Dollar Debt and the Inefficient Global Financial Cycle*

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Abstract

This paper proposes a tractable model of the Global Financial Cycle and study its welfare implications for emerging market economies (EMEs). When local firms issue debt denominated in dollars, central banks must increase their policy rate as the U.S. tightens in order to offset balance sheet effects stemming from the depreciation of their currency. When global financial markets are imperfect, this synchronized policy response has negative spillovers: all individual countries seek to attract capital inflows at the expense of one another, exacerbating the Global Financial Cycle. This congestion externality requires further tightening and results in inefficiently low levels of output and employment in EMEs, and generates gains from coordination. On the contrary, discouraging debt issuance in dollars through macroprudential policy has positive spillovers, and does not necessarily require coordination between EMEs. Its optimal use dampens the Global Financial Cycle and its inefficiencies.

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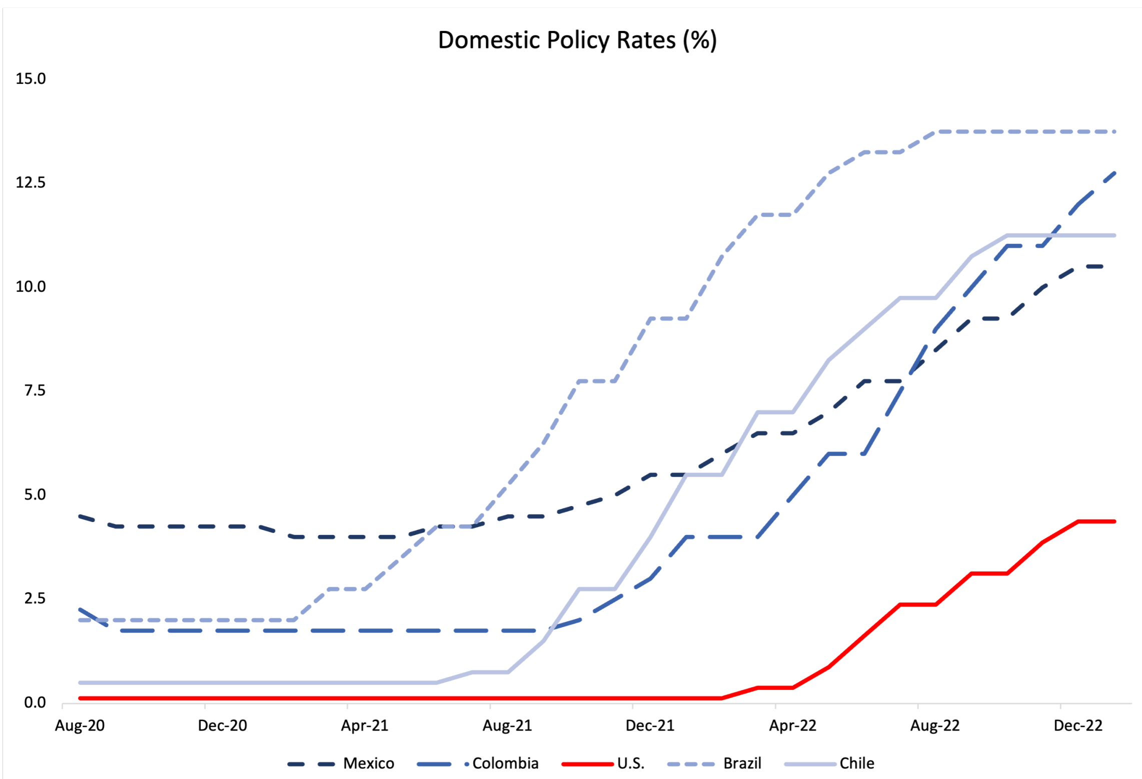
1 Introduction

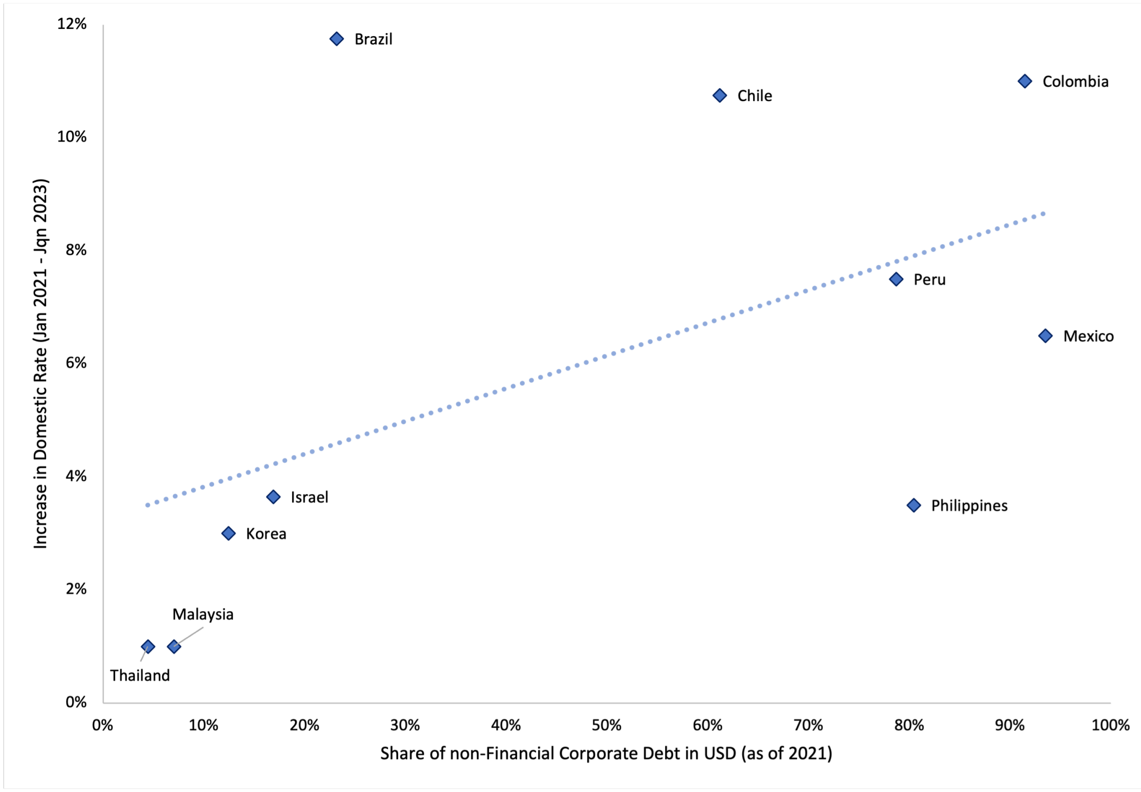
In May 2013, the U.S. Federal Reserve announced it would start tapering its large scale asset purchases. Financial conditions in emerging market economies (EMEs) immediately deteriorated: currencies depreciated, stock markets fell, and bond yields rose. This "taper tantrum" episode highlighted how EMEs may be severely affected by U.S. domestic policy decision: when private debt is denominated in dollars, a depreciation of the currency weakens balance sheets, which hurts financially constrained corporates. To fight such depreciations, central banks in EMEs usually rely on interest rates hikes, putting a drag on aggregate demand. The recent round of interest rate tightenings in EMEs (see Figures 1 and 2) revived this debate.

Figure 1: Interest Rates in Selected Emerging Economies and in the U.S.



While it is now understood that central banks in EMEs are constrained by the actions of the Federal Reserve (Rey 2015), their synchronized response to the Global Financial Cycle raises new questions. First, how should individual policymakers respond when private dollar debt is prevalent in all EMEs? Second, under which conditions are there spillovers from EMEs' monetary policy response to the

Figure 2: Cumulative Interest Rates in Selected Emerging Economies, as a function of non-Financial Corporate Debt in USD. Source: BIS, World Bank.



actions of the Federal Reserve? And third, are there eventual coordination gains for central banks in EMEs?

This paper proposes a tractable model that allows to answer these questions. The central result of the paper is that, when global financial markets are imperfect, a "congestion externality" appears in response to policy decisions in the U.S., exacerbating the Global Financial Cycle: central banks in EMEs raise domestic policy rates to counter depreciationary pressures and balance sheet effects, by attracting more capital inflows. This change in global capital flows, if happening in all EMEs at the same time, increases the world interest rate because of frictions in international financial markets. This feeds back into domestic conditions by creating further depreciationary pressures in emerging economies, requiring another round of tightening. A coordinated response from central banks solves this congestion externality by tightening less in response to a Fed shock, resulting in higher employment and higher output in all EMEs.

I start by developing in Section 2 a model of a small open economy featuring the different forces at play. The model is characterized by two key departures from the neo-classical benchmark: financial frictions and nominal rigidities. The presence of financial frictions implies that the net worth of entrepreneurs plays a crucial role (Tirole 2010 ; Bernanke and Gertler 1990): increasing this net worth allows entrepreneurs to level up more and invest more into productive assets. This channel naturally interacts with the existence of debt denominated in foreign currency — here in dollars. When entrepreneurs' revenues are in local currency, any movement in the exchange rate *vis-à-vis* the dollar impacts the net worth of entrepreneurs, giving rise to balance sheet effects.[1] An increase in the U.S. interest rate provokes capital outflows that depreciate the local currency, weakening the balance sheet of entrepreneurs, forcing them to delever and invest less in productive capital, leading to lower output later on.

The central bank can counter these depreciationary pressures by raising its domestic policy rate. But the existence of nominal rigidities — modeled as rigid wages — implies that there is a monetary policy trade-off, fleshed out in Section 3. By increasing its interest rate, the EME is able to attract capital inflows that will appreciate its currency, lowering the repayment burden imposed on entrepreneurs, and thus leading to higher investment through the net worth effect described above. This increase in the interest rate, however, also leads to a rebalancing of households' demand away from non-tradable goods, eventually leading to involuntary unemployment and lower output in this sector because of rigid wages. This policy analysis provides a closed-form formula for the optimal interest rate. As expected, this optimal interest rate is increasing in the size of dollar debt held by entrepreneurs, and in the U.S. interest rate. The higher the Fed rate, the more difficult it is for the EM central bank to achieve full employment for a given level of dollar debt.

Furthermore, since several EMEs are characterized by high level of dollar debt, all of them will hike in response to a Fed tightening at the same time. Section 4 looks at the general equilibrium effects of this synchronized policy response, which is the main contribution of the paper. In particular, I show that monetary policy spillovers in this context are a cause of concern, but only when global financial markets are imperfect. If global capital flows have to go through financial intermediaries (or arbitrageurs) that face costs of intermediation (Gabaix and Maggiori 2015 ; Fanelli and Straub 2021), then the absolute size of capital flows impact the equilibrium determination of the interest rate for all countries. When central

[1] These effects have been documented in a host of different countries, see e.g. Harvey and Roper (1999), Aguiar (2005), Kim, Tesar and Zhang (2015) and Bruno and Shin (2020).

banks seek to counter depreciationary pressures and balance sheet effects, they need to attract more capital inflows. This change in global capital flows, if happening in all EMEs at the same time, increases the world interest rate because of the intermediation friction. This feeds back into domestic conditions by creating further depreciationary pressures in emerging economies: a higher world interest rate is depreciationary for all EMEs, weakening balance sheets, and thus requiring another round of tightening. At the heart of this feedback is thus what I call a congestion externality: all individual EMEs seek to attract capital inflows at the expense of one another when the Fed tightens, since all of their foreign-currency debt is denominated in the same currency: the dollar. The Global Financial Cycle is thus exacerbated, resulting in inefficiently low levels of employment.

This congestion externality generates gains from coordination. I show that the optimal interest rate implemented by central banks is lower when the response to an U.S. tightening is coordinated, and that the difference with the un-coordinated interest rate is increasing in the severity of the friction on global financial markets. This naturally leads to higher employment and higher output in EMEs, and dampens the Global Financial Cycle.

I end with a study of optimal ex-ante policies in Section 5. Building on the previous analysis, I first show that the issuance of dollar-denominated debt naturally creates externalities when the central bank cannot commit to target only inflation in the future. When atomistic private firms issue in dollars, they fail to take into account the general equilibrium policy response of the central bank in the future. This externality calls for macroprudential regulation ex-ante, albeit taking a specific form: only debt issued in dollar needs to be discouraged with the appropriate tax, rather than all type of short-term borrowing as in traditional model of macroprudential policy in open economies (e.g., Bianchi 2011 ; Farhi and Werning 2016 ; Bianchi and Mendoza 2018 ; Jeanne and Korinek 2019).[2] By taxing issuance in dollars, the social planner relaxes the trade-off faced by the central bank in the future, when the Fed tightens its policy rate. The optimal macroprudential policy does not however entirely forbid dollar-denominated debt. This is because forcing issuance in other currencies is more expensive, resulting in lower investment going forward. The optimal macroprudential tax balances these two forces.

Since frictional global capital markets create negative spillovers from monetary

[2]See also Benigno, Chen, Otrok, Rebucci and Young (2013), Acharya and Bengui (2018), Schmitt-Grohé and Uribe (2021) on open-economy models that deliver under-borrowing. Ottonello, Perez and Varraso (2022) also show that seemingly close assumptions about the form of the financial friction can result in efficient levels of borrowing.

policy and coordination problems, a natural question is whether macroprudential policies suffer from the same issues. I show that, perhaps surprisingly, the implementation of such macroprudential policies have *positive* spillovers on the rest of the EMEs. This is because, taking as given the behavior of other central banks, reducing the amount issued in dollars in its own country allows the central bank to hike less in response to the Fed's actions. By tightening less the country attracts less capital flows, reducing the premium that global intermediaries require as compensation. This marginally lowers the world interest rate faced by other countries, reducing the depreciationary pressures that each central bank is trying to fight. By optimally lowering the amount of corporate debt issued in dollar, each country ameliorates the trade-off that all central banks face, resulting in higher output and employment levels in EMEs. It thus does not require coordination, dampening the global financial cycle and its associated inefficiencies.

Related Literature: The starting motivation of this paper is the conjunction of two well-established facts: corporate debt issuance in dollar in EMEs, and the Global Financial Cycle. First, a large quantity of corporate borrowing in emerging markets is denominated in dollars, and in outsized proportion relative to the wealth share of the U.S. in the world (Bruno and Shin 2015 ; McCauley, McGuire and Sushko 2015 ; Maggiori, Neiman and Schreger 2020). Second, the domestic monetary policy of the U.S. drives a Global Financial Cycle in capital flows, asset prices and in credit growth (Rey 2015 ; Miranda-Agrippino and Rey 2020 ; Miranda-Agrippino and Rey 2022 ; Obstfeld and Zhou 2023). My paper explains the latter fact with the former: the presence of dollar debt ties the hands of central banks in emerging countries. Being forced to respond in a synchronized manner to interest rates movements in the U.S., an inefficient Global Financial Cycle appears.[3,4]

The literature has proposed several explanations for why firms in emerging markets tend to issue in dollars rather than in their domestic currency, exposing

[3]A large literature has proposed different models of the Global Financial Cycle, surveyed in (Miranda-Agrippino and Rey 2022). In Bianchi, Bigio and Engel (2021), Gopinath and Stein (2021) and Jiang, Krishnamurthy and Lustig (2021), dollar safe assets are special. Farhi and Maggiori (2018) present a model where the US is a monopolistic supplier of safe assets. In Kekre and Lenel (2021) and Gourinchas and Rey (2022) the US is special because it is more risk tolerant than the rest of the world. Finally, Miranda-Agrippino and Rey (2022) also propose a model of intermediaries with heterogeneous risk-taking, where US monetary policy drives their funding costs.

