Global Financial Cycle and Liquidity Management*

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Abstract

Emerging market economies smooth the impact of the global financial cycle through the (private and public) accumulation and decumulation of liquid foreign assets. We show in the data that the more financially developed a country, the more volatile and correlated are its gross capital inflows and outflows, the lower is the return spread between its foreign liabilities and its foreign assets, and the lower is the share of the central bank's reserves in its outflows. We analyze this behavior using a tractable three-period model. Private agents sell domestic long-term debt to accumulate reserves when the demand of foreign investors is high and buy those assets back when the demand is low. There is scope for government sterilized interventions in countries with lower levels of financial development. In countries with higher levels of financial development the social planner increases the size of gross capital flows so as to stabilize the price of domestic debt. This results in a rent transfer from foreign investors to the domestic economy.

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1 Introduction

Emerging market (EM) economies are subject to fluctuations in the tightness of global financial conditions—a phenomenon that has been called the global financial cycle. Rey (2015), the IMF (2012), Ostry et al. (2011) and Jeanne, Subramanian and Williamson (2012) have advocated that EM economies use countercyclical controls on capital inflows to smooth the impact of these shocks on their economy. In practice, however, EMs have relied on foreign reserve interventions more than controls on inflows (Jeanne, 2016).

We have little theory to analyze how reserves management can help EMs navigate the global financial cycle. Most of the existing literature (reviewed below) suggests that the preferred policy instruments are countercyclical controls on capital inflows. This paper starts to fill this gap. We present a model in which the best way of reducing the welfare loss due to external financial shocks is to accumulate and deccumulate foreign liquidity. We first assume that foreign liquidity is accumulated by the private sector and then consider the case for public intervention. We look whether there is a gap between the private valuation and the social valuation of international liquidity and whether a social planner should take actions to raise the overall level of liquidity in the economy.

The basic mechanism is presented in a simple three-period model. We consider an EM economy with a large number of private agents who borrow from foreign investors to finance expenditures and to accumulate "private reserves". The model features a risk of global financial tightening in which foreign investors are restricted in the amount of funds that they can lend to the EM economy. When global financial conditions tighten the EM private reserves are used to buy back home debt. The transition between the two states takes the form of "retrenchments" (as defined by Forbes and Warnock (2012)) in which EM economies sell foreign assets at the same time as foreigners sell EM assets. In a decentralized equilibrium the level of private reserves is such that the benefit of reserves from buying assets at a low price is exactly offset by the opportunity cost of carrying the reserves.[1]

The purpose of capital flow management policies is to buffer EM economies against the ebb and flow of the global financial cycle. As noted above the policy instrument that has been mostly considered in the literature is a coun-

[1]The opportunity cost of reserves is measured as the spread between the interest rate on external debt and the return on liquid reserves, as in Rodrik (2006). See Adler and Mano (2016) for a recent review of how to measure the opportunity cost of reserves.

tercyclical tax on capital inflows. Our model highlights another way of pursuing the same objective, which is to buffer inflows with outflows. In our model private outflows have a natural tendency to offset private inflows but there is still room left for public intervention. The stabilization coming from private flows is insufficient because private borrowers do not internalize the impact of their actions on the risk premium paid by domestic borrowers on their external liabilities. A social planner, therefore, attempts to stabilize the price of domestic assets by making capital inflows and outflows more responsive to the global financial cycle than under laissez-faire. This objective can be achieved by using sterilized foreign exchange interventions in less financially developed economies. However, other policy instruments are needed in more developed economies where Ricardian equivalence applies. Irrespective of the instruments, the objective of policy interventions is to increase the size of gross capital flows rather than reducing them.

We show that the implementation of the optimal allocation requires a subsidy on foreign assets (reserves) combined with a tax on foreign borrowing. A subsidy on reserves alone is not sufficient because it leads to excessive capital inflows. The social planner expands gross flows but reduces net capital inflows. Our simple model also points to a potential time consistency problem with the implementation of the optimal policy. In good times, the benefit of reserves comes from the expectation that reserves will be used to stabilize asset prices in times of crisis. When the crisis comes, however, the social planner's incentives to spend the reserves are weaker because the country benefits from buying back its assets from foreign investors at a low price.[2] Achieving the full welfare gains from optimal reserves management thus requires that the social planner can commit to let capital flow out when global financial conditions tighten.

Relationship to the literature. As noted at the beginning of the introduction, most of the theoretical literature on capital flow management has focused on controls on capital inflows—see for example Ostry et al. (2012), Korinek (2011). In Jeanne and Korinek (2010) the financial friction was a collateral constraint in the EM economy and the most appropriate policy instrument was a countercyclical tax on capital inflows. In these models there is no meaningful separate role for reserves management and capital inflow management. What matters in a crisis is the net worth of indebted agents

[2]Aizenman (2011) notes how central banks have been reluctant to draw down their reserves in the global financial crisis of 2008-09.

and it does not matter whether net worth is increased by lowering external debt or increasing external assets. These papers have focused on controls on capital inflows as the policy instrument to reduce external over-borrowing. By contrast we show here that ex-ante reserves management allows the country to receive more net capital inflows. In Aizenman (2011) reserves are used to prevent the liquidation of domestic projects and there is contagion in liquidation. The optimal policy involves both a tax on external borrowing and a subsidy on the accumulation of private reserves.

A line of theoretical literature has studied the optimal level of reserves for an economy with fluctuating access to foreign financial flows. Jeanne and Rancière (2011) present a model of the optimal level of reserves to deal with the risk of 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 (2013) analyze a similar problem when reserves take the form of a noncontingent asset and can be financed by sovereign defaultable debt. Gourinchas, Rey and Govillot (2017) present a model in which EMs holds low-yielding US assets because these assets 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.

