \tag{30}$$

It directly follows from (30) that if ω is strictly positive but close to 0, the global social planner implements a level of physical investment that is about the same as under laissez-faire but also maximizes the level of EM external borrowing in the same way as the EM social planner.

Our results are summarized in the following proposition.

Proposition 7. *Consider the global allocations that either minimize the distance to the first best in the sense of solving problem (P), or maximize global welfare (30) with a vanishingly small bias ω in favor of EM agents. If the constraint $pb \leq \beta$ is not binding under laissez-faire, those allocations are implemented by maximizing gross capital flows while leaving physical capital at the laissez-faire level ($k^{GSP} = k^{LF}$ and $p^{GSP}b^{GSP} = \beta$).*

Proof. See discussion above. ∎

Therefore, the conclusion that gross capital flows should be maximized carries over from local to global social planning under fairly weak assumptions. The main difference is that the global social planner implements a higher level of physical investment than the local social planner.

5.4 Government reserves

We now consider the case where the private sector is constrained under laissez-faire ($\beta < k^{LF} + a^{LF}$) and show that government reserves interventions have a useful role to play.

We introduce an EM government that can borrow and accumulate foreign liquidity or "reserves." The government has no real expenditure. The budget constraints of the government are

$$\begin{aligned} a^g &= pb^g, && (31) \\ a^g + p'b'^g &= a'^g + p'b^g, && (32) \\ b'^g + z &= a'^g, && (33) \end{aligned}$$

where z is a lump-sum transfer to the private sector. The budget constraints (1)-(3) still apply to the EM agents, with the transfer z added to the period-2 budget constraint.

We assume that the government sells all its reserves to buy back EM debt if there is a sudden stop in period 1. That is, $a'^g = 0$ and $z = (1/q - 1/p)a^g > 0$ in the event of a sudden stop. The government does not intervene if external financial conditions are normal: $a'^g = a^g$ and $z = -(1/p - 1)a^g < 0$ (the government imposes a tax $-z$ to pay for the carry cost of reserves).

We interpret these government balance sheet operations as sterilized foreign exchange interventions by the central bank. When the central bank buys foreign reserves and sells the same quantity of domestic government debt, it increases the total supply of debt by the consolidated government sector (treasury plus central bank) to the private sector and accumulates an equivalent quantity of reserves. This corresponds to an increase in b^g and a^g in our model.

We assume that the government has its own borrowing constraint in period 0,

$$pb^g \leq \beta^g.$$

The borrowing constraints of the government and the private sector are separate because they are determined by different factors. The borrowing constraint of private borrowers is determined by private creditor rights and their enforcement, whereas the borrowing constraint of the government is determined by its ability to raise taxes and the cost of defaulting on government debt (Holmström and Tirole, 1998).

It is easy to see (by consolidating the budget constraint of the government with that of the private sector) that under these assumptions, the government can achieve the same allocations as in the laissez-faire equilibrium in which the private sector borrowing capacity is increased from β to $\beta + \beta^g$. That is, allowing the government to use its balance sheet has the same impact on allocations and welfare as financial development.[17]

We then have the following result.

Proposition 8. *(Government reserves interventions) Government reserves interventions are welfare-increasing if and only if the level of domestic financial development β is in the interval $\left(\phi, k^{LF} + a^{LF}\right)$. If the private sector holds a strictly positive amount of liquidity, government accumulation of reserves partially crowds out private liquidity, crowds in physical investment and raises the price of government debt,*

$$-1 < \frac{\partial a}{\partial \beta^g} < 0, \frac{\partial k}{\partial \beta^g} > 0, \frac{\partial p}{\partial \beta^g} > 0.$$

Proof. See Appendix A.1. ■

The impact of government reserves interventions depends on the level of domestic financial development. If financial development is low the country does not issue enough debt to be affected by a sudden stop and there is no benefit from reserves interventions. If financial development is high, the economy is in a Ricardian regime where government reserves interventions have no impact. Hence, government reserves interventions raise welfare only for intermediate levels of financial development.

Expanding the government balance sheet is equivalent to an increase in β and its impact on allocations can be seen in Figure 5. In the intermediate regime where reserves intervention matters, the additional capital inflows allowed by reserves accumulation are almost entirely invested in liquidity in aggregate. A small fraction is accumulated as physical capital, as the private sector responds to the lower cost of funds by investing more. This explains why there is some crowding out of private liquidity by public reserves, but this effect is quantitatively small.