[4]Fukui, Nakamura and Steinsson (2023) show in a large sample estimate that nominal interest rates rise in response to what they call a "regime-induced depreciation". Their approach is constructed to exclude all variation in exchange rates that arises from idiosyncratic shocks to each country.

themselves to currency mismatches. McKinnon and Pill (1998), Burnside, Eichenbaum and Rebelo (2001), and Schneider and Tornell (2004) argue that the excessive use of foreign currency debt stems from bailout guarantees for foreign creditors, creating a moral hazard problem. Caballero and Krishnamurthy (2003) show that limited financial development in emerging markets makes agents undervalue insuring against an exchange rate depreciation, so that agents choose excessive level dollar debt. Jeanne (2002) proposes that lack of monetary credibility is a source of risk, and that the optimal hedging strategy for firms is to issue a large share of debt in foreign currency. Bocola and Lorenzoni (2020) propose a theory in which dollar debt arises because domestic savers ask for a risk premium when saving in local currency, since crises are associated with depreciations. Coppola, Krishnamurthy and Xu (2023) build a model with search frictions where firms optimally choose to denominate their debt in the unit of the asset that is most liquid. Eren, Malamud and Zhou (2023) present a framework where good firms optimally expose themselves to currency risk to signal their type. My paper does not necessarily take a stance on why so many firms in emerging markets issue in dollars: it rather takes this fact as given and explores its general equilibrium consequences for the global financial cycle.[5]

The presence of dollar debt generates powerful balance-sheet effects.[6] This has been studied in response of the East Asian Crisis of the 1990s by, e.g., Krugman (1999), Céspedes, Chang and Velasco (2004), Aghion, Bacchetta and Banerjee (2004), and Chamon and Hausmann (2005). Recent papers have focused on the determination of optimal policy under foreign-denominated debt in modern models. Matsumoto (2021) and Coulibaly (2021) show that discretionary monetary policy is contractionary during crises, in order to mitigate balance sheet effects originating from exchange rate depreciations. Wang (2019) shows that incomplete exchange rate pass-through to goods prices leads to a new form of balance sheet effects, and derives the associated optimal macroprudential policy. More generally, Bianchi and Lorenzoni (2021) reviews the literature on optimal policy under "fear-of-floating."[7] A closely related paper is the recent work of Akinci and Quer-

[5] Relatedly, there is also a large literature on why sovereign debt is often issued in dollars — the so-called "original sin." See Eichengreen, Hausmann and Panizza (2007) for a review. My paper is only concerned with private debt.

[6] Rodnyansky, Timmer and Yago (2022) show that firms with a higher share of dollar debt experience larger stock price decline after a Fed tightening.

[7] This is related to a large literature, which I build upon, studying optimal monetary policy under financial fragility (Boissay, Collard, Galí and Manea 2021 ; Farhi and Werning 2020 ; Asriyan, Fornaro, Martin and Ventura 2021).

alto (2021). They develop a quantitative two-country model that can account for powerful spillovers of U.S. monetary policy on EMEs, but do not study the optimal policy response. My paper builds on these insights, and pushes their implications further: the optimal response of EMEs to these U.S. spillovers itself has spillover effects on other countries and requires coordination.[8]

My results are thus linked to a vast literature on international policy cooperation, starting with Obstfeld and Rogoff (2002) and Benigno and Benigno (2006). Importantly, the seminal work of Korinek (2017) lays out the conditions that need to be violated to generate inefficiency and scope for cooperation. In my paper, this stems from the use of a single instrument (monetary policy) in order to control both employment and the exchange rate. Fornaro and Romei (2019) show that, when monetary policy is constrained by the zero lower bound, non-cooperative financial and fiscal policies can lead to global output losses. Fornaro and Romei (2022) study monetary policy when there is excessive demand for tradable goods. They show that the optimal response is to implement expansionary monetary policy, but that the non-cooperative equilibrium is not expansionary enough. Closer to the mechanism highlighted in my paper, Caballero and Simsek (2020) develop a model with fire sales where domestic authorities want to restrict capital inflows in order to increase fire-sale prices in their countries. This reduces global liquidity, which in general equilibrium exacerbates fire sales.[9] Caballero, Farhi and Gourinchas (2021) show that in a global liquidity trap, countries that want to improve their current account do so at the expense of other countries' output. I also show that imperfections in domestic and international financial markets are necessary to generate spillover. I build on the work of Gabaix and Maggiori (2015), Fanelli and Straub (2021), and Itskhoki and Mukhin (2021), who provide models of such imperfections that micro-found deviations from the UIP condition. The work of Itskhoki and Mukhin (2022) is the closest to my model. To the best of my knowledge, they are the first to show that the monetary response of individual countries to global dollar shock can involve externalities in tradable inflation in the presence of imperfections in international financial markets. My paper highlights a different

[8] Jiang et al. (2021) develop a model of the Global Financial Cycle that starts from the global demand for dollar-denominated safe assets, and highlight in particular the spillovers from U.S. monetary policy. My work is complementary as they are not looking at optimal policy in EMEs affected by this cycle and its welfare consequences.

[9] A different literature also emphasized the role of terms-of-trade manipulation in the analysis of optimal tariffs and its implications for the trade agreements (see, e.g. Bagwell and Staiger 1999 ; Broda, Limao and Weinstein 2008 ; Costinot, Lorenzoni and Werning 2014). These effects are absent in my model because there is a single traded goods.

type of spillovers, where each country tries to attract capital flows at the expense of one another, giving rise to a congestion externalities in flows. The driving force in my model (dollar debt) is also distinct from the model of Itskhoki and Mukhin (2022), and allows me to study implications for macroprudential policy, whereas Itskhoki and Mukhin (2022) highlight the importance of FX interventions to manage the exchange rate.

2 A Small Open Economy Model

Structure We consider a small open economy that can be thought of as an emerging economy.[10] Time is discrete and indexed by $t \in \{1, 2, 3\}$. Since the presence of risk only obfuscates my results, agents have perfect foresight. There are two key types of agents. Households consume and provide labor in period 2 and 3. Entrepreneurs issue debt in period 1 in order to finance investment in a capital stock that will produce domestic goods in period 2 and 3. Entrepreneurs simply seek to maximize profits, which are fully rebated to households. There is a non-tradable good, and a single tradable good. The price of tradables in the rest of the world is normalized to one in dollars, so using the law of one price, the price of tradable goods in pesos is:

$$p_t^T = e_t \tag{1}$$

where e_t is the nominal exchange rate, the price of a dollar in pesos.

The main insights of the paper come from the behavior of the equilibrium in the intermediate period, when entrepreneurs have some dollar debt to repay and need to make investments. I thus start by describing the intermediate period, and will present period $t = 1$ for completeness in Section 5.[11]

2.1 The economy at $t = 2$

Entrepreneurs Entrepreneurs enter period 2 each with a stock of capital K_1, as well as dollar and peso debts to pay back. Their existing stock of capital produces

[10] In Section 4, there is a continuum of infinitesimal countries and the world interest rate is endogenous.

[11] What ultimately matters for my model is that entrepreneurs find it optimal to issue at least some of their initial debt in dollars. This can be for a variety of reasons already highlighted by previous works (see the literature review above). In Section 5, the level of the interest rate on dollar debt depends on the size of the loan, such that entrepreneurs issue in dollars and in the domestic currency, up to the point where they are indifferent between both on the margin.

η_2 units of non-tradables goods per unit of capital. The net worth of entrepreneurs is thus denoted by:

$$n_2 = \eta_2 K_1 - b_1 - e_2 b_1^* \tag{2}$$

After η_2 is realized, a random fraction κ of firms are still productive and can produce in period 3 if they maintain their capital stock, and the remaining fraction $1 - \kappa$ is unproductive: their capital depreciates entirely and they stop producing. Unproductive firms repay their debt, lend to other firms, and rebate the rest of their profits to households.

To maintain their existing stock of capital in order to keep producing non-tradable goods in period 3, productive entrepreneurs must invest s units of non-tradable goods per unit of capital: to maintain k_2 they need to pay $s \cdot k_2$, which will pay off ρk_2 units of non-tradables at $t = 3$. Un-maintained capital fully depreciates. To finance this investment, entrepreneurs can borrow b_2 from other unproductive firms at a 0 interest rate but are subject to a classic monitoring problem (Tirole 2010) that limits the amount they can borrow:

$$b_2 \leq \rho_0 k_2 \tag{3}$$

where ρ_0 is the pledgeable part of the project, with $\rho_0 < s < 1$. Since entrepreneurs seek to maximize future output, their budget constraint is:

$$n_2 + b_2 = s k_2 \quad \text{s.t.} \quad k_2 \leq K_1\,;\, b_2 \leq \rho_0 k_2 \tag{4}$$

The case of interest will be when entrepreneurs are constrained by the plegdeability limit, which will imply that:

$$k_2 = \frac{n_2}{s - \rho_0} \tag{5}$$

As is common in these models, net worth plays a crucial role. Entrepreneurs can lever their wealth with a multiplier $1/(s - \rho_0)$. By improving entrepreneurs net worth, monetary policy will thus be able to prop up investment in the capital stock. Since only a fraction κ of entrepreneurs are productive, the aggregate stock of capital used for production at $t = 3$, when entrepreneurs are constrained, will be given by:

$$K_2 = \kappa \frac{n_2}{s - \rho_0} \tag{6}$$

while the amount of non-tradable goods used for maintaining capital is $s \cdot K_2$.

Households Households receive an endowment of tradable goods y_2^T at time $t = 2$. They only consume starting at $t = 2$ and have the following utility function:

$$U_2 = \frac{1}{1-\sigma}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right) + \beta\left(c_3^N + c_3^T\right) \tag{7}$$

Households have an inelastic supply of labor $\bar{n}$. They can save and borrow in peso-denominated bonds (a_3) or dollar-denominated bonds (a_3^*), at the respective interest rates i_2 and i_2^*. The central bank sets the domestic interest rate i_2. We keep the same convention as for entrepreneurs: a positive position $a_3^* > 0$ means that households are borrowing in dollars. They thus have the following budget constraint:

$$p^T c_2^T + p^N c_2^N = e_2 y^T + w_2 l_2 + \frac{1}{1+i_2} a_3 + \frac{1}{1+i_2^*} e_2 a_3^* \tag{8}$$

Under these conditions, the standard UIP condition holds:

$$1 + i_2 = (1 + i_2^*)\frac{e_3}{e_2} \tag{9}$$

We assume that peso-denominated bonds are only traded domestically. Since households are symmetric, and cannot lend to entrepreneurs, we have $a_3 = 0$ in equilibrium.

Production Perfectly competitive firms produce non-tradable goods using a linear technology $y_2^N = l_2$. Wages are fully rigid at $\bar{w} = 1$, so that involuntary unemployment arises when the interest rate is too high. Firms are competitive, so the price of the non-tradable good is $p_t^N = w_t = 1$.

2.2 The economy at $t = 3$

In the last period, productive entrepreneurs produce and rebate profits to households. Households provide labor to fully competitive firms, settle their foreign currency debt, and consume. Since there is no savings decisions to be made, there is full employment $l_3 = \bar{l}$. The budget constraint is simply:

$$p_3^N c_3^N + p_3^T c_3^T + a_3 + e_3 a_3^* = p_3^T y_3^T + \bar{w}\bar{l} + \Pi_3 \tag{10}$$

We can now formally define the competitive equilibrium.

Definition 1. *A competitive equilibrium is a path of real allocations* $\{c^N_, c_t^T, l_t\}_{(t=1,2)}$, *capital K_2 and capital flows a_3^*, such that, given a domestic policy rate i_2, a world interest rate i_2^* and legacy debt b_1 and b_1^*: (i) households maximize* (7) *under the constraints* (8) *and* (10) *; and (ii) entrepreneurs invest according to* (6).

In what follows, we restrict ourselves to situations where: (i) there is a unique equilibrium ; (ii) productive entrepreneurs are against their borrowing constraint (3) ; and (iii) y_2^T is large enough such that the SOE lends to the rest of the world.[12] Unless stated otherwise, all derivations and proofs are in Appendix A.

3 Dollar Debt and Monetary Policy

This Section studies the optimal policy problem, when the only instrument available is conventional monetary policy.[13] The central bank seeks to maximize the welfare of the representative consumer:

$$\mathcal{W} = \frac{1}{1-\sigma}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right) + \beta\left(c_3^N + c_3^T\right) \tag{11}$$

since entrepreneurs are rebating all of their profits to households. Supporting the wealth of entrepreneurs will however enter the central bank's problem by increasing the output in period $t = 3$. The key premise of this model is that the presence of dollar debt creates a trade-off for the central bank. The first channel works through aggregate demand: changing the domestic interest rate rebalances demand between non-tradable and tradable goods, as can be seen from the following optimality condition:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{(1+i_2)}{(1+i_2^*)}\right)^{-1/\sigma} c_2^T \tag{12}$$

When i_2 decreases, the demand for non-tradables rises relative to tradables (since $\sigma > 0$) which can increase non-tradable output (i.e. lower unemployment) since wages are rigid.

A decrease in i_2, for instance to increase employment and reach potential out-

[12] None of these assumptions are crucial for the results, but the trade-offs are starker in this situation.

[13] Korinek (2017) lays out the conditions that need to be violated to generate inefficiency and scope for cooperation. Here, this stems from the use of a single instrument (monetary policy) in order to control both employment and the exchange rate. If the policymaker was also able to use foreign exchange intervention at zero cost, we would be back to the Korinek (2017) benchmark of the "first welfare theorem."

put, has an impact on the exchange rate through the usual UIP condition:

$$1 + i_2 = (1 + i_2^*)\frac{e_3}{e_2} \tag{13}$$

which mechanically increases e_2. Indeed, a fall in the interest rate creates capital outflows from the small open economy to the rest of the world, depreciating the exchange rate to restore equilibrium in global capital markets.

Because of dollar debt repayments, however, this change in the exchange rate weakens the balance sheet of entrepreneurs that need to borrow subject to the financial friction (3) in order to maintain their capital stock:

$$\frac{dK_2}{di_2} = \frac{e_2 \kappa b_1^*}{s - \rho_0} \tag{14}$$

Thus, when entrepreneurs are constrained a depreciation of the domestic currency *vis-'a-vis* the dollar results in a lower capital stock at $t = 2$. Finally, this decrease in capital has a negative impact on welfare, by lowering output at $t = 3$. The next proposition characterizes, in closed-form, how central banks should trade-off the aggregate demand and net worth effects.

Proposition 1 (Optimal Monetary Policy at $t = 2$)**.** *There exists a unique level of dollar debt $\tilde{b}^*$ such that:*

1. *When $b_1^* > \tilde{b}^*$, optimal monetary policy trades off aggregate demand and balance sheet effects according to:*

$$1 + i_2^{opt} = \Omega \left(\frac{(1 + i_2^*) b_1^*}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma - 1}} \tag{15}$$

   where $\Omega = \left(\sigma \rho \kappa \bar{w} \beta^{1/\sigma}\right)^{\sigma/(2\sigma-1)}$. The optimal interest rate is thus strictly increasing in the level of dollar debt, and we have involuntary unemployment: $l_2 < \bar{l}$.

2. *When $b_1^* \leq \tilde{b}^*$, the central bank implements full employment.*

The first part of the proposition naturally ties together the forces at play. The level of dollar debt directly matters for monetary policy. Its is amplified by the net worth multiplier $1/(s - \rho_0)$: when $s - \rho_0$ is low, a shock to net worth transmits to investment in capital more strongly, thus inflating the effects of a policy hike. At the same time, aggregate demand is hurt by an increase in the interest rate, and here this effect is disciplined by the elasticity of substitution σ that relates how changes in interest rates impact demand for non-tradable goods. Finally, the level of U.S. interest rates matters: the domestic central bank is forced to follow the actions of the Fed to prevent excessive devaluation of the peso that results in adverse balance sheet effects, which is of course costly for aggregate demand.