On the empirical side, our paper is related to the literature that studies the behavior of gross capital flows in the global financial cycle. Forbes and Warnock (2012) and Broner et al. (2013) have documented how gross capital inflows and outflows tend to move together. Broner et al. (2013) document that gross capital flows are very large and volatile, especially relative to net capital flows. When foreigners invest in a country, domestic agents invest abroad, and vice versa. During expansions, foreigners invest more domestically and domestic agents invest more abroad. During crises, total gross flows collapse and there is a retrenchment in both inflows by foreigners and outflows by domestic agents. Davis and van Wincoop (2017) document that the correlation between capital inflows and outflows has increased substantially over time in advanced and developing countries. IMF (2013) shows that buffering foreign capital flows with offsetting resident flows has been a key contributor to EM economies being more resilient to fluctuations in foreign capital inflows after the global financial crisis.

A line of empirical literature has pointed to the stabilizing benefits of reserves. Bussière et al. (2015) show that countries with high reserves relative to short-term debt suffered less from the global financial crisis, particularly when associated with a less open capital account. Ghosh, Ostry and Qureshi (2016) find that countries with higher stocks of foreign exchange reserves are significantly less likely to experience a crisis following surges in capital inflows. Aizenman, Cheung and Ito (2015) find that emerging market economies with lower reserve holdings in 2012 tended to experience exchange rate depreciation against the U.S. dollar when many emerging markets were adjusting to the news of tapering quantitative easing in 2013. 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.

The paper is structured as follows. The next section presents some stylized facts to motivate our analysis. The following sections present the model assumptions, characterize the behavior of capital flows in the laissez-faire equilibrium, and analyze the case for sterilized interventions and more generally for public interventions.

2 Stylized facts

Figure 1 shows the evolution of gross capital flows to emerging markets (EMs) using annual data.[3] Flows are normalized by each country's trend GDP. EMs face very volatile gross capital inflows with extreme fluctuations around the global financial crisis. However, especially from 2000 onwards, the volatility of gross inflows has been largely absorbed through offsetting capital outflows. In other words, when foreign investors increase their holdings of EMs' assets, EMs' residents accumulate foreign assets and viceversa. The public sector actively contributes to this stabilizing mechanism by increasing official reserves when gross inflows increase. However, the chart shows that most of the buffering is done by the private sector. The offsetting dynamics of capital outflows limit the extent to which swings in capital inflows are reflected in current account movements.

The section presents stylized facts about the behavior of capital flows and international borrowing spreads. We use data from the IMF Balance of Payments (BOP) and International Investment Position (IIP) statistics from 1990 onwards. IIP statistics include data on the stock of foreign assets and liabilities. BOP data provide information on gross capital flows, where

[3] We exclude Mauritius because of exceptionally large capital flows from 2010 onwards.

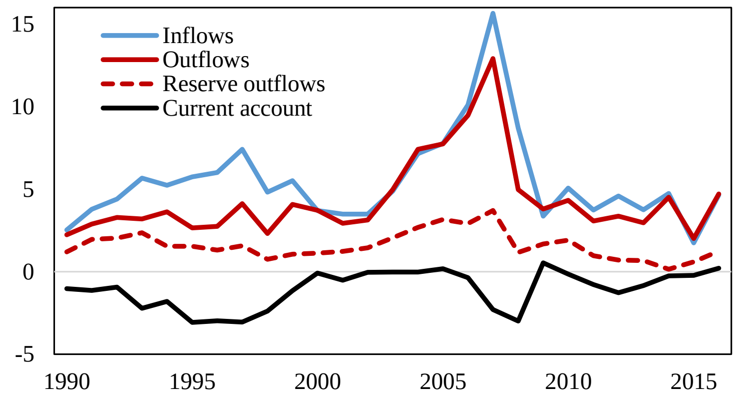

Figure 1: Capital flows (in percent of trend GDP), average across EMs

inflows record the purchase of domestic assets by foreign agents, while outflows record the purchase of foreign assets by domestic agents. BOP statistics include data also on the current account and the investment income that countries pay and receive on gross liabilities and assets. We exclude from the analysis Japan, the United Kingdom, the United States, Switzerland and the countries that adopted the Euro in 1999 since they are generally not destabilized by the global financial cycle. We also leave out countries with less than 1 million people in 2016.

Using BOP and IIP data, we compute for each country and period t the rate of return on foreign assets r_t^A and liabilities r_t^L as follows:

$$r_t^A = \left(A_t - O_t + Y_t^A\right)/A_{t-1} - 1$$
$$r_t^L = \left(L_t - I_t + Y_t^L\right)/L_{t-1} - 1$$

where A_t and L_t denote assets and liabilities, O_t and I_t are gross outflows and inflows, and Y_t^A and Y_t^L are the investment income flows on assets and liabilities. Note that these formulas measure the realized rates of return, not the expected ones. We define a country's international borrowing spread as the difference between the return paid on liabilities and the return earned on assets, $r_t^L - r_t^A$.

The empirical analysis reveals five stylized facts which are illustrated in the tables in Appendix A. In each table, we verify that the results are robust to using either annual or quarterly data. Annual data are generally available for a longer time span, but for several countries quarterly data provide more data points given the higher frequency of observation. When using annual data, we include all countries with at least 10 years of data about capital flows, assets and liabilities, and borrowing spreads. For quarterly data, we consider countries with at least 5 years of data.

We also verify that results are robust to removing outliers, by dropping countries that exceed the 95 percentile of the cross-country distribution of the variables used in each table. Furthermore, we show that results are broadly unchanged if we restrict the sample to emerging markets (EMs).[4] Finally, we verify that results are robust to an alternative definition of capital outflows. In principle, the difference between outflows and inflows should be equal to the current account. In practice, errors and omissions may create significance discrepancies. Therefore, we check the robustness of the results to an "adjusted" definition of capital outflows given by the sum of gross inflows and the current account.