A natural question is how government reserves interventions and capital controls compare. An illustrative but revealing answer is provided by Figure 6, which was constructed with the same parameter values as Figure 5.[18] The left-hand side panel shows

[17]One caveat to this statement is that if the private sector holds zero liquidity, which can occur in the Ricardian regime if the government holds a large amount of reserves, private and public liquidity are not equivalent because the private sector's constraint $a \geq 0$ is binding separately.

[18]The maximum level of government borrowing was set to $\beta^g = 0.5$. We set the optimal level of reserves to zero when reserves interventions do not affect welfare.

how the optimal size of reserves interventions varies with the level of private financial development. The right-hand side panel compares the welfare gains from the optimal reserves interventions with the optimal reserves subsidy discussed in section 5.2.

The figure shows that when reserves interventions matter, their welfare gains are substantially larger than that of capital controls. The fact that the two policies have different welfare gains is not surprising because they operate through very different channels. Capital controls affect the allocation of capital inflows between physical capital and foreign liquidity subject to the private sector's financial constraint $pb \leq \beta$. Instead, government balance sheet management relaxes that constraint in aggregate by consolidating it with the government's constraint. Figure 6 shows that relaxing the aggregate constraint yields substantially larger welfare gains than reallocating the resources under the constraint.

Links to the evidence. The model variant presented in this section sheds light on the use of capital flow management policies in the real world. As shown in Figure 1 foreign exchange interventions are used to offset changes in gross capital inflows. The model explains this fact by the desire to stabilize domestic asset prices and reduce risk premia. As shown in Figure 2, foreign exchange interventions are used primarily by countries with intermediate levels of financial integration. In the model, these are the countries where those interventions are both effective and beneficial.

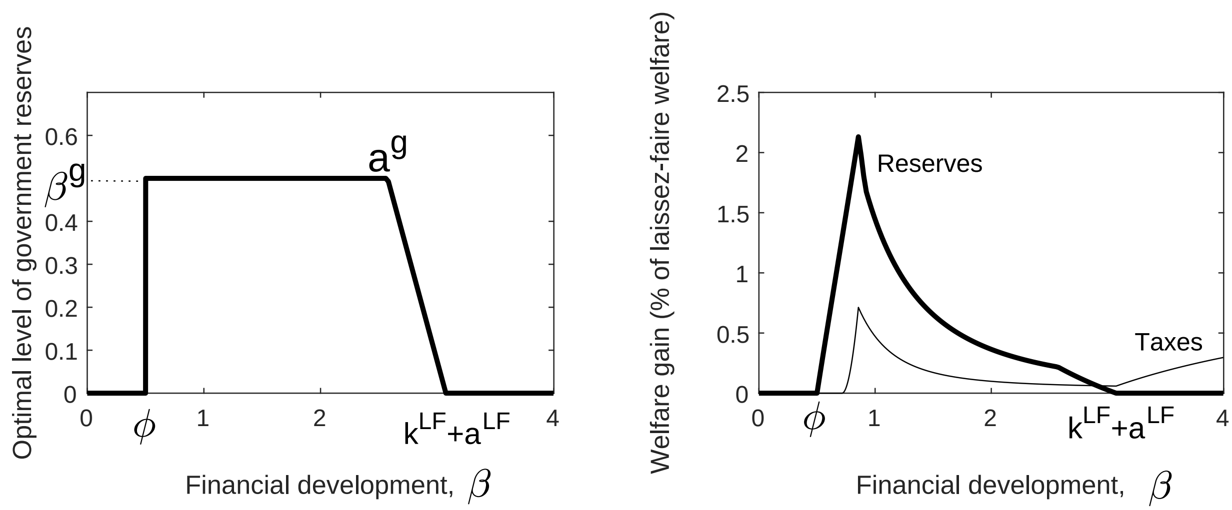


Figure 6: Optimal government reserves interventions

6 Conclusions

The global financial cycle exposes emerging markets to large fluctuations in capital inflows. A common policy prescription is to increase resilience by restricting capital flows, for example through the use of capital controls. In this paper, we offered a different perspective by pointing out that countries can buffer the volatility of capital inflows with offsetting capital outflows. We formalized this argument using a tractable model which shows that emerging markets can use their balance sheets to manage the ebb and flow of the global financial cycle. This requires accumulating reserves when capital inflows are high and using them to buy back domestic assets at lower prices when foreign investors disinvest. In financially developed countries this buffering role is played by the private sector.