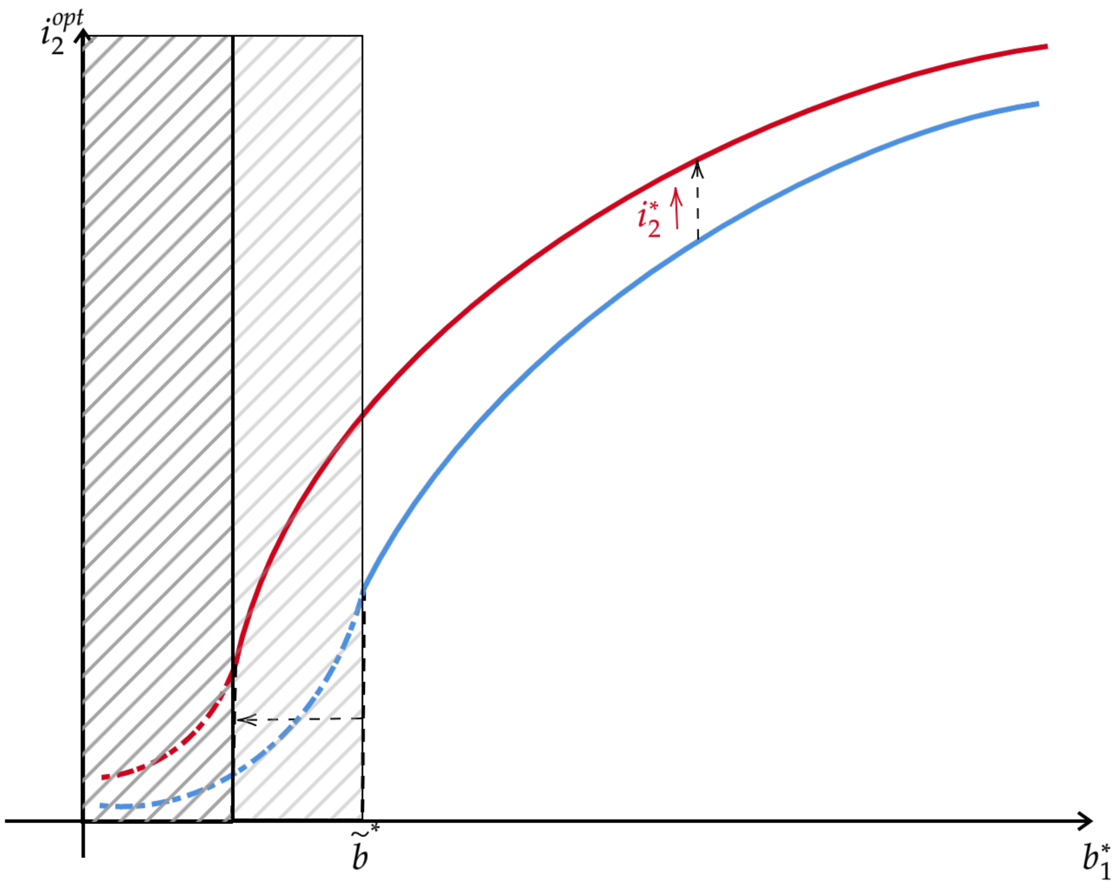
Finally, notice how the second part of the proposition links to the large literature studying aggregate demand externalities (Korinek and Simsek 2016 ; Farhi and Werning 2016 ; Guerrieri and Lorenzoni 2017 ; Fornaro and Romei 2019). The interest rate necessary to achieve full employment is decreasing in b_1, the amount of domestic debt issued by entrepreneurs in the first period. It is then further assumed in this literature that a zero lower bound constraint binds at period 2: in such a case, a higher debt at $t = 1$ translates into weaker aggregate demand at $t = 2$, and the policymaker is unable to stimulate the economy enough, resulting in unemployment and low output. In my paper, the ZLB constraint does not play any role: the presence of foreign debt makes the policymaker more likely to hike interest rates.[14]

The optimal interest rate chosen by the central bank, as a function of dollar debt, is pictured on Figure 3. The red dashed line corresponds to the case where the U.S. interest rate is higher (an increase in i_2^*). As can be seen graphically or from Proposition 1, an increase in the Federal Reserve rate worsens the emerging market's monetary policy dilemma: it becomes harder to achieve full employment because of balance sheet effects.

The Global Financial Cycle An immediate implication of Proposition 1 is that the presence of dollar debt creates a synchronization between the domestic policy decisions of emerging markets. Irrespective of their own aggregate demand shocks, all central banks fearing balance sheet effects from dollar debt optimally tighten in the face of tighter financial conditions in the U.S. For instance, Proposition 1 illustrates the "taper tantrum" episode of 2013, where emerging markets' central banks aggressively hiked after the Fed hinted that it would raise rates in the near future. The fact that all countries privately act in a manner consistent with 1 can create coordination issues, however. This is the focus of the next Section.

[14] In a full-fledged model, the central bank would overheat the economy below the threshold $\tilde{b}^*$. I focus on the under-employment issue in this paper since the trade-offs are starker, but the intuitions are similar.

Figure 3: Optimal interest rate chosen by the central bank, as a function of dollar debt b_1^*. The shaded grey areas correspond to regions where the central bank is able to achieve full employment. A shock to the U.S. interest rate i_2^* moves the full employment threshold to the left, meaning that it becomes harder to achieve full employment.



Discussion of Assumptions The model contains a number of assumptions to keep the results tractable, especially once we shift the focus to an equilibrium with a continuum of SOEs. In particular, the linearity of utility in the last period will allow for tractable expressions of capital flows, without altering the presence of a trade-off between balance sheet effects and aggregate demand.[15] The fact that entrepreneurs need to borrow in order to finance production in period $t = 3$ while wages are rigid in period 2 allows for a clean separation of the two effects across time, resulting in a simple closed-form formula for the optimal interest rate. Finally, the fact that there is a single traded good (whose price is fixed by international conditions) eliminates terms-of-trade manipulation motives, such that the only reason to affect the exchange rate is because of the dollar debt revaluation

[15]Alternatively, one could write an infinite-horizon version of the model where prices are flexible from period $t = 3$ onward, with similar results.

channel.

I also assumed an extreme form of currency mismatch: entrepreneurs only have revenues in local currency. It is straightforward to extend the framework to include less extreme form of currency mismatch (see Appendix B.2), which only weakens the strength of the balance sheet effect. On a similar vein, it is assumed that the debt in dollars is due to foreigners: if the debt was due to households, the central bank should take into account the loss incurred to households by the appreciation of the currency. This would once again weaken the balance sheet effects, but given that entrepreneurs are constrained and households are not, an appreciation of the currency on the margin would still be desirable (in other words, redistribution from households to constrained entrepreneurs is valuable).

4 Spillovers

The previous analysis studies a small open economy in isolation, taking U.S. interest rates as given. In practice, many emerging economies are characterized by high level of corporate debt dollarization. This raises questions about coordination issues and possible spillovers: when the Federal Reserve hikes U.S. interest rates, each country faces depreciationary pressures. Each government would then find it optimal to increase their domestic rates in order to counter the net worth effects, as highlighted in Proposition 1. If global financial markets are frictional, this general movement towards higher rates will backfire and amplify even further depreciationary pressures.

4.1 The World Economy

We consider a similar setup as in Section 2 but this time with a continuum of identical and symmetric small open economies. Each country is indexed by j. In particular, country j at time $t = 2$ sets its nominal interest rate at $i_{2,j}$, taking all other world interest rates as given. Small open economies are in mass of 1, and we denote the aggregate variables without the subscript j: $b^*_{1,j}$ thus refers to the dollar debt of country j, and b^*_1 to the aggregate dollar debt of emerging economies. Importantly, we still assume that this continuum of small open economies is small relative to the rest of the world, such that the decision of this continuum has no impact on the price of tradables in dollars, still set to 1.[16]

4.2 Global Financial Markets

We assume that global financial markets are not frictionless in the spirit of Gabaix and Maggiori (2015) and Fanelli and Straub (2021). Each country can only trade dollar-denominated bonds with a continuum of global arbitrageurs indexed by g, at rate i_2^*. Since countries are symmetric and there is no risk, each arbitrageur is indifferent between lending to a country relative to another, in other words arbitrageurs see individual SOEs as perfect substitutes. Global arbitrageurs can borrow directly on U.S. financial markets at the rate set by the Fed, $i_2^\$$, but following Fanelli and Straub (2021) they are subject to a net open position limit $\gamma > 0$, and face heterogeneous participation costs. In particular, intermediary g has costs of g per dollar invested. This implies that intermediary g solves the following profit-maximization program:

$$\max_{x_g \in [-\gamma, \gamma]} x_g (i_2^* - i_2^\$) - g|x_g| \tag{16}$$

Hence, the marginal intermediary verifies:

$$\bar{g} = |i_2^* - i_2^\$| \tag{17}$$

We denote by $\int_j a_{3,j}^*/(1+i_2^*) dj$ the aggregate capital flow from the continuum of SOEs to the rest of the world. Since each intermediary is against the net position constraint, a total of $\bar{g}$ intermediaries have a position of γ, which yields the equilibrium relationship between interest rates and aggregate flows:

$$i_2^* = i_2^\$ + \frac{\int_j \frac{a_{3,j}^*}{1+i_2^*} dj}{\gamma} \tag{18}$$

This expression intuitively means that, the larger the capital flows between our SOEs and the rest of the world, the bigger the markup intermediaries need to

[16] This distinguishes the spillovers identified in this paper to the work of Itskhoki and Mukhin (2022), which function through tradables inflation.

charge individual countries to compensate for participation costs.[17]

4.3 Benchmark: a No-Spillover Result

Before introducing a key friction that creates spillovers in response to the Global Financial Cycle, it is instructive to look at the benchmark case that does *not* create spillovers, and to understand why.

Since each country is taking i_2^* as given, the optimal policy program is entirely unchanged from the perspective of a single monetary authority. We thus know, thanks to Proposition 1, that country j reacts to the interest rate it faces, i_2^*, with a domestic rate of:

$$1 + i_{2,j} = \Omega \left(\frac{(1+i_2^*)b_{1,j}^*}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma-1}} \tag{20}$$

Now, however, the part $(1 + i_2^*)$ is endogenous. It must be determined by the aggregation of all capital flows from EMEs, as explicit in the next Lemma.

Lemma 1 (Benchmark Equilibrium Capital Flows)**.** *The aggregate capital flow from emerging economies towards the U.S. at period $t = 2$ is given by:*

$$\frac{1}{1+i_2^*} a_3^* = \left(\beta\phi \frac{1}{1+i_2^*} \right)^{\frac{1}{\sigma}} + b_1^* - y_2^T \tag{21}$$

where the interest rate i_2^* is the implicitly defined according to:

$$i_2^* = i_2^\$ + \gamma^{-1} \left(\left(\beta\phi \frac{1}{1+i_2^*} \right)^{\frac{1}{\sigma}} + b_1^* - y_2^T \right) \tag{22}$$

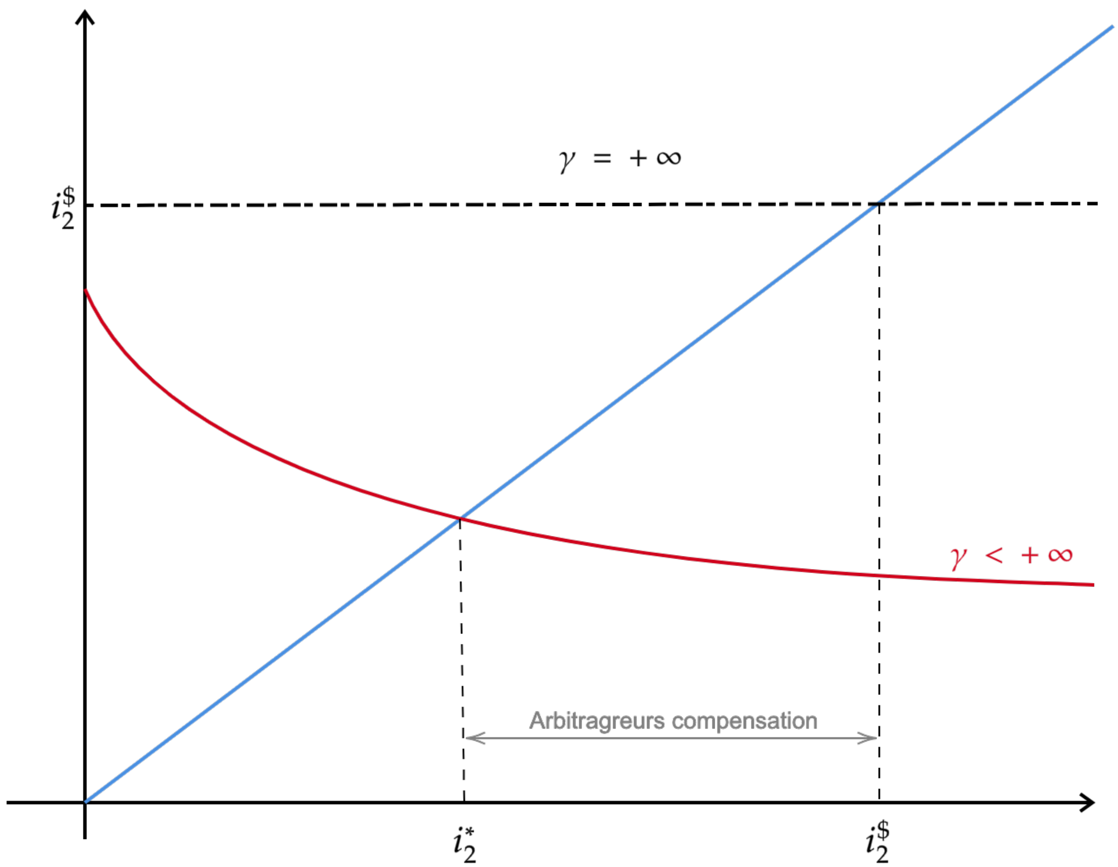
The determination of the equilibrium interest rate at which emerging economics can save can be graphically seen on Figure 4. A low level of γ indicates large friction on global financial markets, such that global entrepreneurs must be compensated more for intermediating capital flows from emerging economies. This result in a lower i_2^* compared to the Fed nominal rate.

[17]Equivalently, we could also directly postulate as in Bianchi and Lorenzoni (2021) that the global arbitrageur has a quadratic cost function for intermediating all capital flows:

$$\Phi \left(\int_j a_{3,j}^* dj, 1 + i_2^* \right) = \frac{1}{2\gamma} \left(\frac{\int_j a_{3,j}^* dj}{1 + i_2^*} \right)^2 \tag{19}$$

Profit maximization for the global arbitrageur thus leads to the same expression as in Equation (18).

Figure 4: Aggregate Capital Flows and Equilibrium Interest Rate. The blue line is the 45° line. The black line corresponds to the case where global markets are perfectly elastic: the size of capital flows has no impact on the equilibrium rate. The red curve depicts the right-hand side of equation (22), i.e. the size of global capital flows from emerging economies to the U.S. as a function of the interest rate charged by global arbitrageurs.



The key feature of Lemma 1, however, is that equation (21) (determining aggregate capital flow for an emerging economy) does not depend on the domestic rate of interest, i_2. This, in turn, means that any change in the domestic policy rates of emerging economies will not create spillovers effects on the exchange rates of other emerging economies. As a result, all emerging economies hike their interest rate in a synchronized fashion in response to an increase in the U.S. policy rate, but their is no need for coordination since domestic actions do not spillover other international financial conditions.

4.4 Global Capital Flow and the Financial Wedge

As hinted just previously, the benchmark "no-spillover" result hinges on the peculiar fact that capital flows are independent of the policy rate. There are, however, numerous ways to depart from this condition. In the spirit of this paper, I focus on a financial friction that breaks this irrelevance result.[18] The financial friction view favored here is simply an example of why such spillovers would arise, but serves two purposes. First, it allows me to relate to a large literature on financial shocks and exchange rate puzzles (Itskhoki and Mukhin 2021). Second, it also relates to the widespread use of dollar savings in emerging countries that are intermediated by domestic banks (Montamat 2020).