Stylized fact 1: *Countries with larger foreign liabilities tend to experience more volatile capital inflows.* For each country, we compute the standard deviation of capital inflows and the average size of liabilities, both expressed in percent of trend GDP computed with the HP filter.[5] We then regress across countries the volatility of inflows over the size of liabilities. Columns (1) to (3) in Table 1 show that using annual data countries with larger foreign liabilities tend to experience more volatile gross capital inflows. This is true for the entire country sample in column (1), dropping outliers in column (2), and restricting the sample to EMs in column (3). Similar results are obtained using quarterly data in columns (4) to (6).

Stylized fact 2: *Countries with larger foreign liabilities tend to experience a higher covariance between capital inflows and outflows.* Table 2 shows that countries with larger foreign liabilities tend to have a higher covariance between gross inflows and gross outflows. This is true using both annual and quarterly data as well as when dropping outliers or restricting the sample to EMs. Similar results are obtained if capital outflows are measured as

[4]Emerging markets include: Argentina, Bangladesh, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Czech Republic, Ecuador, Egypt, Estonia, Hungary, India, Indonesia, Israel, Korea, Latvia, Lithuania, Malaysia, Mauritius, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, Slovenia, South Africa, Thailand, Turkey, Ukraine, Venezuela.

[5]We normalize capital flows and international investment positions by trend GDP rather than GDP to avoid introducing volatility arising from cyclical fluctuations in GDP. Note also that when using quarterly data, we normalize international investment positions by four times quarterly trend GDP.

the sum of gross inflows and the current account. This suggests that, even though countries with larger liabilities have more volatile inflows (fact 1), they are able to better buffer movements in inflows with offsetting changes in outflows.

Stylized fact 3: *Countries tend to experience a positive correlation between capital flows and realized international borrowing spreads.* For each country, we compute the correlation of international borrowing spreads with gross inflows, gross outflows, and gross "adjusted"' outflows measured as the sum of inflows and the current account. Table 3 reports the cross-country averages showing that they are positive at both annual and quarterly frequency and across different country samples. This suggests than when a positive global financial cycle shock increases the value of countries' liabilities (thus raising the realized borrowing spread), both gross inflows and outflows tend to increase. In other words, foreigners increase their holdings of domestic assets, while residents purchase foreign assets.

Stylized fact 4: *Countries with larger foreign liabilities tend to have lower international borrowing spreads.* For each country, we compute the average international borrowing spread, using an annualized rate in the case of quarterly data. Table 4 shows that countries with larger liabilities tend to benefit from lower borrowing spreads. This result is robust to using annual or quarterly data and different country samples.

Stylized fact 5: *Countries with larger foreign liabilities tend to have a lower share of official reserves in foreign assets.* For each country, we compute the average share of official reserves in total foreign assets. Table 5 shows that reserves tend to be lower in countries with larger liabilities. This is true using both annual and quarterly data and across different country samples.

3 Model

We consider a small open (emerging market or EM) economy over three periods $t = 0, 1, 2$. The country is populated by a continuum of mass one of identical borrowers. Borrowers issue long-term debt to finance capital. The debt is sold to foreign investors who may be financially constrained in period 1, leading to a fall in the price of debt.

The budget constraints of the representative EM borrower are,

$$\begin{aligned} a+k &= pb, & (1)\\ a'+p'b &= a+p'b' & (2)\\ b'+c &= y+a'. & (3) \end{aligned}$$

In period 0 the EM borrower finances an investment k as well as reserves a by issuing bonds b. Period 1 is a time when the borrower can change his balance sheet by buying or selling bonds for reserves. Production and consumption take place in period 2. The investment is of fixed size and yields $y > k$ in period 2. (We consider in section 7 an extension of the model where production is an increasing and concave function of investment.) Reserves and debt are non-negative.

Domestic welfare is equal to expected consumption,

$$U_o = E_0\left(c\right). \qquad (4)$$

We make assumptions about foreign investors to capture the fluctuations in the availability of external finance to emerging markets that characterize the global financial cycle. We assume that there are two successive rounds of investors and that the EM debt must change hands between them in period 1.[6] The investors who buy the debt in period 0 have utility $E_0\left(c_0^i + mc_1^i\right)$ where m is a stochastic discount factor of mean 1. These investors have a large amount of funds to lend to the EM economy. The investors who buy the debt in period 1 have utility $E_1\left(c_1^i + c_2^i\right)$ and the amount of funds that they can lend to the EM economy is limited when m is high. This could be for example because the two rounds of investors have signed state-contingent contracts transferring funds from the late investors to the early investors when the latter's utility for cash is high, leaving less funds for the second round of nivestors to lend to the EM economy. This could also be interpreted as the fact that global banks must reduce their leverage when global financial conditions are tighter, like in Gabaix and Maggiori (2014). A high level of m restricts the supply of funds to the EM economy and will be interpreted as a tightening of global financial conditions.

For tractability we assume that the stochastic discount factor can take two values. Global financial conditions can be tight ($m = m_H$) or loose

[6] This assumption implies that investors do not accumulate reserves for the same reason as EM borrowers.

$(m = m_L < m_H)$. The probabilities of tight and loose financial conditions are respectively denoted by π_H and π_L, with $\pi_H + \pi_L = 1$. If $m = m_L$, the second round of lenders have enough funds that the price of EM debt is equal to its expected payoff. If $m = m_H$, the lenders have only ϕ to buy the EM debt, that is, $p'b' \leq \phi$. As a result the period-1 price of debt depends on the global financial conditions as follows,

$$m = m_L \Longrightarrow p' = 1, \tag{5}$$

$$m = m_H \Longrightarrow p' = \min\left(1, \frac{\phi}{b'}\right). \tag{6}$$

The price of debt in period 0 is given by

$$p = E\left(mp'\right). \tag{7}$$

Observe that if the price of EM debt p' falls when global financial conditions are tight, the first round of investors will demand a pure risk premium in order to hold the debt, that is, $p < E\left(p'\right)$. The pure risk premium contributes to the opportunity cost of holding reserves.