The model also revealed that the private sector tends to under-invest in liquidity because it does not internalize how the country's balance sheet affects asset prices. Contrary to conventional policy prescriptions, a social planner would thus increase (rather than restrict) the size of gross capital flows beyond the laissez-faire equilibrium. This exposes the country to higher volatility in gross flows but leads to more stable domestic asset prices, reducing the risk premium on international borrowing. The social planner's solution can be implemented with a subsidy on the accumulation of foreign reserves by the private sector.

In countries at a relatively low level of financial development—where financial constraints limit the issuance of international debt by private agents—the government can use its own balance sheet to manage the global financial cycle. By accumulating official reserves when global conditions are loose and selling them when conditions are tight, the government can complement the buffering role provided by the private sector. As financial development progresses, foreign exchange intervention becomes less helpful since the private sector can insure itself to a larger extent. The model implications are in line with the empirical facts presented in the introduction to the paper, namely that in more financially integrated countries a larger share of gross inflows is offset by private outflows rather than government reserves.

There are several directions for future research. On the empirical side, the model makes predictions about how the behavior of gross capital flows is correlated with the volatility of asset prices and risk premia. Future research could investigate the extent to which a tighter co-movement between gross inflows and outflows is associated with less volatile asset prices and lower risk premia as predicted by the model. On the theoretical side, the paper used a stylized three-period model to clarify the key mechanisms behind financial buffering. This analysis can be extended in several directions. First, by introducing non-tradable goods, the model can be used to examine whether and how financial buffering can also help to stabilize the real exchange rate. Second, the model can be nested into a DSGE framework to analyze its quantitative implications.

A Model Appendix

A.1 Proof of Propositions

Proof of Lemma 1. Using equation (8) and (10) to substitute out q and p from the budget constraint (1) gives

$$R^e(k+a) = (1-\pi)b + \pi R \min(b, a+\phi).$$

If $b \le a+\phi$ this equation reduces to $k+a=b$. If $b \ge a+\phi$ simple manipulations of this equation give

$$b = a+\phi+\frac{R^e}{1-\pi}(k-\phi). \tag{34}$$

Using this expression to substitute out b from (8) gives

$$q = \min\left\{1, \left[1+\frac{R^e}{1-\pi}\frac{(k-\phi)}{a+\phi}\right]^{-1}\right\}. \tag{35}$$

There are two cases. Either $k \le \phi$ and $q=1$, or $k \ge \phi$ and q is given by the second argument of the min in (35). These two cases are summarized by equation (13). Using (10) then gives (12).

Proof of Lemma 2. Using that p' is equal to 1 with probability $1-\pi$ and to q with probability π and equation (10), the l.h.s. of (17) can be written

$$1-\pi+\frac{\pi}{q}-\frac{1-\pi+\pi R}{1-\pi+\pi R q} = \pi(1-\pi)\frac{1-q}{q}\frac{1-Rq}{1-\pi+\pi R q}. \tag{36}$$

Condition (17) is satisfied if and only if $q=1/R$ or $q=1$. If $q<1/R$ ($q>1/R$), the marginal benefit of accumulating (decumulating) liquidity is strictly positive (negative), so that EM agents accumulate (decumulate) liquidity until $q=1/R$. The solution $q=1$ is ruled out by $k^{FB}>\phi$. If $q=1$ then $k=k^{FB}$ by (16) but (13) implies $q<1$, a contradiction.

Proof of Proposition 3. Assume that the constraint $a \ge 0$ is not binding so that (17) applies. Then by Lemma 2 q is equal to $1/R$ and equation (10) implies $p=1/R^e$. Condition (16) implies $f'\left(k^{LF}\right)=R^e$. The expressions in (20) and (21) result from the budget constraint $k^{LF}+a=b/R^e$ and $1/R=(a+\phi)/b$ from equation (8). Condition (18), which is equivalent to $k^{LF}>\phi R/R^e$, is necessary and sufficient to ensure that the expression for a given in (21) is strictly positive.

Proof of Proposition 4. In equilibrium k and a satisfy

$$\begin{aligned} k + a &= \beta, \\ f'(k) &= 1 - \pi + \frac{\pi}{q(k,a)}. \end{aligned}$$

The first equation is the budget constraint (1) using the fact that (22) is binding. The second equation equates the marginal product of capital and the marginal benefit of liquidity. These two equations can be represented by respectively a downward-sloping locus and upward-sloping locus in the space (k,a). An increase in β shifts the downward-sloping locus up and so increases both k and a. Using the second equation, one can see that this increases q and so p.