We thus assume that, to save in dollar bonds, households in emerging economies need to go through domestic banks, which are perfectly competitive. However, banks have to incur a cost to intermediate dollar savings that is proportional to the domestic rate, which can naturally be understood as the costs of holding reserves at the central bank. Specifically, banks in country j have to incur a unit opportunity cost of:

$$c_{\$,j} = (1 + i_2^*)^{\psi} \tag{23}$$

with $\psi \in [0, 1[$.[19] Such a financial friction yields the following modified UIP condition:

$$1 + i_2 = \left((1 + i_2^*) \frac{e_3}{e_2} \right)^{\frac{1}{1+\psi}} \tag{24}$$

where the ψ plays the role of a "financial wedge." This can equivalently be seen as writing the effective interest rate at which the emerging economy can save as:

$$(1 + \hat{i}_2^*) = (1 + i_2^*)(1 + i_2)^{-\psi} \tag{25}$$

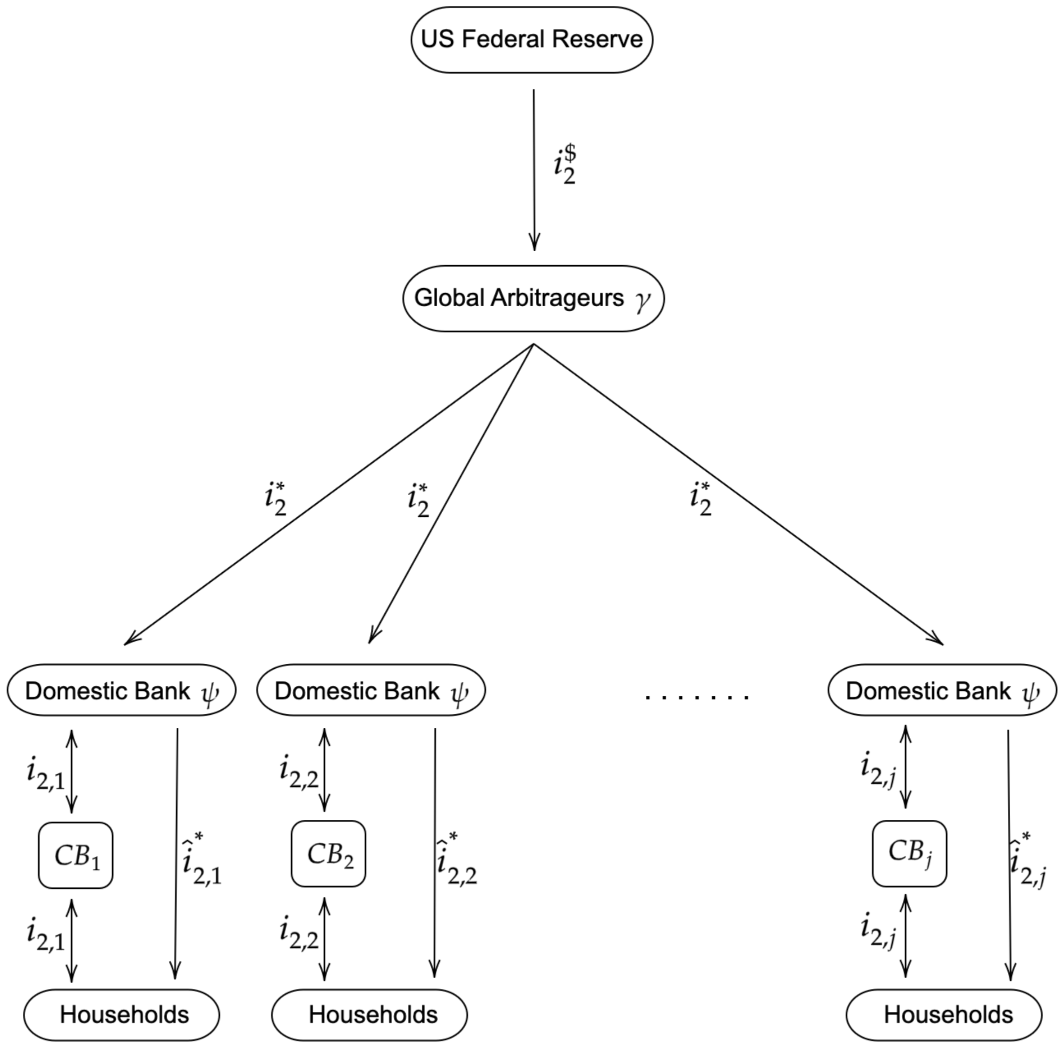
which is equivalent to saying that the perceived rate of return on dollar savings is decreasing in the domestic policy rate.[20]

[18]For instance, one could break this benchmark result by using non-separable preferences, a form of external habit formation, or a reach-for-yield type of mechanism. The analysis for non-separable preferences is presented in Appendix B.1.

[19]This function form is simply taken to keep the optimal policy problem tractable. What matters is that this relation between costs and the interest rate is increasing. Notice that for small ψ, this cost function can equivalently be expressed as $c_{\$,j} = e^{\psi i_2}$, which yields an UIP condition similar to the one proposed by Itskhoki and Mukhin (2021).

[20]This idea was expressed in Schnabel (2023): "The reason is that monetary policy tightening typically reduces intermediaries' risk-bearing capacity, thereby raising the compensation they require for warehousing risk, over and beyond changes in the quality of borrowers' balance sheet." See

Figure 5: Architecture of the Global Financial System



The full structure of this stylized global financial system is depicted on Figure 5. This leads naturally to capital flows from country j to be equal to:

$$\frac{1}{1+\hat{i}_2^*}a_{3,j}^* = \left(\beta\phi\frac{(1+i_2)^{\psi}}{1+i_2^*}\right)^{\frac{1}{\sigma}} + b_{1,j}^* - y_{2,j}^T \tag{26}$$

In the case where households are saving in dollars ($a_3^* < 0$) an increase in the

also the models of Gertler and Karadi (2011), Adrian and Shin (2014), and Vayanos and Vila (2021). This is also reminiscent of Drechsler, Savov and Schnabl (2017)., who present a model with market power in deposit markets. They show that when the Fed funds rate rises, banks widen the spreads they charge on deposits. Appendix C shows that this relation holds in a sample of countries where the interest rate on savings in dollars is available in the IFS database.

domestic rate $i_{2,j}$ makes it more costly to save, reducing the size of dollar savings and thus decreasing the absolute magnitude of capital outflows.

This functional form allows for a description of the optimal domestic policy rate in closed form. This is fleshed out in the following lemma.

Lemma 2 (Optimal Monetary Policy with an Endogenous Financial Wedge)**.** *With a financial wedge as posited in equation* (23)*, optimal monetary policy above the threshold* $\tilde{b}^*$ *is now given by:*

$$1 + i_2^{opt} = \Omega_\psi \left(\frac{b_1^*(1 + i_2^*)}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma - 1 + \sigma\psi}} \tag{27}$$

with a coefficient defined by:

$$\Omega_\psi = \left(\sigma(1 + \psi)\rho\kappa\bar{\varpi}\beta^{\frac{1-\sigma\psi}{\sigma}} \right)^{\frac{\sigma}{2\sigma - 1 + \sigma\psi}} \tag{28}$$

Equation (27) quantifies how the ψ friction modifies the optimal interest rate implemented by the central bank. When ψ is higher, the response of the central bank to any change in dollar debt b_1^* or U.S. interest rate i_2^* is inhibited compared to the frictionless case. Indeed, because of intermediation frictions a rise in the interest rate helps appreciates the currency through two independent channels: first through the usual expenditure switching mechanism, and second through the spreads charged by banks that makes it less attractive to save in dollars and thus reduces capital outflows.

4.5 Congestion Externalities

We are now ready to develop the main result of this paper. The intuition for this result comes from the juxtaposition of the four main equilibrium conditions, linking the Fed policy rate to the domestic policy rate of each emerging economy:

$$i_2^* = i_2^{\$} + \frac{\int_j \frac{a_{3,j}^*}{1 + \hat{i}_{2,j}^*} dj}{\gamma} \tag{29}$$

$$\frac{a_{3,j}^*}{1 + \hat{i}_{2,j}^*} = \left(\frac{\beta\phi}{1 + \hat{i}_{2,j}^*} \right)^{\frac{1}{\sigma}} + b_{1,j}^* - y_{2,j}^T \tag{30}$$

$$1 + \hat{i}_{2,j}^* = (1 + i_2^*)(1 + i_{2,j})^{-\psi} \tag{31}$$

$$1 + i_{2,j} = \Omega_\psi \left(\frac{b^*_{1,j}(1+i^*_2)}{s-\rho_0} \right)^{\frac{\sigma(1+\psi)}{2\sigma(1+\psi)-1}} \tag{32}$$

The first equation, (29), links the U.S. domestic rate to the world interest rate charged by global arbitrageurs give the aggregate size of capital flows. The second equation, (30), gives the size of the flows given the interest rate charged by domestic banks. The third equation, (31), links this rate offered by domestic banks to the financial wedge and the domestic rate of the emerging economy. The final equation (32) links the domestic policy rate to the world interest rate by trading-off balance sheet effects and aggregate demand.

A shock to the U.S. domestic policy rate then transmits through EMEs by trickling up these equilibrium conditions. The central bank from the emerging economy increases its domestic policy rate to counter depreciationary pressures and balance sheet effects, and attract more capital inflows as a result. This change in global capital flows, if happening in all small emerging economies at the same time, increases the world interest rate because of frictions in international financial markets. This feeds back into domestic conditions by creating further depreciationary pressures in emerging economies, requiring another round of tightening. At the heart of this feedback is an externality: individual emerging countries do not internalize that they their domestic policy rate decisions have spillovers and impact the equilibrium determination of the world interest rate i^*_2.

Proposition 2 (Monetary Policy Spillovers)**.** *Individual central banks in emerging economies do not internalize that their domestic decisions spill over to the equilibrium determination of the world interest rate:*

$$\mathscr{C}(i_2, i^*_2) = \frac{d\ln(1+i^*_2)}{d\ln(1+i_2)} = \psi \frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}} \frac{(1+i^*_2)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}} + 1} \tag{33}$$

The result in Proposition 2 highlights why the two frictions on the international financial market are necessary to create spillovers. Fist, if $\psi = 0$, then changes in the domestic rate do not impact the world interest rate since global capital flows are constant. Second, if $\gamma = +\infty$, global arbitrageurs do not face intermediation costs and changes in flows do not impact the world interest rate. It is the combination of those two ingredients that yield the spillover result, and create a need for coordination.[21]

Proposition 3 (Coordinated Monetary Policy)**.** *A Social Planner that coordinates monetary policy across emerging economies implements a lower interest rate than in the decentralized case, and the difference between the two interest rates is exactly quantified by the congestion externality:*

$$1 + i_2^{SP} = \Omega_\psi \left(\frac{b_1^*(1+i_2^*)}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma - 1 + \sigma\psi}} \left(1 - \frac{1}{1+\psi} \mathscr{C}(i_2^{SP}, i_2^*) \right)^{\frac{\sigma}{2\sigma - 1 + \sigma\psi}} \tag{34}$$

Employment and output are higher in each emerging country in the coordinated equilibrium than in the un-coordinated one.

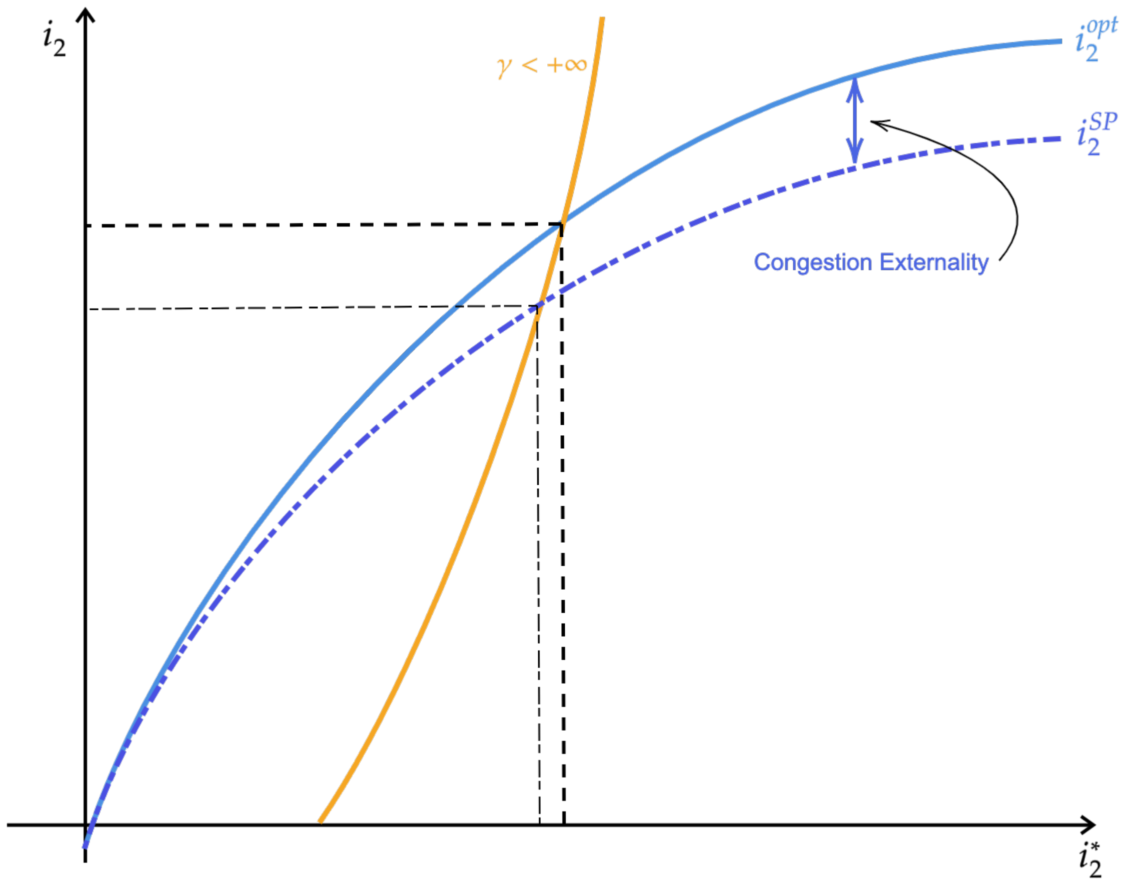
This proposition and its implications for the global equilibrium can be understood graphically on Figure 6. This Figure pictures the best responses of central banks in the uncoordinated and coordinated equilibria. The difference between the two is the congestion externality highlighted above. The equilibrium is at the intersection of central banks' best response, and the "γ locus" that traces the relation between the world interest rate and the individual domestic rates in emerging countries, given the intermediation friction given by equation (30). By internalizing how their capital inflow will create congestion and result in a higher world interest rate, central bank in the coordinated equilibrium raise rates by less (in proportion to the externality in Proposition 2) which leads to less depreciation, and an equilibrium with higher employment and output.

4.6 Discussion of Results

Because the model presented here is stylized and has many moving parts, it is useful to detail which assumptions matter and which do not matter for the results. The conceptual point made in this paper is straightforward: if several countries have to respond optimally to a tightening of the Fed funds rate by tightening their own domestic policy rates in order to appreciate their currencies, then pecuniary spillovers arise between these countries if two conditions are met: (i) increasing their policy rate results in a capital inflow ; and (ii) global financial markets are frictional, such that the size of aggregate capital flows determines the interest rate

[21] Appendix B.1 studies a version of the model where $\psi = 0$, but preferences are non-separable. This way, changes in the domestic rate still affect capital flows. Proposition 7 in the appendix derives a similar expression for the congestion externality of Proposition 2 in this non-separable case.

Figure 6: Coordinated and Uncoordinated Equilibria. The blue line is the individual best response of an individual central bank for a given world interest rate i_2^*. The dashed blue line is the best response of central banks taking into account the effect of their rate setting on aggregate capital flows and the resulting world interest rate. The orange line depicts the world interest rate determination for a given $\gamma < +\infty$.



at which these countries can finance themselves. In this paper, the synchronization of policy rates arises because of the presence of dollar debt on the balance sheet of corporations, but this is of course not the only way to arrive at such a result.[22] Condition (i) is generally true in conventional models with non-separable preferences. In this paper, I used separable preferences for tractability but this property holds true because of domestic banks intermediating dollar savings. Condition (ii) is met when global arbitrageurs view capital flows from different symmetric SOEs as substitutes. This condition would then not be satisfied if one were to write a model where markets are segmented *between* symmetric SOEs. For instance, if we assume that each country faces a different arbitrageurs that has costs of intermedi-

[22]The results of Section 5, however, rest on the presence of dollar debt as the source of this policy problem.

ation, each country would face a different interest rate $i^*_{2,j}$ determined by its own capital flows, but would not create spillovers on the interest rate faces by other countries.

5 Excessive Dollar Debt Issuance and Macroprudential Policy

Taking stock, the previous section derived the welfare implications of having an outstanding level of dollar debt b^*_1 on the balance sheet of entrepreneurs. This level, however, is the result of a maximization problem by the same entrepreneurs at $t = 1$. The goal of this section is to characterize the equilibrium level of dollar debt issuance, as well as the policy options at $t = 1$, when the central bank cannot commit to only target inflation at $t = 2$.