4 Laissez-faire equilibrium

We now solve for the laissez-faire equilibrium in which: (i) the EM borrowers set the levels of a, a', b, and b' so as to maximize their utility (4) subject to the budget constraints (1)-(3) and taking the prices p and p' as given; and (ii) the prices p and p' satisfy (5), (6) and (7). The period-2 endogenous variables are functions of the state.

Using the budget constraints to substitute out c and omitting unimportant constant terms, period-0 welfare can be written,

$$U_0 = y - \frac{k}{p} + a\left[E_0\left(\frac{1}{p'}\right) - \frac{1}{p}\right].$$

The expected marginal net benefit of reserves, $E_0\left(\frac{1}{p'}\right) - \frac{1}{p}$, is the benefit of buying back debt at price p' in period 1 net of the opportunity cost of borrowing the reserves by selling debt at price p in period 0.

Denote by $\widehat{p}$ the period-1 price of EM debt if global financial conditions are tight (the fire-sale price of debt). Then using (7) the marginal net benefit of reserves can be written,

$$E_0\left(\frac{1}{p'}\right)-\frac{1}{p}=\pi_L+\frac{\pi_H}{\widehat{p}}-\frac{1}{\pi_L m_L+\pi_H m_H\widehat{p}}.$$

This benefit is positive if $\widehat{p}$ is lower than m_L/m_H and negative if $\widehat{p}$ is larger than m_L/m_H. Since reserves are used to buy back the EM debt at the fire-sale price, the benefit of holding reserves is larger if this price is lower. Furthermore, the linearity of the utility in a implies that in an equilibrium where the EM borrowers hold a strictly positive level of reserves, the fire-sale price is exactly equal to m_L/m_H. From now on we consider equilibria that have this property and will derive later a condition ensuring that this is true,

$$\widehat{p}=\frac{m_L}{m_H}. \tag{8}$$

Next we derive the demand for reserves. In a fire-sale equilibrium one has,

$$\widehat{p}b=a+\phi. \tag{9}$$

The resources of the second round of investors, ϕ, plus the reserves, a, are used to buy the outstanding EM debt. The two previous equations then give us the demand for reserves as a function of debt,

$$a=\frac{m_L}{m_H}b-\phi. \tag{10}$$

This is the quantity of reserves that EM borrowers wish to hold for a given level of debt b. (The EM borrowers do not keep reserves between period 1 and 2 if $p'<1$.) An increase in debt, other things equal, lowers the fire-sale price of debt below m_L/m_H, which makes it worthwhile to accumulate more reserves until the price $\widehat{p}$ has returned to its equilibrium level.

There is a second relationship between reserves and debt that comes from the balance-of-payments equation $k=pb-a$. Using $p=\pi_L m_L+\pi_H m_H\widehat{p}$ and equation (7) to substitute out $\widehat{p}$ gives,

$$k=\pi_L m_L\left(b-a\right)+\pi_H m_H\min\left(b-a,\phi\right). \tag{11}$$

The demand for reserves (10) and the balance-of-payments equation (11) can be used to solve for a and b. The resulting equilibrium is characterized in the following proposition.

Proposition 1 *EM borrowers hold a strictly positive level of reserves in the laissez-faire equilibrium if and only if the funding constraint is sufficiently tight,*

$$\phi < \frac{k}{m_H}. \tag{12}$$

If this condition is satisfied the equilibrium quantities of debt and reserves are given by,

$$b^{LF} = \frac{m_H}{m_L}\frac{k-\phi}{m_H-1}, \tag{13}$$

$$a^{LF} = \frac{k-m_H\phi}{m_H-1}. \tag{14}$$

The period-1 price of EM debt is $p^{LF} = m_L$. The price of EM debt falls to $\widehat{p} = m_L/m_H$ when global financial conditions are tight.

Proof. See discussion above. Equation (10) implies that $\min(b-a,\phi) = \phi$ in equation (11). Then solve for a and b in the two equations. ■

The funding constraint must be sufficiently tight (i.e., ϕ must be sufficiently low) for EM borrowers to hold reserves in equilibrium. Otherwise the fire-sale price of debt is not low enough to make holding reserves worthwhile, given their opportunity cost. Observe that as m_H goes to 1, the levels of debt and reserves go to infinity. A pure risk premium is necessary to have a finite optimal level of reserves. If $p = E(p')$, then the marginal benefit of reserves $E(1/p') - 1/p$ is positive as long as p' is stochastic because of the concavity of the inverse function.

5 Financial development and sterilized interventions

We now look at the impact of financial development on the behavior of capital flows. Financial development is modeled as an upper bound on the level of debt,

$$b \leq \bar{b}. \tag{15}$$

This is a limit on the size of the repayment that borrowers can pledge to foreign creditors, for example because of weak creditor rights, legal enforcement, or underdeveloped financial markets. The upper bound $\bar{b}$ can also be interpreted as a control on capital inflows.

The constraint is binding if $\bar{b} < b^{LF}$. The model equilibrium is solved by considering that in case of a fire sale the country sets $a' = 0$ and by using the budget constraints (1)-(3) and the price equations (5), (6) and (7). Figure 2 illustrates the model implications as a function of financial development, based on the values $\pi_L = 0.9$, $\pi_H = 0.1$, $m_L = 0.98$, $m_H = 1.2$, $k = 0.4$, $\phi = 0.3$ and $\bar{b} = 1$. The top-left panel shows that an increase in $\bar{b}$ is associated with a proportional increase in reserves a. This implies that the country can support bond prices $\hat{p}$ more effectively in case of global financial tightening, as shown in the top-right panel. In turn, this leads to higher bond prices at time-0 (bottom-left panel). Financial development allows also for a compression in the country's borrowing spread, defined as the difference between the return paid on foreign liabilities and the return earned on international reserves. The bottom-right panel shows that the average spread in period 0 and 1 declines with financial development by about 1.4 percent.[7] These properties hold in general and are not specific to the parameter values used to construct Figure 2.