Proof of Proposition 5. Using equation (28) the Lagrangian for the social planner's problem is,

$$U_0^{EM} = f(k) - R^e k + \pi\phi\left(R - \frac{1}{q(k,a)}\right) + \lambda(\beta - k - a).$$

The first-order condition for a is

$$\lambda = \frac{\pi\phi}{q^2}\frac{\partial q}{\partial a} > 0,$$

which implies that $pb \leq \beta$ is binding.

The first-order condition for k is

$$f'(k) = R^e - \frac{\pi\phi}{q^2}\frac{\partial q}{\partial k} + \lambda.$$

Since $\partial q/\partial k < 0$, one has $f'(k) > R^e$ which implies $k^{SP} < k^{LF}$.

Proof of Proposition 6. With the Pigouvian taxes in equation (29) the welfare of the EM representative resident is

$$\begin{aligned} U_0^{EM} &= f(k) - b + aE\left(\frac{1}{p'}\right), \\ &= f(k) - (1+\tau_b)\frac{k + (1+\tau_a)a - z}{p} + aE\left(\frac{1}{p'}\right). \end{aligned}$$

The first-order conditions of the decentralized equilibrium are

$$f'(k) = \frac{1+\tau_b}{p} + \lambda, \tag{37}$$

$$E\left(\frac{1}{p'}\right) = \frac{(1+\tau_a)(1+\tau_b)}{p} + \lambda, \tag{38}$$

where λ is the shadow cost of constraint $k+a \leq \beta$. The optimal Pigouvian taxes are such that these equations are satisfied for the social planner allocation with $q^{SP} = q\left(k^{SP}, a^{SP}\right)$ and $p^{SP} = p\left(k^{SP}, a^{SP}\right)$.

Substituting out λ in equations (37) and (38) gives

$$(1+\tau_b)\tau_a = -p^{SP}\left[f'\left(k^{SP}\right) - \left(1 - \pi + \frac{\pi}{q^{SP}}\right)\right]. \tag{39}$$

Equation (39) implies that $(1+\tau_b)\tau_a$ is uniquely determined and negative. The r.h.s. of (39) is equal to zero if k^{SP} and q^{SP} are replaced by k^{LF} and q^{LF}. The fact that $k^{SP} < k^{LF}$ and $a^{SP} > a^{LF}$ implies that $q^{SP} > q^{LF}$ so that the r.h.s. of equation (39) is negative.

One solution is a subsidy on reserves only, i.e., $\tau_b = 0$ and $\tau_a < 0$. With this subsidy the constraint $k+a \leq \beta$ is strictly binding, i.e., $\lambda > 0$. This results from (37) and $f'\left(k^{SP}\right)p^{SP} > 1$, an implication of $f'\left(k^{LF}\right)p^{LF} = 1$, $k^{SP} < k^{LF}$ and $p^{SP} > p^{LF}$.

Proof of Proposition 8. If $\beta \leq \phi$, p and q are equal to 1 so that the government does not change welfare with reserves interventions. If $\beta \geq k^{LF} + a^{LF}$, the economy is in a Ricardian regime in which government reserves interventions have no impact because they are offset by the private sector (as long as they are small enough to leave private reserves strictly above zero, which is true if $\beta^g < a^{LF}$). Thus, government reserves interventions can be welfare-increasing only if $\beta \in \left(\phi, k^{LF} + a^{LF}\right)$.

Government reserves interventions are indeed welfare-increasing if β is in this interval. If the private sector does not accumulate reserves under laissez-faire ($k = \beta$), a marginal accumulation of government reserves does not change k but raises q, which increases welfare by (28). If the private sector accumulates reserves under laissez-faire ($k < \beta$ and $a > 0$), a marginal accumulation of government reserves is equivalent to a marginal increase in financial development under laissez-faire, which raises welfare. This increases total reserves, physical capital, and the price of EM debt as shown in Proposition 4.

A.2 Ex-post interventions and commitment

We have assumed in the text that the EM social planner does not intervene in period 1. We show in this section that the EM social planner cannot strictly increase EM welfare by committing to state-contingent ex-post interventions.

State-contingent ex-post debt taxation. First, the social planner could commit to state-contingent taxation of the long-term debt repayments to the foreign bankers. The allocations that can be achieved in this way are the same as if EM agents were allowed to issue state-contingent long-term debt in the baseline model. This is the assumption that we make in the following (this will also show that the results of the baseline model are robust to the introduction of state-contingent debt).