5.1 The economy at $t = 1$

Supply of Funds Entrepreneurs must issue debt to finance an investment of fixed size, K_1. They can either issue in local currency or in dollars.[23] Various papers in the literature have proposed theories that explain why firms issue in dollars, exposing themselves to a currency mismatch (McKinnon and Pill 1998 ; Burnside et al. 2001 ; Schneider and Tornell 2004 ; Caballero and Krishnamurthy 2003 ; Jeanne 2002 ; Bocola and Lorenzoni 2020). I remain agnostic about the underlying mechanism as my work focuses on the global consequences for monetary policy and the GFC. As such, I use a linear supply of funds for both peso and dollar liabilities (Bianchi and Lorenzoni 2021):

$$\frac{b^*_1}{1 + \hat{i}^*_1} = \omega^*(\hat{i}^*_1 - i^*_1) \quad \text{and} \quad \frac{b_1}{1 + \hat{i}_1} = \omega(\hat{i}_1 - i_1) \tag{35}$$

To issue b^*_1 in dollars, investors need to compensate lenders with a premium over the dollar interest rate, promising a rate of $\hat{i}^*_1$ that is linearly increasing with the size of b^*_1. Similarly, entrepreneurs issue b_1 in pesos, compensating lenders with a premium over the domestic interest rate, $\hat{i}_1$. The slopes are respectively ω^* and ω.

[23] Markets are thus assumed to be exogenously incomplete. A recent literature has documented that firms engage in limited hedging, see e.g. Alfaro, Calani and Varela (2023) and Jung et al. (2021).

Issuance Entrepreneurs then issue debt to minimize repayments, taking into account the equilibrium exchange rate at $t = 2$, e_2:

$$\min_{b_1, b_1^*} \quad b_1 + e_2 b_1^* \tag{36}$$

$$\text{s.t.} \quad \frac{b_1}{1+\hat{i}_1} + \frac{e_1 b_1^*}{1+\hat{i}_1^*} = K_1 \tag{37}$$

We ignore in the rest of the paper knife-edge cases where all issuance is done in only one currency.[24] Taking as given the interest rates on peso and dollar debt, the optimal amount issued in dollars by entrepreneurs is characterized in the following lemma.

Lemma 3 (Dollar Debt Issuance)**.** *The amount of dollar debt that needs to be paid back at $t = 2$ is given by:*

$$b_1^* = \omega^* \frac{K_1 + e_1 \omega^* (1 + i_1^*) + \omega(1 + i_1)}{\left(\omega \frac{e_2}{e_1} + e_1 \omega^*\right)^2} \left(K_1 + \omega \left(1 + i_1 - \frac{e_2}{e_1}(1 + i_1^*)\right)\right) \tag{38}$$

This expression is intuitive: entrepreneurs issue up to the point where they pay the same interest rate for both type of debt. Accordingly, they issue more in dollars when they expect a stronger currency next period (low e_2). For completeness, the following lemma provides the equilibrium interest rates charged on domestic currency and foreign currency debt.

Lemma 4. *The equilibrium interest rates are given by:*

$$1 + \hat{i}_1 = \frac{K_1 + \omega(1 + i_1) + e_1 \omega^* (1 + i_1^*)}{\omega + e_1 \omega^* \frac{e_1}{e_2}} \tag{39}$$

and:

$$1 + \hat{i}_1^* = \frac{K_1 + e_1 \omega^* (1 + i_1^*) + \omega(1 + i_1)}{\omega \frac{e_2}{e_1} + e_1 \omega^*} \tag{40}$$

Remark 1. Although I used the same class of financial frictions at time $t = 1$ and $t = 2$, their modeling purpose is entirely different. In the initial period where firm make their currency issuance choices, the point of the ω friction is to avoid corner

[24] It is immediate to characterize the equilibrium when we are in such corner solutions. If all debt is issued in peso, monetary policy does not face a trade-off at $t = 2$ in response to a Fed tightening, and so there are no congestion externalities or need for macroprudential policies. If all issuance is done in dollars, the social planner can only mitigate the previous externalities by discouraging dollar issuance so much that we are back to an interior solution, which is what we study here.

solutions such that firms are indifferent on the margin between issuing in dollars or in domestic currency. In the second period, the γ friction serves to introduce strategic complementarities in the actions of small countries: aggregate flows drive the wedge between i_2^* and the U.S. domestic policy rate.

5.2 Externalities when Global Financial Markets are Frictionless

We start by studying the externalities associated with dollar debt issuance when global financial markets are frictionless at time $t = 2$, i.e. when $\gamma = \infty$. When this is the case, the size of individual capital flows have no impact on the determination of the world interest rate. Hence, the amount of debt issued by an EME will tie the hand of its domestic central bank, but will not have an impact on the policies of *other* EMEs.

The presence of issuance externalities can be simply understood by writing jointly the two key equilibrium relations of the model: first, the level of dollar debt issuance as a function of e_2, the exchange rate at $t = 2$. And second, the optimal response of the central bank at $t = 2$ given the size of dollar debt to be repaid by entrepreneurs.

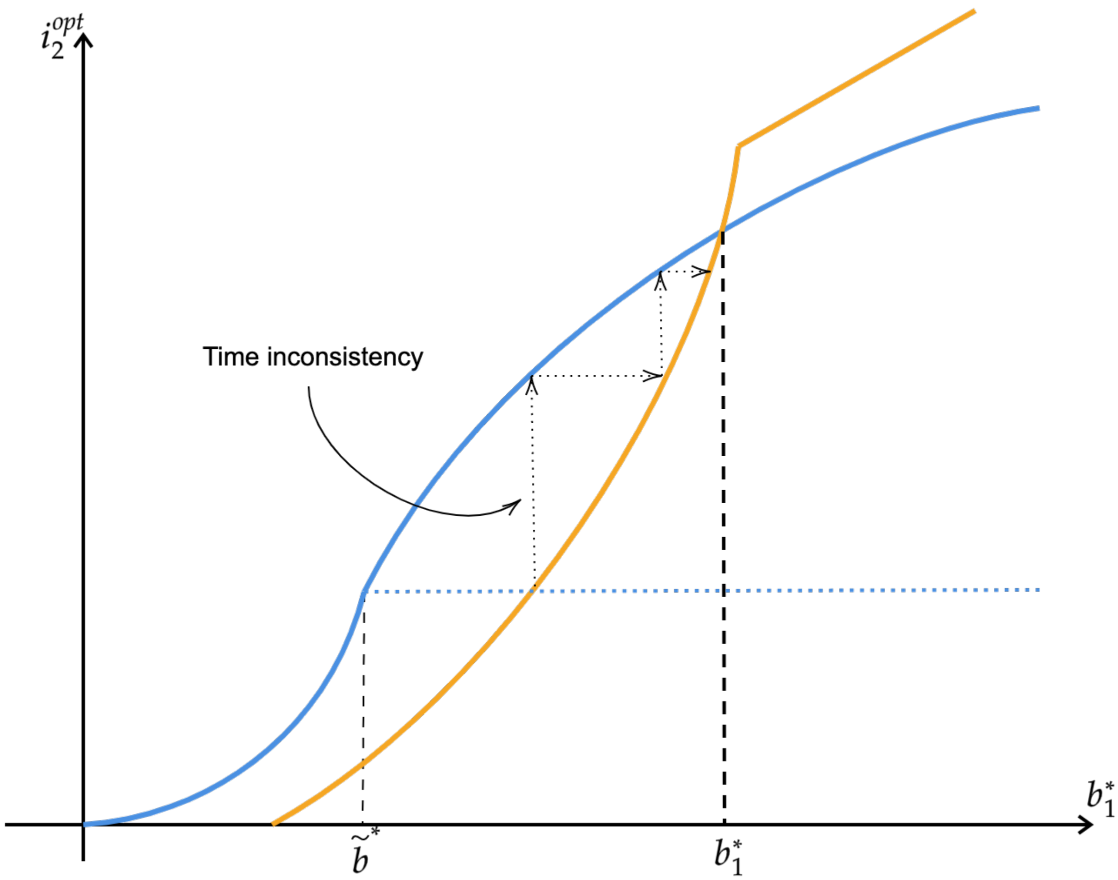
$$b_1^* = \omega^* \frac{K_1\big(K_1 + \omega^* e_1(1+i_1^*) + \omega(1+i_1)\big)}{\left(\omega \frac{e_2^{opt}}{e_1} + e_1\omega^*\right)^2} \tag{41}$$

$$e_2^{opt} = \frac{\Big((1+i_2^{\$})^{\sigma-1+\sigma\psi}(s-\rho_0)^{\sigma}\Big)^{\frac{1}{2\sigma-1+\sigma\psi}}}{\Omega_\psi} b_1^{*\,-\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{42}$$

The amount of foreign debt that needs to be repaid at $t = 2$ is clearly a decreasing function of the exchange rate e_2^{opt} implement by the central bank. This is because a higher interest rate at $t = 2$ appreciates the currency, which makes it more attractive to issue in dollar. Conversely, as we demonstrated earlier, the optimal exchange rate at $t = 2$ is also a decreasing function of b_1^*: the more foreign debt outstanding there is in the economy, the stronger the incentive for the central bank to appreciate the currency in order to allow entrepreneurs to finance their productive investment more easily. The equilibrium determination of b_1^* is depicted in Figure 7.[25]

[25] As is apparent in Figure 1, we can find parameters such that the issuance at $t = 1$ exhibits multiple

Figure 7: Equilibrium Dollar Debt Issuance



An intuitive way to understand the time inconsistency problem faced by the central bank is to look at the blue dashed line in Figure 7. This line represents the hypothetical case where the central bank tries to commit to implement at time $t = 2$ a domestic rate that would be consistent with full employment for the threshold level of debt $\tilde{b}^*$. But even if entrepreneurs believe that this policy rate will be implemented, they still choose an equilibrium dollar debt level higher than this $\tilde{b}^*$. When time $t = 2$ comes, it is then optimal for the central bank to deviate from that planned interest rate, as can be seen from the dotted arrow going up to the line tracing the optimal policy rate, leading to an equilibrium with potentially large

equilibria. This will happen if strategic complementarities are strong enough: if everyone expects the central bank to tighten strongly in the future, all debt will be issued in dollars and the central bank will have to tighten aggressively. And if everyone expects the central bank to implement full employment, all issuance will be in peso and the central bank will find it optimal to implement full employment. This possibility has been studied by Chang and Velasco (2006), which is why we focus here on the case where the equilibrium is unique. Coppola et al. (2023) also propose a theory with equilibrium multiplicity, where issuing in dollars endogenously raises the liquidity of dollar assets, incentivizing more issuance in dollars.

unemployment.

Proposition 4 (Dollar Debt Issuance Externalities)**.** *Entrepreneurs do not internalize that issuance denominated in dollars has a pecuniary effect on future interest rates, which then reduce aggregate demand in equilibrium. This uninternalized effect is quantified by the following expression:*

$$\frac{dl_2}{db_1^*} = -\frac{c_2^N}{b_1^*(2\sigma - 1 + \sigma\psi)} \tag{43}$$

This proposition simply quantifies the equilibrium employment losses caused by an increase in foreign currency debt issued by entrepreneurs.

5.3 Optimal Macroprudential Policy

Making entrepreneurs internalize these externalities can be achieved through a simple tax on dollar debt issuance, whose proceeds are rebated lump-sum to entrepreneurs. It is important to notice, however, that such a policy has a cost: entrepreneurs optimally issue debt in dollars up to the point where the interest rates are equalized. As such, forcing entrepreneurs to issue more in domestic currency will automatically result in a more expensive cost of debt, and hence in smaller net worth in period $t = 2$.

To see this, express by τ the tax imposed on dollar debt issuance. The maximization program of entrepreneurs is now given by:

$$\min_{b_1, b_1^*} \quad b_1 + e_2 b_1^* \tag{44}$$

$$\text{s.t.} \quad \frac{b_1}{1+\hat{i}_1} + \frac{e_1 b_1^*}{1+\hat{i}_1^*}(1-\tau) + T = K_1 \tag{45}$$

where T is the tax rebate. The following lemma provides the resulting equilibrium expressions.

Lemma 5 (Issuance with Macroprudential Policy)**.** *The amount of dollar debt that needs to be paid back at $t = 2$ is given by:*

$$b_1^* = \omega^* \frac{K_1 + e_1\omega^*(1+i_1^*) + \omega(1+i_1) - \tau\omega\frac{e_2}{e_1}}{\left(\omega\frac{e_2}{e_1} + e_1\omega^*\right)^2} \left(K_1 + \omega\left(1 + i_1 - \frac{e_2}{e_1}(1 + i_1^* + \tau)\right)\right) \tag{46}$$

which is decreasing in τ, while the peso debt to pay back is:

$$b_1 = \omega \frac{K_1 + \omega(1+i_1) + e_1\omega^*(1+i_1^*) + \tau e_1 \omega^* \frac{e_1}{e_2}}{\left(\omega + e_1\omega^* \frac{e_1}{e_2}\right)^2} \left(K_1 + e_1\omega^* \left(1 + i_1^* - \frac{e_1}{e_2}(1 + i_1 - \tau)\right)\right) \tag{47}$$

which is increasing in τ.

Proposition 5 (Macroprudential Trade-off)**.** *The optimal tax on dollar issuance lowers the amount issued in dollars, b_1^*, such that:*

$$\frac{1-\phi}{2\sigma - 1 + \sigma\psi} \left(\beta\Omega_\psi \left(\frac{1+i_2^\$}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}}\right)^{-\frac{1-\sigma}{\sigma}} (b_1^*)^{-\sigma\frac{1+\psi}{2\sigma-1+\sigma\psi}} = \frac{\beta\rho\kappa}{s-\rho_0}\frac{dn_2}{db_1^*} \tag{48}$$

The left hand side of this expression encodes the benefits of a lower debt in dollars: less forced to resist the depreciation of its currency, the central bank can hike less and thus stay closer to full employment. The right hand side expresses the other side of the trade-off: by discouraging dollar debt issuance, the social planner makes it more expensive for entrepreneurs to issue debt in general, resulting in lower net worth and thus lower investment in productive capital.

Consistent with these results, Bergant, Grigoli, Hansen and Sandri (2020) empirically show that tighter macroprudential regulation allows monetary policy in EMEs to respond more countercyclically to global financial shocks, but do not find evidence that capital controls provide similar benefits. Through the lens of my model, this is because the externalities constraining the central banks are rooted in the presence of dollar debt on private balance sheets, which in itself is orthogonal to the question of whether capital inflows are excessive.

5.4 Macroprudential Policies on the Global Scale

We can now flesh out the final result of this paper. In the full model with a continuum of EMEs and frictional global financial markets, what are the impact of these macroprudential policies? The main insight of this section is that, while monetary policy has negative spillovers on other EMEs, macroprudential policies aimed at reducing dollar debt issuance (b_1^*) have *positive* spillovers. As such, the implementation of these spillovers do not require coordination between EMEs, and dampen the coordination problems of central banks. The following proposition expresses how a change in the tax on dollar issuance spills over to the determination of the world interest rate.

Proposition 6 (Macroprudential Policy Spillovers)**.** *Individual policymakers in emerging economies do not internalize that their tax on dollar debt issuance spill over to the equilibrium determination of the world interest rate:*

$$\frac{d\ln(1+i_2^*)}{d\tau} = \psi\frac{\sigma(1+\psi)}{2\sigma(1+\psi)-1}\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}}\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}}+1}\frac{d\ln(b_1^*)}{d\tau} \tag{49}$$

Lowering b_1^* through the use of macroprudential policies ex-ante automatically allows the central bank to hike less at $t=2$. As we have seen previously, by tightening less the EME attracts less capital flows, reducing the premium that global intermediaries require as compensation. This marginally lowers the world interest rate when implemented on a global scale, reducing the depreciationary pressures that each central bank is trying to fight. By implementing macroprudential policies aimed at lowering the amount of corporate debt issued in dollar, each country ameliorates the trade-off that all central banks face in the future.

6 Conclusion

This paper shows that the presence of dollar debt in emerging markets has profound normative and positive implications, not only for individual emerging markets themselves, but also for the global financial system. The presence of dollar debt makes all central banks acting in the same direction when the Federal Reserve changes its interest rates. The key result of this paper is that this in turn initiates congestion externalities, since all central banks seek to maximize capital inflows in order to appreciate their currency, at the expense of other countries. This leads to inefficiently high interest rates in emerging economies, and inefficiently low levels of employment, highlighting the need for coordination amongst central banks in the face of the Global Financial Cycle. Finally, I showed that the anticipation of this (then optimal) behavior by individual central banks encourages even more dollar debt issuance in emerging countries, amplifying the Global Financial Cycle and worsening central banks' dilemma. Macroprudential policy, by discouraging dollar issuance and encouraging issuance in other currencies, can be used to counter this issuance externality and has positive spillovers on the rest of the world, dampening the global financial cycle and relaxing the coordination problem faced by individual central banks when the Fed tightens its policy rate.