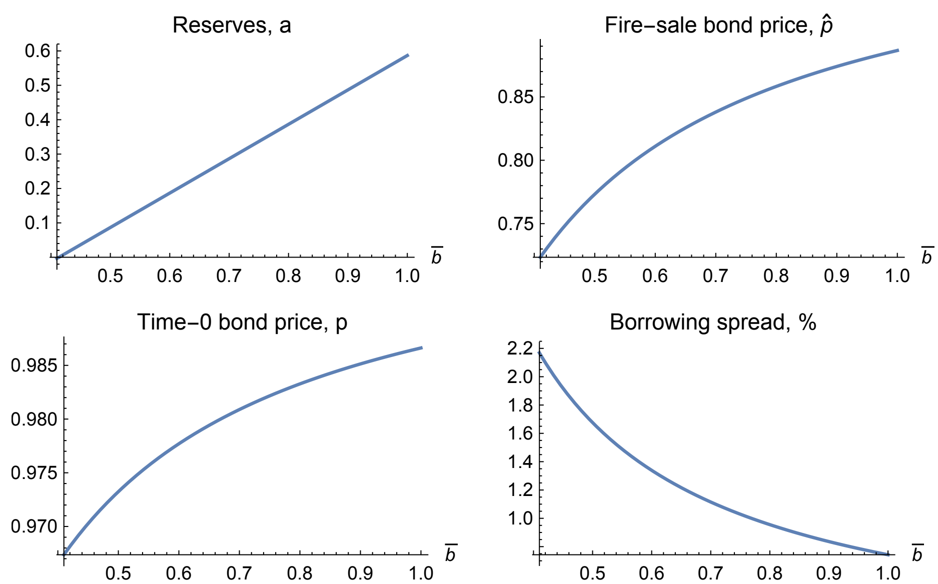

Figure 2: Model implications as a function of financial development

The model implications are consistent with the stylized facts presented

[7] Consistent with the empirical analysis, we compute the average spread across period 0 and 1 as $(\pi_L(1/p-1) + \pi_H(\hat{p}/p - 1 + 1/\hat{p} - 1))/2$.

in Section 2. An increase in $\bar{b}$ raises both capital inflows and capital outflows in period 0. It also leads to a large retrenchment of capital flows if there is global financial tightening in period 1 (if there is no tightening the capital flows are zero). Thus, an increase in $\bar{b}$ raises the variance of capital flows (Stylized Fact 1) and the covariance between inflows and outflows (Stylized Fact 2). The model also explains the positive correlation between capital inflows and the return on the EM liabilities (Stylized Fact 3). In period 1, a global financial tightening triggers a fall in both capital inflows and the price of EM debt. Finally, the model predicts a negative association between financial development and borrowing spreads in line with Stylized Fact 4.

To analyze the scope for foreign exchange intervention, we now introduce an EM government that can borrow and accumulate reserves. The government has no expenditure in period 0. The budget constraints of the government are

$$a^g = pb^g, \tag{16}$$

$$a^g = p'\left(b^g - b'^g\right) \tag{17}$$

$$z = b'^g, \tag{18}$$

where z is a lump-sum tax on the private sector levied in period 2 to repay government debt. We assume that the government sells all its reserves to buy back the country's debt when the funding constraint is binding in period 1.

We interpret a change in a^g and b^g as a sterilized intervention. When a central bank buys 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.

To distinguish the balance sheet of the government and that of the private sector we denote the variables for the private borrowers with the subscript p. The budget constraints (1)-(3) still apply to the households, with y replaced by the income net of tax, $y - z$. As a result the budget constraints (1)-(3) also apply to the whole country (consolidating the household sector and the government), if one defines total assets and liabilities as $a = a^p + a^g$, $b = b^p + b^g$ and $b' = b'^p + b'^g$. The price of debt is still given by (5), (6) and (7).

We assume that the government and households have separate borrowing constraints in period 0,

$$\begin{aligned} b^p &\leq \overline{b}^p, \\ b^g &\leq \overline{b}^g. \end{aligned}$$

We assume separate constraints because the borrowing constraints of the government and that of private borrowers are determined by different factors. The borrowing constraint of private borrowers is determined by private creditor rights and their enforcement. The borrowing constraint of the government is determined by its ability to raise taxes and by the cost of a government default. Thus the government might be able to expand the country's total borrowing limit. We assume that private debt and government are perfect substitutes for global investors, in particular the funding constraint $p'b' \leq \phi$ applies to the sum $b' = b'^p + b'^g$ and the two types of debt have the same price.

The impact of sterilized interventions depends on the level of financial development as measured by $\overline{b}^p$. First, assume that $\overline{b}^p < b^{LF}$, i.e., the private sector cannot borrow as much as it would like under laissez-faire. Then as long as $\overline{b}^p + b^g < b^{LF}$, the private sector does not change its own balance sheet in response to sterilized interventions. The borrowers remain constrained because they still have a positive marginal benefit from accumulating reserves. This implies that the government can increase the price of debt as well as welfare by accumulating reserves. Increasing p also increases private reserves $a^p = p\overline{b}^p - k$, that is, the accumulation of government reserves "crowds in" the accumulation of private reserves.

By contrast, if $\overline{b}^p > b^{LF}$, the economy is in a Ricardian regime where sterilized interventions have no impact. This is because the demand equation (10) is satisfied for the total level of total reserves $a^{LF} = a^p + a^g$. If the government increases its own reserves, this lowers the benefit of reserves for private borrowers who then reduce their reserves so as to keep total reserves at the equilibrium level. Our results are summarized in the following proposition.