More formally, let us assume that EM agents can issue a quantity b^S (b^N) of state-contingent debt that pays one unit of good in period 2 if there is a sudden stop (if there is no sudden stop). State-contingent debt does not change the fact that foreign bankers must liquidate legacy assets in a sudden stop if $k \geq \phi$. The available liquidity in a sudden stop is $\phi + a$, which is not sufficient to repay $d \geq k + a$ if $\phi < k$. Using the first-order conditions for the supply of funds by bankers as in section 3, it is possible to show that the ex-ante prices of state-contingent debt are given by

$$\begin{aligned} p^N &= \frac{1-\pi}{R^e}, \\ p^S &= \frac{\pi R q}{R^e}. \end{aligned}$$

The ex-ante welfare of EM borrowers is

$$\begin{aligned} U_0^{EM} &= f(k) + a\left(1 - \pi + \frac{\pi}{q}\right) - (1-\pi)b^N - \pi b^S \\ &= f(k) - R^e k + \pi\left(\frac{1}{q} - R\right)(a - q b^S), \end{aligned} \tag{40}$$

where the second line was derived by using the period-0 budget constraint $k + a = p^N b^N + p^S b^S$ and the expressions for p^N and p^S to substitute out b^N. Like in the baseline case, an equilibrium where EM agents hold a non-zero finite level of liquidity must have $q = 1/R$.[19] In such an equilibrium EM welfare is given by $U_0^{EM} = f(k) - R^e k$, the same level as when debt is non-contingent. Thus, making EM state-contingent does not increase EM welfare.

Liquidity hoarding. Second, the EM social planner could decide to spend less liquidity in period 1 than under laissez-faire in the sudden stop state (liquidity hoarding). Let us assume that the social planner spends a level of liquidity $a' \leq a$ if there is a sudden stop. The fire-sale price of debt is

$$q = \frac{a' + \phi}{b}. \tag{41}$$

[19] Equation (40) shows that the demand for liquidity is $a = 0$ if $q > 1/R$. If $q < 1/R$ the demand for liquidity is infinite and it is financed exclusively by debt paying in the N state ($b^S = 0$).

In the sudden stop state EM welfare is given by,

$$U_1^{EM} = f(k) - b + \frac{a'}{q} + a - a',$$

where k and b are pre-determined. Using (41) to substitute out q and leaving out constant terms, the period-1 social planner's problem can be written,

$$\max_{a' \leq a} \frac{a'}{a' + \phi} b - a'.$$

The solution is

$$a' = \min\left(a, \sqrt{\phi b} - \phi\right).$$

The social planner uses all the liquidity if and only if

$$a \leq \sqrt{\phi b} - \phi.$$

If this condition is not satisfied the social planner spends only a fraction of the liquidity in period 1 in order to increase the monopoly profit from buying back EM debt at a low price. Using (34) to substitute out b the condition can be rewritten

$$a(a + \phi) \leq \frac{R^e}{1 - \pi} \phi (k - \phi).$$

This condition is not always satisfied. For example, when β goes to infinity so does a in the social planner allocation whereas k remains below k^{LF} (Proposition 5). Hence this condition is violated by the social planner allocation for large levels of β. The implied upper bound on a is a constraint on the social planner's ex-ante problem that reduces welfare if it is binding. Thus it is optimal for the EM social planner to commit to let the private sector use all its liquidity in period 1.

Our analysis was limited to ex-post interventions by the EM social planner. Ex-post interventions by a global social planner could increase EM welfare, for example by providing liquidity to the EM economy in a sudden stop. This could be achieved with a crisis lending arrangement that can lend to EM agents at a zero interest rate between periods 1 and 2 in the event of a sudden stop.

B Data Appendix

Figures 1 and 2 are constructed using data from the Balance of Payments and International Investment Position Statistics.

The country sample of Figure 1 includes: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, India, Indonesia, Kuwait, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Russia, Saudi Arabia, South Africa, South Korea, Thailand, and Turkey.

The country sample of Figure 2 is expanded to include a broader range of emerging markets, as well as low-income countries and advanced economies: Afghanistan, Albania, Angola, Argentina, Armenia, Australia, Austria, Bangladesh, Belarus, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Canada, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Côte d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Haiti, Honduras, Hungary, India, Indonesia, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Lesotho, Liberia, Lithuania, Madagascar, Malawi, Malaysia, Mali, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Senegal, Serbia, Sierra Leone, Slovak Republic, Slovenia, South Africa, South Korea, Spain, Sudan, Sweden, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, Uruguay, Uzbekistan, Venezuela, and Zambia.

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