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A Proofs and Derivations

A.1 Equilibrium at $t = 2$

$$U_2 = \frac{1}{1-\sigma}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right) + \beta\left(c_3^N + c_3^T\right) \tag{A.1}$$

and call the consumption index C_2: $C_2 = \phi^\eta (c_2^T)^{1-\sigma} + (1-\phi)^\eta (c_2^N)^{1-\sigma}$.

Budget constraints (and Lagrange Multipliers):

$$p_2^T c_2^T + p_2^N c_2^N = e_2 y_2^T + w_2 l_2 + \Pi_2 + \frac{1}{1+i_2} a_3 + \frac{1}{1+i_2^*} e_2 a_3^* \qquad (\lambda_2) \tag{A.2}$$

$$p_3^N c_3^N + p_3^T c_3^T + a_3 + e_3 a_3^* = p_3^T y_3^T + \bar{w}\bar{l} + \Pi_3 \qquad (\lambda_3) \tag{A.3}$$

with $p_t^T = e_t$ and $p_t^N = \bar{w}$. First-order conditions for households are:

$$\frac{\lambda_2}{1+i_2} = \beta\lambda_3 \tag{A.4}$$

$$\frac{\lambda_2}{1+i_2^*} e_2 = \beta\lambda_3 e_3 \tag{A.5}$$

$$\phi(c_2^T)^{-\sigma} = \lambda_2 p_2^T \tag{A.6}$$

$$(1-\phi)(c_2^N)^{-\sigma} = \lambda_2 p_2^N \tag{A.7}$$

$$1 = \lambda_3 p_3^N \tag{A.8}$$

$$1 = \lambda_3 p_3^T \tag{A.9}$$

which can be used to write non-tradable demand as:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{p_2^N}{p_2^T}\right)^{-1/\sigma} c_2^T = \left(\frac{\phi}{1-\phi}\frac{\bar{w}}{e_2}\right)^{-1/\sigma} c_2^T \tag{A.10}$$

The savings/borrowing decisions in peso and dollar yield the standard UIP condition since there is no uncertainty:

$$1 + i_2 = (1 + i_2^*)\frac{e_3}{e_2} \tag{A.11}$$

Using the fact that the price of tradables is equal to the exchange rate, and that the price of non-tradables is the wage since firms are perfectly competitive, we have the following demand function for non-tradables:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{w_2}{e_2}\right)^{-1/\sigma} c_2^T \tag{A.12}$$

and plugging the UIP condition:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{(1+i_2)w_2}{(1+i_2^*)e_3}\right)^{-1/\sigma} c_2^T \tag{A.13}$$

which shows how monetary policy can shift demand between T and NT.

A.2 Market clearing

Market clearing coupled with the linear production function for non-tradable goods imply that:

$$c_2^N = l_2 + \eta_2 K_1 - sK_2 - \frac{b_1}{\bar{w}} \tag{A.14}$$

Since households cannot lend to entrepreneurs, we must have $a_3 = 0$ (0 net supply of peso bonds for households). Unproductive entrepreneurs rebate profits to households equal to:

$$\Pi_2 = \bar{w}\eta_2 K_1 - (b_1 + e_2 b_1^*) - \bar{w}sK_2 \tag{A.15}$$

such that the budget constraint of households at $t = 2$ implies:

$$e_2 c_2^T = e_2 y_2^T - e_2 b_1^* + \frac{1}{1+i_2^*} e_2 a_3^* \tag{A.16}$$

Given the relation between the consumption of tradables and non-tradables, and the market clearing relation, this determines the amount of foreign borrowing by households:

$$\frac{1}{1+i_2^*} e_2 a_3^* = e_2 \left(-y_2^T + b_1^* + \left(\frac{\phi}{1-\phi}\frac{\bar{w}}{e_2}\right)^{1/\sigma} \left(l_2 + \eta_2 K_1 - sK_2 - \frac{b_1}{\bar{w}} \right) \right) \tag{A.17}$$

with a capital stock of:

$$K_2 = \kappa \frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s - \rho_0} \tag{A.18}$$

and the consumption level of tradables in the final period:

$$c_3^T = y_3^T - a_3^* \tag{A.19}$$

A.3 Proof of Proposition 1

We start by characterizing how a change in the interest translates into higher production through aggregate demand. Using the same condition as for the full employment interest rate, we get by differentiating in logs and approximating for i close enough to 0:

$$\frac{dc_2^N}{di_2} = \frac{dl_2}{di_2} - s\frac{dK_2}{di_2} = -\frac{c_2^N}{\sigma} \tag{A.20}$$

while at the same time, as long as entrepreneurs are constrained, capital moves according to:

$$\frac{dK_2}{di_2} = \frac{e_2 \kappa b_1^*}{s - \rho_0} \tag{A.21}$$

through the appreciation of the currency and the UIP condition. Aggregate demand thus follows:

$$\frac{dl_2}{di_2} = -\frac{c_2^N}{\sigma} + s\kappa\frac{e_2 b_1^*}{s - \rho_0} \tag{A.22}$$

The first part of this expression is the usual aggregate demand channel. The second part comes from the crowding out of aggregate demand by entrepreneurs that use non-tradables good as an input to maintain their existing stock of capital.

The impact of i_2 on the consumption of non-tradables at time $t = 3$ is straightforward (no rigidities):

$$\frac{dc_3^N}{di_2} = \rho\frac{dK_2}{di_2} = \rho\kappa\frac{e_2 b_1^*}{s - \rho_0} \tag{A.23}$$

We are now ready to study the optimization of the planner. The problem of the central bank can thus be written as:[26]

$$\max_{l_2, e_2} \frac{1-\phi}{1-\sigma}\left(l_2 + \eta_2 K_1 - s\kappa\frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s - \rho_0} - \frac{b_1}{\bar{w}}\right)^{1-\sigma}$$

[26]Using the envelope theorem and separable preferences, monetary policy will not impact welfare when it comes to tradable consumption.

$$+\beta\left(\bar{l}+\rho\kappa\frac{\eta_2 K_1-b_1-e_2 b_1^*}{s-\rho_0}\right) \quad \text{(A.24)}$$

with the constraints:

$$l_2 \leq \bar{l} \quad \text{(A.25)}$$

$$l_2+\eta_2 K_1-s\kappa\frac{\eta_2 K_1-b_1-e_2 b_1^*}{s-\rho_0}-\frac{b_1}{\bar{w}}=\left(\frac{e_2}{\beta\bar{w}(1+i_2^*)}\right)^{\frac{1}{\sigma}} \quad \text{(A.26)}$$

Let us denote by ν the Lagrange multiplier associated with the slackness condition (A.25), and ϵ the Lagrange multiplier on (A.26). Maximization implies:

$$(1-\phi)(c_2^N)^{-\sigma}=\nu+\epsilon \quad \text{(A.27)}$$

and

$$(1-\phi)\frac{s\kappa b_1^*}{s-\rho_0}(c_2^N)^{-\sigma}-\beta\rho\kappa\frac{b_1^*}{s-\rho_0}= \epsilon\left(\frac{s\kappa b_1^*}{s-\rho_0}-\frac{1}{\sigma\beta\bar{w}(1+i_2^*)}\left(\frac{e_2}{\beta\bar{w}(1+i_2^*)}\right)^{\frac{1}{\sigma}-1}\right) \quad \text{(A.28)}$$

Replacing this value for ϵ in the first condition yields:

$$(1-\phi)\left(c_2^N\right)^{-\sigma}=\nu+\frac{(1-\phi)\left(c_2^N\right)^{-\sigma}-\beta\rho}{1-\frac{s-\rho_0}{\sigma s\kappa\beta\bar{w}b_1^*(1+i_2^*)}(\beta(1+i_2))^{\frac{\sigma-1}{\sigma}}} \quad \text{(A.29)}$$

If we are away from full employment, then $l_2<\bar{l}$, and hence $\nu=0$ which leads to:

$$(1-\phi)\left(c_2^N\right)^{-\sigma}\frac{s-\rho_0}{\sigma s\kappa\beta\bar{w}b_1^*(1+i_2^*)}(\beta(1+i_2))^{\frac{\sigma-1}{\sigma}}=\beta\rho \quad \text{(A.30)}$$

Next, use the optimality condition:

$$(1-\phi)\left(c_2^N\right)^{-\sigma}=\beta(1+i_2) \quad \text{(A.31)}$$

to finally get:

$$(\beta(1+i_2))^{\frac{2\sigma-1}{\sigma}}=\frac{\beta\rho}{\frac{s-\rho_0}{\sigma s\kappa\beta\bar{w}b_1^*(1+i_2^*)}} \quad \text{(A.32)}$$

So that the optimal interest rate is given by:

$$1 + i_2^{opt} = \beta^{\frac{1}{2\sigma-1}} \left(\frac{\rho s \sigma \kappa \bar{w} b_1^*(1+i_2^*)}{s-\rho_0} \right)^{\frac{\sigma}{2\sigma-1}} \tag{A.33}$$

where there is an increasing relationship between the level of dollar debt and the optimal interest rate. Define Ω as:

$$\Omega = \left(\sigma \rho \kappa \bar{w} \beta^{1/\sigma} \right)^{\sigma/(2\sigma-1)} \tag{A.34}$$

to end up with:

$$1 + i_2^{opt} = \Omega \left(\frac{b_1^*(1+i_2^*)}{s-\rho_0} \right)^{\frac{\sigma}{2\sigma-1}} \tag{A.35}$$

These calculations were valid only under the case where $\nu = 0$. When this is not satisfied, there is full employment and a change in the interest rate has no effect on the amount of labor supplied by households. That case is then equivalent to maximizing:

$$\max_{e_2} \frac{1-\phi}{1-\sigma} \left(\bar{l} + \eta_2 K_1 - s\kappa \frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0} - \frac{b_1}{\bar{w}} \right)^{1-\sigma} + \beta \left(\bar{l} + \rho\kappa \frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0} \right) \tag{A.36}$$

which leads to the following first-order condition:

$$\kappa \frac{b_1^*}{s-\rho_0} = s(1-\phi) \left(\bar{l} + \eta_2 K_1 - s\kappa \frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0} - \frac{b_1}{\bar{w}} \right)^{-\sigma} - \beta\rho \tag{A.37}$$

Isolating e_2 from this expression yields:

$$e_2^{full} = (s-\rho_0) \frac{\left(\frac{\kappa \frac{b_1^*}{s-\rho_0} + \beta\rho}{s(1-\phi)} \right)^{-\frac{1}{\sigma}} - \bar{l} - \eta_2 K_1 + \frac{b_1}{\bar{w}} + \frac{s\kappa}{s-\rho_0}(\eta_2 K_1 - b_1)}{s\kappa b_1^*} \tag{A.38}$$

which leads to the optimal domestic interest rate in the full employment case using the UIP condition:

$$1 + i_2^{full} = \frac{(1+i_2^*)\bar{w}}{e_2^{full}} \tag{A.39}$$

Finally, the regime-switching occurs when the two conditions intersect. When this is the case, there is full employment but agents are still against their Euler equation, hence:

$$\kappa \frac{b_1^*}{s-\rho_0} + \beta\rho = s(1-\phi)\left(c_2^N\right)^{-\sigma} \tag{A.40}$$

$$= s\beta(1+i_2) \tag{A.41}$$

$$= s\beta\Omega\left(\frac{b_1^*(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1}} \tag{A.42}$$

This equation has up to two solutions since $\sigma \geq 1$. We restrain ourselves to the case where there is only one solution (which only requires an assumption on the size of K_1: we want the second solution to be for greater foreign debt than if all initial investment in K_1 was made in foreign debt). □

A.4 Proof of Lemma 1

Recall that consumption of tradables is given by the following expression for each country j:

$$c_{2,j}^T = \left(\frac{\phi}{1-\phi}\frac{1+i_2}{1+i_2^*}\right)^{\frac{1}{\sigma}} c_{2,j}^N \tag{A.43}$$

where we can replace NT consumption with the level of domestic rates:

$$c_{2,j}^T = \left(\frac{\phi}{1-\phi}\frac{1+i_2}{1+i_2^*}\right)^{\frac{1}{\sigma}} \left(\frac{1+i_2}{(1-\phi)\beta}\right)^{-\frac{1}{\sigma}} \tag{A.44}$$

Combining this with the market clearing expression for foreign debt (A.16):

$$\frac{1}{1+i_2^*} a_{3,j}^* = \left(\beta\phi\frac{1}{1+i_2^*}\right)^{\frac{1}{\sigma}} + b_{1,j}^* - y_{2,j}^T \tag{A.45}$$

And finally using the rate determination from global arbitrageurs (18):

$$i_2^* = i_2^\$ + \gamma^{-1}\left(\left(\beta\phi\frac{1}{1+i_2^*}\right)^{\frac{1}{\sigma}} + b_1^* - y_2^T\right) \tag{A.46}$$

□

A.5 Proof of Lemma 2

We neglect the country subscript j for this part. Taking the financial wedge into account, the link between the domestic policy rate and the exchange rate is now given by:

$$(1+i_2) = \left((1+i_2^*)\frac{\bar{\omega}}{e_2}\right)^{\frac{1}{1+\psi}} \tag{A.47}$$

which is convenient for the aggregate demand condition using the interest rate since:

$$(1+i_2)^{-\frac{1}{\sigma}} = \left((1+i_2^*)\frac{\bar{\omega}}{e_2}\right)^{-\frac{1}{\sigma(1+\psi)}} \tag{A.48}$$

Going back to the optimal policy program, we can now write it as:

$$\max_{l_2,e_2} \frac{1-\phi}{1-\sigma}\left(l_2+\eta_2 K_1 - s\kappa\frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0} - \frac{b_1}{\bar{\omega}}\right)^{1-\sigma} + \beta\left(\bar{l}+\rho\kappa\frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0}\right) \tag{A.49}$$

with the constraints:

$$l_2 \leq \bar{l} \tag{A.50}$$

$$l_2+\eta_2 K_1 - s\kappa\frac{\eta_2 K_1 - b_1 - e_2 b_1^*}{s-\rho_0} - \frac{b_1}{\bar{\omega}} = \left(\frac{e_2}{\beta\bar{\omega}(1+i_2^*)}\right)^{\frac{1}{\sigma(1+\psi)}} \tag{A.51}$$

Thanks to this functional form, the resolution of the optimal policy problem is almost identical. A few steps of algebra yield the first-order condition:

$$(1-\phi)\left(c_2^N\right)^{-\sigma}\frac{s-\rho_0}{\sigma(1+\psi)s\kappa\beta\bar{\omega}b_1^*(1+i_2^*)}(\beta(1+i_2))^{\frac{\sigma(1+\psi)-1}{\sigma}} = \beta\rho \tag{A.52}$$

Next, use the optimality condition:

$$(1-\phi)\left(c_2^N\right)^{-\sigma} = \beta(1+i_2) \tag{A.53}$$

to finally get:

$$(\beta(1+i_2))^{\frac{2\sigma-1}{\sigma}+\psi} = \frac{\beta\rho}{\frac{s-\rho_0}{\sigma(1+\psi)s\kappa\beta\bar{\omega}b_1^*(1+i_2^*)}} \tag{A.54}$$

So that the optimal interest rate is given by:

$$1 + i_2^{opt} = \beta^{\frac{2\sigma}{2\sigma-1+\sigma\psi}-1} \left(\frac{\rho s \sigma (1+\psi) \kappa \bar{w} b_1^* (1+i_2^*)}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.55}$$

where there is an increasing relationship between the level of dollar debt and the optimal interest rate. Define Ω_ψ as:

$$\Omega_\psi = \left(\sigma(1+\psi) \rho \kappa \bar{w} \beta^{\frac{1-\sigma\psi}{\sigma}} \right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.56}$$

to end up with:

$$1 + i_2^{opt} = \Omega_\psi \left(\frac{b_1^*(1+i_2^*)}{s - \rho_0} \right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.57}$$