Proposition 2 *Government sterilized interventions have an impact if and only if the level of domestic financial development is low enough ($\overline{b}^p < b^{LF}$). Then government reserves accumulation raises the price of government debt, lowers borrowing spreads, and increases welfare. A welfare-maximizing government intervenes until total (private and public) reserves are at the uncon-*

strained laissez-faire level or the government's constraint is binding,

$$b^g = \min\left(b^{LF} - \overline{b}^p, \overline{b}^g\right).$$

For higher levels of financial development ($\overline{b}^p \geq b^{LF}$) the economy is in a Ricardian regime where sterilized interventions have no impact.

This explains Stylized Fact 5: government reserves interventions are more prevalent in financially less developed and open economies.

6 Social planner

We now consider a social planner who sets a and b in period 0 subject to the same constraints as the private sector. The social planner is benevolent and maximizes the same welfare function as individual borrowers but she takes into account that the price of debt is endogenous to reserves. The question is interesting for countries that are at a level of financial development where sterilized interventions do not work since there is no beneficial deviation from the laissez-faire allocation if the economy is constrained, $\overline{b} < b^{LF}$.

First we compute global welfare, defined as the sum of the welfare of the EM borrower and the expected profit of the late lenders (the welfare of the early lenders is pinned down by perfect competition and can be ignored),

$$U_0^W = \underbrace{y - b + a\left(\pi_L + \frac{\pi_H}{\widehat{p}}\right)}_{U_0} + \pi\phi_H\left(\frac{1}{\widehat{p}} - 1\right).$$

The endogenous variables a, b and $\widehat{p}$ can be substituted out from this expression using (11) and (9). It is useful in this step of the analysis to note that by (11) the difference between b and a is constant and larger than ϕ,

$$b - a = \kappa > \phi, \tag{19}$$

where $\kappa \equiv (k - \pi_H m_H \phi) / (\pi_L m_L)$. The result is that,

$$U_0^W = y - \frac{k}{m_L} + \pi_H\phi\left(\frac{1}{m_L/m_H} - 1\right).$$

We find that *global welfare is constant* and independent of the EM's balance sheet. Hence the laissez-faire equilibrium is constrained efficient. The best that the EM social planner can do is to transfer welfare from the foreign investors to its own residents. This result was not obvious a priori because one might have thought that stabilizing the period-1 price of the EM debt could generate a net welfare gain by making EM debt more attractive to early lenders. It is true that stabilizing the price of debt reduces the pure risk premium paid by EM borrowers but this gain is offset by the lower gain on the EM reserves.

Thus, maximizing the welfare of the EM economy is equivalent to minimizing the welfare of foreign investors,

$$\min_{a,b} \pi_H \phi \left(\frac{1}{\widehat{p}} - 1 \right),$$

that is, maximizing the fire-sale price $\widehat{p}$. Using (19) we have,

$$\widehat{p} = \frac{\phi + a}{b} = 1 - \frac{\kappa - \phi}{\kappa + a}.$$

Hence the fire-sale price of debt increases with EM reserves, and the EM social planner maximizes domestic welfare by setting the reserves to the highest possible level.

Proposition 3 *A benevolent social planner who sets the country's balance sheet ex ante (in period* 0*) maximizes the levels of debt and reserves,*

$$\begin{aligned} b^{SP} &= \bar{b}, \\ a^{SP} &= \bar{b} - \kappa. \end{aligned}$$

Proof. See discussion above. ■

This implies that if the ex-ante debt constraint does not bind under laissez-faire, $b^{LF} < \bar{b}$, then *the social planner should increase ex-ante gross flows above the laissez-faire level.* This result runs directly counter the idea that the problem with the global financial cycle is that it generates excessively large and volatile gross capital flows. The problem is the opposite: gross flows are not sufficiently large and volatile under laissez-faire. Gross flows plays a stabilizing role in our model because they stabilize the price of domestic liabilities and thus reduce the risk premium that the country has to pay.

The reason for public intervention in this model is not the kind of pecuniary externality at work in Jeanne and Korinek (2010), Bianchi (2011), Benigno et al. (2013) and others. The EM social planner exercises monopoly power to dilute and appropriate the rent of foreign investors. The foreign investors do not have monopoly power but extract a rent from the financial friction in the form of an excess return. The EM social planner transfers this rent to her residents by accumulating reserves. The social planner does not remedy the underlying financial distortion, since global welfare remains below the frictionless level (which is $y-k$, the level obtained when ϕ is large enough to ensure $p=1$).

The direction of the desirable adjustment is in some sense the opposite of the previous literature. In Jeanne and Korinek (2010) the focus was on net (rather than gross) flows and there was overborrowing because private borrowers did not internalize the negative impact of aggregate debt on the price of debt in a fire sale with binding collateral constraints. Thus it was optimal to lean against the wind and tax net capital inflows in proportion to the risk of crisis. There is no such collateral externality here, and the fire sale does not make the economy constrained inefficient.

The normative analysis is illustrated in Figure 3 which compares the private incentives to accumulate reserves with those of the social planner. The private marginal benefit of accumulating reserves falls to zero when reserves are equal to 0.2, which is thus the equilibrium level of reserves under laissez-faire. By contrast, the social marginal benefit of accumulating reserves remains positive all the way to the maximum level $a = 0.59$, which is the optimal level of reserves under the social planner. Relative to the laissez-faire equilibrium, the social planner increases reserves by a factor of about three.

We conclude this section with remarks about the implementation of the social planner allocation, mainly by pointing to a time-consistency problem that arises when the social planner controls gross capital flows both ex ante (in period 0) and ex post (in period 1).

We have assumed that the social planner spent all the reserves in period 1. This is a feature of the laissez-faire equilibrium but it is not clear a priori that a social planner who controls gross flows would want to do the same. Let us assume that the social planner may hold a positive quantity of reserves $a' \leq a$ between periods 1 and 2. The budget constraints for periods 1 and 2

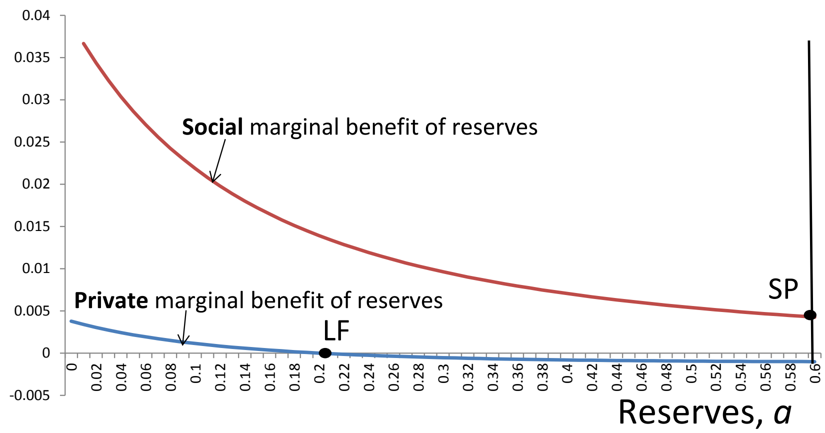

Figure 3: Marginal benefit of reserves over quantity of reserves

become

$$\begin{aligned} a - a' &= p' (b - b'), \\ c_2 &= y + a' - b', \end{aligned}$$

so that the country's welfare is given by,

$$U_1 = y - b + \frac{a - a'}{a'} + a',$$

where the ex-post price of debt is,

$$p' = \min\left(1, \frac{a - a' + \phi}{b}\right).$$

It is then possible to show (the details are not reported here) that the social planner never spends all reserves ($a' < a$), but chooses to retain some ($a' > 0$). The social planner does not spend all the reserves to exploit its monopsonist power in the market for EM debt and reduce the price at which she buys back the debt. This is optimal ex post but not ex ante since this reduces the benefit of stabilizing the price of debt. It cannot be optimal ex ante to pay a positive opportunity cost to accumulate reserves that are not used ex post. The social planner would like to commit to spend all the reserves.

For financially developed countries, policy instruments other than sterilized interventions are needed because Ricardian equivalence applies. One policy instrument could be liquidity regulation, such as a rule constraining the EM borrowers to hold a minimum fraction of their external debt in reserves. In practice, this type of regulation can be implemented if the borrowers are part of the regulated financial sector. The government could also use taxes or subsidies on capital flows. In this model it is equivalent to subsidize capital inflows or capital outflows because the current account is fixed. We now consider an extension of our basic model where the current account balance is endogenous so that there is a meaningful distinction between taxes on inflows and outflows.

7 Optimal capital controls

We extend the model so as to have an endogenous current account and continuous margins of adjustment on both foreign assets and liabilities. We now assume that the level of capital is variable and that period-2 output is an increasing and concave function of k,

$$y = f(k).$$

Furthermore we assume that EM borrowers pay an increasing and convex cost of issuing bonds $g(b)$. The constraint $b \leq \bar{b}$ that we have assumed before is the limit case where $g(\cdot)$ increases very fast at $\bar{b}$. We will assume in the following that $g\left(b^{LF}\right) = 0$, i.e., the laissez-faire equilibrium is unaffected by the cost of issuing bonds.

Domestic welfare is now given by

$$U = f(k) - b + aE\left(\frac{1}{p'}\right) - g(b). \tag{20}$$

We denote by τ_a and τ_b the tax rates on, respectively, foreign asset and foreign debt. The period-0 budget constraint becomes

$$k + (1+\tau_a)\,a = (1-\tau_b)\,pb + z, \tag{21}$$

where z is the lump-sum rebate of the taxes. We are interested in the tax rates that implement the social planner allocation. Like before we assume that the social planner intervenes only ex ante.

Proposition 4 *The EM social planner allocation has larger gross capital inflows and outflows but smaller net capital inflows that under laissez-faire,*

$$a^{SP} > a^{LF},\ b^{SP} > b^{LF},\ k^{SP} < k^{LF}.$$

The social planner allocation can be implemented with a subsidy on reserves accumulation combined with a tax on capital inflows (the tax rate on inflows being smaller than the subsidy rate on outflows),

$$\tau^b > 0,\ \tau^a < -\tau^b.$$

Proof. The first-order conditions for the maximization of (20) subject to (21) are

$$f'(k)(1-\tau_b)p = 1 + g'(b), \tag{22}$$

$$f'(k)(1+\tau_a) = E\left(\frac{1}{p'}\right). \tag{23}$$

The social planner solves the problem,

$$\begin{cases} \max_{k,\widehat{p}} U = f(k) - \frac{k}{m_L} + \pi_H \phi \left(\frac{1}{m_L/m_H} - \frac{1}{\widehat{p}}\right) - g(b), \\ k - \phi = \pi_L m_L (1-\widehat{p}) b. \end{cases}$$

The second equation is obtained by using (9) to substitute out $\widehat{p}$ from $k = \pi_L m_L (b-a) + \pi_H m_H \phi$. The first-order conditions for $\widehat{p}$ and k are

$$\frac{\pi_H \phi}{\widehat{p}^2} = \frac{k-\phi}{\pi_L m_L (1-\widehat{p})^2} g'(b), \tag{24}$$

$$f'(k) = \frac{1}{m_L}\left(1 + \frac{g'(b)}{\pi_L (1-\widehat{p})}\right). \tag{25}$$

The first equation implies $g'\left(b^{SP}\right) > 0$ and so $b^{SP} > b^{LF}$ since by assumption $g'\left(b^{LF}\right) = 0$. Since $f'\left(k^{LF}\right) = 1/p^{LF} = 1/m_L$ the second equation implies $k^{SP} < k^{LF}$. Finally $a^{SP} = p^{SP} b^{SP} - k^{SP}$ together with $b^{SP} > b^{LF}$, $k^{SP} < k^{LF}$ and $p^{SP} > p^{LF}$ implies $a^{SP} > a^{LF}$.