□

A.6 Proof of Proposition 2

We start form the three key equations that determine the equilibrium on global financial markets, given domestic interest rates in EMEs and the U.S. interest rate:

$$i_2^* = i_2^\$ + \frac{\int_j \frac{a_{3,j}^*}{1+\hat{i}_{2,j}^*} dj}{\gamma} \tag{A.58}$$

$$\frac{a_{3,j}^*}{1+\hat{i}_{2,j}^*} = \left(\frac{\beta\phi}{1+\hat{i}_{2,j}^*} \right)^{\frac{1}{\sigma}} + b_{1,j}^* - y_{2,j}^T \tag{A.59}$$

$$1 + \hat{i}_{2,j}^* = (1+i_2^*)(1+i_{2,j})^{-\psi} \tag{A.60}$$

We then differentiate in the order of flows: a change in the domestic interest rate in EMEs has an impact on the rate charged by domestic banks, which then impacts the rates charged by global arbitrageurs. Hence first:

$$\frac{d \ln(1+\hat{i}_{2,j}^*)}{d \ln(1+i_{2,j})} = \frac{d \ln(1+i_2^*)}{d \ln(1+i_{2,j})} - \psi \tag{A.61}$$

Then the capital flow equation:

$$\frac{d\frac{a^*_{3,j}}{1+\hat{i}^*_{2,j}}}{d(1+\hat{i}^*_{2,j})} = -\frac{1}{\sigma}(\beta\phi)^{1/\sigma}(1+\hat{i}^*_{2,j})^{-\frac{1}{\sigma}-1} \tag{A.62}$$

$$= -\frac{1}{\sigma}(\beta\phi)^{1/\sigma}((1+i^*_2)(1+i_{2,j})^{-\psi})^{-\frac{1}{\sigma}-1} \tag{A.63}$$

and in log-form:

$$\frac{d\frac{a^*_{3,j}}{1+\hat{i}^*_{2,j}}}{d\ln(1+\hat{i}^*_{2,j})} = -\frac{1}{\sigma}(\beta\phi)^{1/\sigma}((1+i^*_2)(1+i_{2,j})^{-\psi})^{-\frac{1}{\sigma}} \tag{A.64}$$

And finally global arbitrageurs' condition:

$$\frac{d\ln(1+i^*_2)}{d\ln(1+\hat{i}^*_{2,j})} = \frac{1}{\gamma(1+i^*_2)}\frac{d\frac{a^*_{3,j}}{1+\hat{i}^*_{2,j}}}{d\ln(1+\hat{i}^*_2)} \tag{A.65}$$

Putting everything together with the chain rule:

$$\frac{d\ln(1+i^*_2)}{d\ln(1+i_2)} = \frac{d\ln(1+i^*_2)}{d\ln(1+\hat{i}^*_2)}\frac{d\ln(1+\hat{i}^*_2)}{d\ln(1+i_2)} \tag{A.66}$$

$$= -\left(\frac{d\ln(1+i^*_2)}{d\ln(1+i_{2,j})} - \psi\right)\frac{1}{\sigma\gamma(1+i^*_2)}(\beta\phi)^{1/\sigma}((1+i^*_2)(1+i_2)^{-\psi})^{-\frac{1}{\sigma}} \tag{A.67}$$

which yields:

$$\frac{d\ln(1+i^*_2)}{d\ln(1+i_2)} = \psi\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{1/\sigma}}\frac{(1+i^*_2)^{\frac{\sigma+1}{\sigma}}}{(1+i^*_2)^{1+\frac{\psi}{\sigma}}}+1} \tag{A.68}$$

□

A.7 Proof of Proposition 3

We look at the case of a planner that takes into account how domestic policy rate decisions impact the equilibrium determination of the world interest rate. To do so, we manipulate this condition in order to only have e_2 and i_2^*:

$$c_2^T = \left(\beta\phi\frac{(1+i_2)^\psi}{1+i_2^*}\right)^{\frac{1}{\sigma}} \tag{A.69}$$

$$= \left(\beta\phi\frac{(1+i_2^*)^{\frac{\psi}{1+\psi}}(e_2)^{\frac{-\psi}{1+\psi}}(\bar{w})^{\frac{\psi}{1+\psi}}}{1+i_2^*}\right)^{\frac{1}{\sigma}} \tag{A.70}$$

$$= \left(\beta\phi\frac{(\bar{w})^{\frac{\psi}{1+\psi}}}{(1+i_2^*)^{1-\frac{\psi}{1+\psi}}(e_2)^{\frac{\psi}{1+\psi}}}\right)^{\frac{1}{\sigma}} \tag{A.71}$$

$$= \left(\beta\phi\frac{(\bar{w})^{\frac{\psi}{1+\psi}}}{(1+i_2^*)^{\frac{1}{1+\psi}}(e_2)^{\frac{\psi}{1+\psi}}}\right)^{\frac{1}{\sigma}} \tag{A.72}$$

The optimal policy problem can now equivalently be written:

$$\max_{l_2,e_2,i_2^*} \frac{1-\phi}{1-\sigma}\left(l_2+\eta_2K_1 - s\kappa\frac{\eta_2K_1-b_1-e_2b_1^*}{s-\rho_0} - \frac{b_1}{\bar{w}}\right)^{1-\sigma} + \beta\left(\bar{l}+\rho\kappa\frac{\eta_2K_1-b_1-e_2b_1^*}{s-\rho_0}\right) \tag{A.73}$$

with the constraints:

$$l_2 \leq \bar{l} \tag{A.74}$$

$$l_2+\eta_2K_1 - s\kappa\frac{\eta_2K_1-b_1-e_2b_1^*}{s-\rho_0} - \frac{b_1}{\bar{w}} = \left(\frac{e_2}{\beta\bar{w}(1+i_2^*)}\right)^{\frac{1}{\sigma(1+\psi)}} \tag{A.75}$$

$$i_2^* = i_2^\$ + \frac{1}{\gamma}\left(\frac{\beta\phi\bar{w}^{\frac{\psi}{1+\psi}}}{(1+i_2^*)^{\frac{1}{1+\psi}}e_2^{\frac{\psi}{1+\psi}}}\right)^{\frac{1}{\sigma}} + \frac{b_1^*-y_2^T}{\gamma} \tag{A.76}$$

We denote, respectively, the Lagrange multipliers on these three constraints as ν, ϵ and λ^*. Maximization then implies:

$$(1-\phi)(c_2^N)^{-\sigma} = \nu+\epsilon \tag{A.77}$$

and

$$
\begin{aligned}
(1-\phi)\frac{s\kappa b_1^*}{s-\rho_0}(c_2^N)^{-\sigma} - \beta\rho\kappa\frac{b_1^*}{s-\rho_0} = \\
\epsilon\left(\frac{s\kappa b_1^*}{s-\rho_0} - \frac{1}{\sigma(1+\psi)}\frac{(\beta(1+i_2))^{\frac{\sigma(1+\psi)-1}{\sigma}}}{\beta\bar{\varpi}(1+i_2^*)}\right) \\
+ \frac{\lambda^*\psi}{\gamma\sigma(1+\psi)}\frac{c_2^T}{e_2}
\end{aligned} \tag{A.78}
$$

and finally:

$$
\frac{\epsilon}{\sigma(1+\psi)}\frac{(\beta(1+i_2))^{-\frac{1}{\sigma}}}{1+i_2^*} = -\frac{\lambda^*}{\gamma\sigma(1+\psi)}\frac{c_2^T}{1+i_2^*} - \lambda^* \tag{A.79}
$$

which yield the following relation between the Lagrange multipliers:

$$
\lambda^* = -\frac{\epsilon(\beta(1+i_2))^{-\frac{1}{\sigma}}}{\sigma(1+\psi)(1+i_2^*) + \frac{c_2^T}{\gamma}} \tag{A.80}
$$

And putting the last two condition together to eliminate λ^*:

$$
\begin{aligned}
(1-\phi)\frac{s\kappa b_1^*}{s-\rho_0}(c_2^N)^{-\sigma} - \beta\rho\kappa\frac{b_1^*}{s-\rho_0} = \\
\epsilon\left(\frac{s\kappa b_1^*}{s-\rho_0} - \frac{1}{\sigma(1+\psi)}\frac{(\beta(1+i_2))^{-\frac{1}{\sigma}}}{e_2}\right) \\
- \frac{\epsilon\psi}{\sigma(1+\psi)}\frac{(\beta(1+i_2))^{-\frac{1}{\sigma}}}{e_2}
\end{aligned} \tag{A.81}
$$

we arrive at an expression for ϵ that resembles the one from the individual central bank optimization problem:

$$
\epsilon = \frac{(1-\phi)(c_2^N)^{-\sigma} - \beta\rho}{1 - \frac{(s-\rho_0)(1+i_2)^{1+\psi}}{s\kappa b_1^*\sigma\bar{\varpi}}\frac{c_2^N}{(1+\psi)(1+i_2^*) - \frac{\psi c_2^T}{\gamma\sigma + \frac{c_2^T}{1+i_2^*}}}} \tag{A.82}
$$

which leads up to, when we are away from full employment:

$$
\frac{(s-\rho_0)(1+i_2)^{1+\psi}}{s\kappa b_1^*\sigma\bar{\varpi}}\frac{c_2^N}{(1+\psi)(1+i_2^*) - \frac{\psi c_2^T}{\gamma\sigma + \frac{c_2^T}{1+i_2^*}}} = \beta\rho \tag{A.83}
$$

Using the equilibrium condition between domestic rates and consumption of non-tradables:

$$(1+i_2)^{\frac{2\sigma-1}{\sigma}+\psi} = \left(s\kappa\sigma\bar{w}(1+\psi)\right)\frac{b_1^*(1+i_2^*)}{s-\rho_0}\left(1-\frac{\psi c_2^T}{(1+\psi)\left(\gamma\sigma(1+i_2^*)+c_2^T\right)}\right) \tag{A.84}$$

Finally, some algebra on the last congestion externality to express it as:

$$\frac{\psi c_2^T}{(1+\psi)\left(\gamma\sigma(1+i_2^*)+c_2^T\right)} = \frac{\psi}{1+\psi}\frac{1}{\gamma\sigma\frac{(1+i_2^*)}{c_2^T}+1} \tag{A.85}$$

$$= \frac{\psi}{1+\psi}\frac{1}{\gamma\sigma\frac{(1+i_2^*)}{\left(\beta\phi\frac{(1+i_2)^{\psi}}{1+i_2^*}\right)^{\frac{1}{\sigma}}}+1} \tag{A.86}$$

$$= \frac{\psi}{1+\psi}\frac{1}{\gamma\sigma\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(\beta\phi(1+i_2)^{\psi})^{\frac{1}{\sigma}}}+1} \tag{A.87}$$

$$= \frac{\psi}{1+\psi}\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}}\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}}+1} \tag{A.88}$$

The optimal interest rate thus verifies:

$$1+i_2^{SP} = \Omega_\psi\left(\frac{b_1^*(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}}\left(1-\frac{\psi}{1+\psi}\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}}\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}}+1}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.89}$$

This condition is very similar to the original one, except for the additional congestion externality that work through the γ and ψ coefficients that denote the modified exchange rate sensitivity to interest rates. Finally, this last part is exactly the monetary policy spillover we identified in Proposition 2, leading to:

$$1+i_2^{SP} = \Omega_\psi\left(\frac{b_1^*(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}}\left(1-\frac{1}{1+\psi}\mathscr{C}(i_2^{SP},i_2^*)\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.90}$$

□

A.8 Proof of Lemma 3

Entrepreneurs' optimization program is given by:

$$\min_{b_1, b_1^*} \quad b_1 + e_2 b_1^* \tag{A.91}$$

$$\text{s.t.} \quad \frac{b_1}{1+\hat{i}_1} + \frac{e_1 b_1^*}{1+\hat{i}_1^*} = K_1 \tag{A.92}$$

An interior solution exists when a simple UIP condition using the equilibrium interest rates is verified:

$$\frac{e_2}{e_1} = \frac{1+\hat{i}_1}{1+\hat{i}_1^*} \tag{A.93}$$

Since firms are raising K_1 in total, we can write:

$$K_1 = \frac{b_1}{1+\hat{i}_1} + \frac{e_1 b_1^*}{1+\hat{i}_1^*} \tag{A.94}$$

$$K_1 = \omega(\hat{i}_1 - i_1) + e_1\omega^*(\hat{i}_1^* - i_1^*) \tag{A.95}$$

$$K_1 = \omega(1+\hat{i}_1 - 1 - i_1) + e_1\omega^*\left(\frac{e_1}{e_2}(1+\hat{i}_1) - 1 - i_1^*\right) \tag{A.96}$$

$$K_1 = (1+\hat{i}_1)(\omega + e_1\omega^*\frac{e_1}{e_2}) - [\omega(1+i_1) + e_1\omega^*(1+i_1^*)] \tag{A.97}$$

$$\tag{A.98}$$

leading to the equilibrium interest domestic rate of borrowing:

$$1+\hat{i}_1 = \frac{K_1 + \omega(1+i_1) + e_1\omega^*(1+i_1^*)}{\omega + e_1\omega^*\frac{e_1}{e_2}} \tag{A.99}$$

and similarly for the dollar rate (using the UIP condition):

$$1+\hat{i}_1^* = \frac{K_1 + e_1\omega^*(1+i_1^*) + \omega(1+i_1)}{\omega\frac{e_2}{e_1} + e_1\omega^*} \tag{A.100}$$

From this, we get:

$$\hat{i}_1^* - i_1^* = \frac{K_1 + \omega\left(1 + i_1 - \frac{e_2}{e_1}(1+i_1^*)\right)}{\omega\frac{e_2}{e_1} + e_1\omega^*} \tag{A.101}$$

which finally yields:

$$b_1^* = \omega^* \frac{K_1 + e_1\omega^*(1+i_1^*) + \omega(1+i_1)}{\left(\omega\frac{e_2}{e_1} + e_1\omega^*\right)^2} \left(K_1 + \omega\left(1 + i_1 - \frac{e_2}{e_1}(1+i_1^*)\right)\right) \tag{A.102}$$

□

A.9 Proof of Proposition 4

This is directly coming from the optimal policy expression derived in Lemma 2:

$$1 + i_2^{opt} = \Omega_\psi \left(\frac{b_1^*(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.103}$$

Using the optimality condition:

$$(1-\phi)\left(c_2^N\right)^{-\sigma} = \beta(1+i_2) \tag{A.104}$$

and the market clearing condition $c_2^N = l_2$, we get:

$$-\sigma(1-\phi)\frac{dl_2}{db_1^*}\left(c_2^N\right)^{-\sigma-1} = \beta\frac{di_2}{db_1^*} \tag{A.105}$$

The optimal policy response gives us:

$$\frac{di_2}{db_1^*} = \Omega_\psi \left(\frac{(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \frac{\sigma}{2\sigma-1+\sigma\psi} b_1^{*\,\frac{\sigma}{2\sigma-1+\sigma\psi}-1} \tag{A.106}$$

which we rewrite for conciseness:

$$\frac{di_2}{db_1^*} = \frac{(1+i_2)}{b_1^*}\frac{\sigma}{2\sigma-1+\sigma\psi} \tag{A.107}$$

and similarly we get:

$$-\sigma\frac{dl_2}{db_1^*}\beta\frac{1+i_2}{l_2} = \beta\frac{di_2}{db_1^*} \tag{A.108}$$

Putting everything together yields:

$$-\sigma\frac{dl_2}{db_1^*}\frac{1+i_2}{l_2} = \frac{(1+i_2)}{b_1^*}\frac{\sigma}{2\sigma-1+\sigma\psi} \tag{A.109}$$

which simplifies to:

$$\frac{dl_2}{db_1^*} = -\frac{l_2}{b_1^*(2\sigma - 1 + \sigma\psi)} \tag{A.110}$$

□

A.10 Proof of Lemma 5

The UIP condition necessary for the interior solution is now :

$$\frac{e_2}{e_1} = \frac{1+\hat{i}_1}{1+\hat{i}_1^*}(1-\tau) \tag{A.111}$$

We follow the same steps as for the proof of Lemma 3.