Given that $p^{SP} > m_L$ equations (22) and (25) imply $\tau_b > 0$. Substituting out $f'(k)$ between (22) and (23) gives,

$$\frac{1+\tau_a}{1-\tau_b} = E\left(\frac{1}{p'}\right)\frac{p}{1+g'(b)} < 1.$$

The inequality comes from $E\left(\frac{1}{p'}\right) - \frac{1}{p} < 0$ for the social planner allocation. It implies $\tau_a + \tau_b < 0$. ■

The social planner increases the size of the country's external balance sheet for the same reason as in the model with fixed capital (this stabilizes the domestic asset price in period 1). The social planner finds it optimal to finance reserves by reducing physical capital. This reduces global welfare: transferring welfare from foreign investors to the EM economy now has an efficiency cost.

The subsidy on outflows and tax on inflows make private borrowers internalize that the price of debt p increases with a but decreases with b. The tax τ^b reduces investment and the net capital inflow. There is a net subsidy $-(\tau_a + \tau_b)$ on financing reserves with debt, which increases the size of the country's balance sheet. The social planner subsidizes the financing of reserves by debt but taxes the accumulation of physical capital by debt.

8 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 extract rents from 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 low prices when foreigner investors disinvest.

To fully benefit from this buffering mechanism, countries need to be sufficiently financially developed, i.e. the need to have large enough international balance sheets. When financial constraints limit the issuance of international debt by private agents, the government can use foreign exchange intervention to enhance buffering. Foreign exchange intervention becomes instead ineffective in countries with high financial development since private agents undo government intervention because of Ricardian equivalence effects. The model implications are in line with empirical stylized facts showing that more financially developed countries tend to have greater covariance between inflows and outflows, benefit from lower borrowing spreads, and rely less on official reserves.

Contrary to conventional policy prescriptions, the model thus calls for dealing with the global financial cycle by expanding the balance sheets of emerging markets by using foreign exchange intervention and fostering financial development. Furthermore, the model provides a rationale to increase a country's balance sheets beyond the laissez-faire equilibrium level. This is because a social planner internalizes the effects on bond prices arising from the management of balance sheets. The planner's solution involves, however, some implementation challenges. First, the planner's equilibrium cannot be attained with foreign exchange intervention because of Ricardian effects. It instead requires using taxes and subsidies to induce agents to hold larger balance sheets. Second, to implement the planner's solution, governments should have commitment. Otherwise, during a crisis they would not use reserves enough to buy back debt in order to keep debt prices low.

In the paper, we used a stylized three-period model to clarify the key mechanisms behind financial buffering. The analysis can be extended in several directions. First, the model can be extended to incorporate non-tradable goods and study how financial buffering can also help to stabilize the real exchange rate. Second , the model can be nested into a conventional DSGE framework to analyze its quantitative implications.

A Stylized facts

Table 1: Standard deviation of capital inflows over size of foreign liabilities

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual data			Quarterly data		
		Without outliers			Without outliers	
	All	All	EMs	All	All	EMs
Liabilities	0.033***	0.049***	0.071***	0.031***	0.034**	0.045***
	(0.002)	(0.008)	(0.010)	(0.003)	(0.013)	(0.014)
Constant	3.550***	2.126***	0.076	4.763***	4.527***	2.933*
	(0.436)	(0.754)	(0.834)	(0.645)	(1.404)	(1.416)
Countries	90	84	35	44	39	19
R-squared	0.752	0.325	0.616	0.674	0.160	0.393

*** p<0.01, ** p<0.05, * p<0.1

Table 2: Covariance of inflows and outflows over size of foreign liabilities

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual data			Quarterly data		
		Without outliers			Without outliers	
	All	All	EMs	All	All	EMs
Liabilities	16.0***	0.3***	0.6***	3.5***	0.9***	1.0***
	(0.8)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)
Constant	-1,439.9***	-6.1	-26.2***	-296.9***	-37.5*	-43.8*
	(178.3)	(10.5)	(6.3)	(26.1)	(18.6)	(24.0)
Countries	90	85	34	44	39	19
R-squared	0.806	0.082	0.595	0.941	0.417	0.492

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Correlation of capital flows with borrowing spreads

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual data			Quarterly data		
		Without outliers			Without outliers	
Corr. spread with:	All	All	EMs	All	All	EMs
Inflows	0.07**	0.04	0.08*	0.08***	0.06***	0.16***
Outflows	0.15***	0.13***	0.21***	0.13***	0.11***	0.20***
Adjusted outflows	0.15***	0.12***	0.21***	0.11***	0.08***	0.18***

*** p<0.01, ** p<0.05, * p<0.1

Table 4: International borrowing spreads over size of foreign liabilities

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual data			Quarterly data		
		Without outliers			Without outliers	
	All	All	EMs	All	All	EMs
Liabilities	-0.020***	-0.033**	-0.040***	-0.042	-0.081***	-0.128***
	(0.005)	(0.014)	(0.014)	(0.120)	(0.022)	(0.039)
Constant	5.189***	5.299***	6.674***	24.491	10.172***	15.154***
	(1.056)	(1.454)	(1.231)	(23.415)	(2.428)	(4.172)
Countries	90	81	33	44	38	19
R-squared	0.155	0.062	0.202	0.003	0.283	0.394

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Share of reserves in foreign assets over size of foreign liabilities

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual data			Quarterly data		
		Without outliers			Without outliers	
	All	All	EMs	All	All	EMs
Liabilities	-0.019	-0.159***	-0.194**	-0.050***	-0.165**	-0.166*
	(0.012)	(0.044)	(0.071)	(0.018)	(0.067)	(0.086)
Constant	43.138***	54.105***	56.217***	41.544***	53.033***	52.126***
	(2.547)	(4.435)	(6.093)	(3.566)	(7.441)	(9.289)
Countries	90	82	34	44	39	19
R-squared	0.027	0.139	0.188	0.149	0.143	0.182

*** p<0.01, ** p<0.05, * p<0.1

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