$$K_1 = \frac{b_1}{1+\hat{i}_1} + \frac{e_1 b_1^*}{1+\hat{i}_1^*} \tag{A.112}$$

$$K_1 = \omega(\hat{i}_1 - i_1) + e_1\omega^*(\hat{i}_1^* - i_1^*) \tag{A.113}$$

$$K_1 = \omega(1+\hat{i}_1 - 1 - i_1) + e_1\omega^*\left(\frac{e_1}{e_2}(1+\hat{i}_1 - \tau) - 1 - i_1^*\right) \tag{A.114}$$

$$K_1 = (1+\hat{i}_1)(\omega + e_1\omega^*\frac{e_1}{e_2}) - \tau e_1\omega^*\frac{e_1}{e_2} - [\omega(1+i_1) + e_1\omega^*(1+i_1^*)] \tag{A.115}$$

$$\tag{A.116}$$

hence:

$$1+\hat{i}_1 = \frac{K_1 + \omega(1+i_1) + e_1\omega^*(1+i_1^*) + \tau e_1\omega^*\frac{e_1}{e_2}}{\omega + e_1\omega^*\frac{e_1}{e_2}} \tag{A.117}$$

and similarly for the dollar interest rate charged on entrepreneurs:

$$1+\hat{i}_1^* = \frac{K_1 + e_1\omega^*(1+i_1^*) + \omega(1+i_1) - \tau\omega\frac{e_2}{e_1}}{\omega\frac{e_2}{e_1} + e_1\omega^*} \tag{A.118}$$

From this, we get:

$$\hat{i}_1^* - i_1^* = \frac{K_1 + \omega\left(1 + i_1 - \frac{e_2}{e_1}(1+i_1^*)\right) - \tau\omega\frac{e_2}{e_1}}{\omega\frac{e_2}{e_1} + e_1\omega^*} \tag{A.119}$$

which finally yields:

$$b_1^* = \omega^* \frac{K_1 + e_1\omega^*(1+i_1^*) + \omega(1+i_1) - \tau\omega\frac{e_2}{e_1}}{\left(\omega\frac{e_2}{e_1} + e_1\omega^*\right)^2} \left(K_1 + \omega\left(1 + i_1 - \frac{e_2}{e_1}(1+i_1^*+\tau)\right)\right) \tag{A.120}$$

The same thing for local currency debt gives us:

$$b_1 = \omega \frac{K_1 + \omega(1+i_1) + e_1\omega^*(1+i_1^*) + \tau e_1\omega^*\frac{e_1}{e_2}}{\left(\omega + e_1\omega^*\frac{e_1}{e_2}\right)^2} \left(K_1 + e_1\omega^*\left(1 + i_1^* - \frac{e_1}{e_2}(1+i_1-\tau)\right)\right) \tag{A.121}$$

□

A.11 Proof of Proposition 5

This proposition simply stems from combining the result of Lemma 2 with the observation that consumption at time $t = 3$ is a direct function of the net worth of entrepreneurs. We start with:

$$1 + i_2^{opt} = \Omega_\psi \left(\frac{b_1^*(1+i_2^*)}{s - \rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.122}$$

and notice that consumption at $t = 2$ and the interest rate are linked through the usual Euler equation:

$$\frac{1-\phi}{1-\sigma}(c_2^N)^{1-\sigma} = (\beta(1+i_2^{opt})^{-\frac{1-\sigma}{\sigma}} \tag{A.123}$$

which implies that lowering b_1^* through a macroprudential tax on dollar issuance leads to:

$$\frac{dU_2}{db_1^*} = -\frac{1-\phi}{2\sigma-1+\sigma\psi}\left(\beta\Omega_\psi\left(\frac{1+i_2^{\$}}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}}\right)^{-\frac{1-\sigma}{\sigma}} (b_1^*)^{-\sigma\frac{1+\psi}{2\sigma-1+\sigma\psi}} \tag{A.124}$$

We then combine this with how consumption at $t = 3$ varies with net worth, which is immediate given the production function of entrepreneurs and the linear utility in the last period:

$$\frac{dU_3}{db_1^*} = \frac{\rho\kappa}{s-\rho_0}\frac{dn_2}{db_1^*} \tag{A.125}$$

The optimal level if thus when:

$$\frac{1-\phi}{2\sigma-1+\sigma\psi}\left(\beta\Omega_\psi\left(\frac{1+i_2^\$}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}}\right)^{-\frac{1-\sigma}{\sigma}}(b_1^*)^{-\sigma\frac{1+\psi}{2\sigma-1+\sigma\psi}}=\beta\frac{\rho\kappa}{s-\rho_0}\frac{dn_2}{db_1^*} \tag{A.126}$$

□

A.12 Proof of Proposition 6

We use the characterization of Proposition 2:

$$\frac{d\ln(1+i_2^*)}{d\ln(1+i_2)}=\psi\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}}\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}}+1} \tag{A.127}$$

And next again the fact that according to Lemma 2:

$$1+i_2^{opt}=\Omega_\psi\left(\frac{b_1^*(1+i_2^*)}{s-\rho_0}\right)^{\frac{\sigma}{2\sigma-1+\sigma\psi}} \tag{A.128}$$

This allows us to directly quantify by how much a chance in b_1^*, thanks to the macroprudential tax on dollar issuance, changes the optimal interest rate implemented by the central bank at $t=2$:

$$\frac{d(1+i_2^{opt})}{db_1^*}=\frac{\sigma(1+\psi)}{2\sigma(1+\psi)-1}\frac{(1+i_2^{opt}}{b_1^*} \tag{A.129}$$

The result of Proposition 6 then follows from the use of the chain rule, as:

$$\frac{d\ln(1+i_2^*)}{d\tau}=\frac{d\ln(1+i_2^*)}{d\ln(1+i_2)}\frac{d(1+i_2^{opt})}{d\ln(b_1^*)}\frac{d\ln(b_1^*)}{d\tau} \tag{A.130}$$

and putting everything together yields the desired expression:

$$\frac{d\ln(1+i_2^*)}{d\tau}=\psi\frac{\sigma(1+\psi)}{2\sigma(1+\psi)-1}\frac{1}{\frac{\gamma\sigma}{(\beta\phi)^{\frac{1}{\sigma}}}\frac{(1+i_2^*)^{\frac{\sigma+1}{\sigma}}}{(1+i_2)^{\frac{\psi}{\sigma}}}+1}\frac{d\ln(b_1^*)}{d\tau} \tag{A.131}$$

□

B Extensions

B.1 Non-Separable Preferences

This Section studies the case where the utility function is as follows:

$$U_2 = \frac{1}{1-\rho}\left(\phi (c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}} + \beta\left(c_3^N + c_3^T\right) \tag{B.1}$$

so that tradable and non-tradable consumption are non-separable. The point of this Section is to show that, under these circumstances, capital flows in equilibrium depend on the domestic interest rate (even without the ψ friction) so that the congestion externality results are present. The budget constraints are identical:

$$p_2^T c_2^T + p_2^N c_2^N = e_2 y_2^T + w_2 l_2 + \Pi_2 + \frac{1}{1+i_2} a_3 + \frac{1}{1+i_2^*} e_2 a_3^* \qquad (\lambda_2) \tag{B.2}$$

$$p_3^N c_3^N + p_3^T c_3^T + a_3 + e_3 a_3^* = p_3^T y_3^T + \bar{w}\bar{l} + \Pi_3 \qquad (\lambda_3) \tag{B.3}$$

with $p_t^T = e_t$ and $p_t^N = \bar{w}$. We thus end up with the following first-order conditions for households:

$$\frac{\lambda_2}{1+i_2} = \beta\lambda_3 \tag{B.4}$$

$$\frac{\lambda_2}{1+i_2^*} e_2 = \beta\lambda_3 e_3 \tag{B.5}$$

$$\phi (c_2^T)^{-\sigma}\left(\phi (c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}-1} = \lambda_2 p_2^T \tag{B.6}$$

$$(1-\phi)(c_2^N)^{-\sigma}\left(\phi (c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}-1} = \lambda_2 p_2^N \tag{B.7}$$

$$1 = \lambda_3 p_3^N \tag{B.8}$$

$$1 = \lambda_3 p_3^T \tag{B.9}$$

By taking the ration between the T and NT conditions, we can still write non-tradables demand as:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{p_2^N}{p_2^T}\right)^{-1/\sigma} c_2^T = \left(\frac{\phi}{1-\phi}\frac{\bar{w}}{e_2}\right)^{-1/\sigma} c_2^T \tag{B.10}$$

The savings/borrowing decisions in peso and dollar also still yield the standard

UIP condition since there is no uncertainty:

$$1 + i_2 = (1 + i_2^*)\frac{e_3}{e_2} \tag{B.11}$$

Using the fact that the price of tradables is equal to the exchange rate, and that the price of non-tradables is the wage since firms are perfectly competitive, we have the following demand function for non-tradables:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{w_2}{e_2}\right)^{-1/\sigma} c_2^T \tag{B.12}$$

and plugging the UIP condition we have the now-familiar condition:

$$c_2^N = \left(\frac{\phi}{1-\phi}\frac{(1+i_2)}{(1+i_2^*)}\right)^{-1/\sigma} c_2^T \tag{B.13}$$

We also have:

$$(1-\phi)(c_2^N)^{-\sigma}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}-1} = \beta(1+i_2) \tag{B.14}$$

where the consumption composite is now preventing us from having a simple expression only involving the interest rate and the consumption of non-tradables. This implies that the consumption levels can be expressed as:

$$(c_2^T)^{-\sigma} = \frac{\beta(1+i_2^*)}{\phi}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}-1} \tag{B.15}$$

$$(c_2^N)^{-\sigma} = \frac{\beta(1+i_2)}{1-\phi}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\right)^{\frac{1-\rho}{1-\sigma}-1} \tag{B.16}$$

These two equations determine (implicitly) the consumption of tradables, as a function of the domestic and international interest rates. The capital flow from a country is then:

$$\frac{1}{1+i_2^*}a_{3,j}^* = c_{2,j}^T + b_{1,j}^* - y_{2,j}^T \tag{B.17}$$

We then close this part by adding the equilibrium condition for the world interest rate as a function of the dollar interest rate:

$$i_2^* = i_2^\$ + \frac{\int_j \frac{a_{3,j}^*}{1+i_2^*}dj}{\gamma} \tag{B.18}$$

The intuition works exactly as before: a change in the domestic interest rate $i_{2,j}$ provokes a change in capital flows, this time through the consumption of tradables given non-separable preferences. This in turn impacts the equilibrium determination of the world interest rate through the global arbitrageurs condition.

We can get at the congestion externality in a similar way, but have to go through a supplementary round of implicit derivatives first. First, as previously we have:

$$\frac{di_2^*}{di_2} = \frac{1}{\gamma}\frac{d}{di_2}\frac{a_3^*}{1+i_2^*} = \frac{1}{\gamma}\frac{dc_2^T}{di_2} \tag{B.19}$$

which will be more useful in log-form:

$$\frac{d\ln(1+i_2^*)}{d\ln(1+i_2)} = \frac{1}{\gamma}\frac{d}{di_2}\frac{a_3^*}{1+i_2^*} = \frac{c_2^T}{\gamma(1+i_2^*)}\frac{d\ln c_2^T}{d\ln(1+i_2)} \tag{B.20}$$

Differentiating now the consumption equations, starting with Equation (B.15):

$$\frac{d\ln c_2^T}{d\ln(1+i_2)} = \frac{d\ln(1+i_2^*)}{d\ln(1+i_2)} + (\rho-\sigma)\frac{\phi\frac{dc_2^T}{d\ln(1+i_2)}(c_2^T)^{-\sigma} + (1-\phi)\frac{dc_2^N}{d\ln(1+i_2)}(c_2^N)^{-\sigma}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}} \tag{B.21}$$

or equivalently:

$$\frac{d\ln c_2^T}{d\ln(1+i_2)} = \frac{d\ln(1+i_2^*)}{d\ln(1+i_2)} + (\rho-\sigma)\frac{\phi\frac{d\ln c_2^T}{d\ln(1+i_2)}(c_2^T)^{1-\sigma} + (1-\phi)\frac{d\ln c_2^N}{d\ln(1+i_2)}(c_2^N)^{1-\sigma}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}} \tag{B.22}$$

and similarly for Equation (B.16) we can write:

$$\frac{d\ln c_2^N}{d\ln(1+i_2)} = 1 + (\rho-\sigma)\frac{\phi\frac{d\ln c_2^T}{d\ln(1+i_2)}(c_2^T)^{1-\sigma} + (1-\phi)\frac{d\ln c_2^N}{d\ln(1+i_2)}(c_2^N)^{1-\sigma}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}} \tag{B.23}$$

where we can wee that the case of separable preferences ($\rho = \sigma$) gives the simple derivatives from the main text. Subtracting these two equations yields:

$$\frac{d\ln c_2^N}{d\ln(1+i_2)} - \frac{d\ln c_2^T}{d\ln(1+i_2)} = 1 - \frac{d\ln(1+i_2^*)}{d\ln(1+i_2)} \tag{B.24}$$

and using the equation linking global arbitrageurs to the dollar interest rate:

$$\frac{d\ln c_2^N}{d\ln(1+i_2)} - \frac{d\ln c_2^T}{d\ln(1+i_2)} = 1 - \frac{c_2^T}{\gamma(1+i_2^*)}\frac{d\ln c_2^T}{d\ln(1+i_2)} \tag{B.25}$$

so that:

$$\frac{d\ln c_2^N}{d\ln(1+i_2)} = 1 + \frac{d\ln c_2^T}{d\ln(1+i_2)}\left(1 - \frac{c_2^T}{\gamma(1+i_2^*)}\right) \tag{B.26}$$

The goal is to isolate the derivative of c^T, as it is the one changing capital flows and thus the world interest rate. Make use of (B.26) to express:

$$\begin{aligned}\phi\frac{d\ln c_2^T}{d\ln(1+i_2)}(c_2^T)^{1-\sigma} + (1-\phi)\frac{d\ln c_2^N}{d\ln(1+i_2)}(c_2^N)^{1-\sigma}\\ = \frac{d\ln c_2^T}{d\ln(1+i_2)}\left(\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}\left(1-\frac{c_2^T}{\gamma(1+i_2^*)}\right)\right)\\ + (1-\phi)(c_2^N)^{1-\sigma}\end{aligned} \tag{B.27}$$

This implies that the last term in (B.22) can be written:

$$\begin{aligned}\frac{\phi\frac{d\ln c_2^T}{d\ln(1+i_2)}(c_2^T)^{1-\sigma} + (1-\phi)\frac{d\ln c_2^N}{d\ln(1+i_2)}(c_2^N)^{1-\sigma}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}}\\ = \frac{d\ln c_2^T}{d\ln(1+i_2)}\left(1 - \frac{(1-\phi)(c_2^N)^{1-\sigma}\frac{c_2^T}{\gamma(1+i_2^*)}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}}\right)\\ + \frac{(1-\phi)(c_2^N)^{1-\sigma}}{\phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma}}\end{aligned} \tag{B.28}$$

Call the composite consumption C:

$$C \equiv \phi(c_2^T)^{1-\sigma} + (1-\phi)(c_2^N)^{1-\sigma} \tag{B.29}$$

and for ease of notation also write $dT \equiv \frac{d\ln c_2^T}{d\ln(1+i_2)}$. Going back to (B.22), we have:

$$dT = \frac{c_2^T}{\gamma(1+i_2^*)}dT + (\rho-\sigma)dT\left(1 - \frac{(1-\phi)(c_2^N)^{1-\sigma}\frac{c_2^T}{\gamma(1+i_2^*)}}{C}\right) + (\rho-\sigma)\frac{(1-\phi)(c_2^N)^{1-\sigma}}{C} \tag{B.30}$$

so that we have an expression for the change in tradable consumption with the domestic interest rate:

$$\frac{d\ln c_2^T}{d\ln(1+i_2)} = \frac{(\rho-\sigma)(1-\phi)(c_2^N)^{1-\sigma}}{C\left(1 - \frac{c_2^T}{\gamma(1+i_2^*)} - (\rho-\sigma)\right) + (\rho-\sigma)(1-\phi)(c_2^N)^{1-\sigma}\frac{c_2^T}{\gamma(1+i_2^*)}} \tag{B.31}$$

Putting everything together, since the change in capital flows is equal to the change in the consumption of tradables, we have the following Proposition.

Proposition 7 (Monetary Policy Spillovers with Non-Separable Preferences)**.** *Individual central banks in emerging economies do not internalize that their domestic decisions spill over to the equilibrium determination of the world interest rate:*

$$\mathscr{C}(i_2, i_2^*) = \frac{(\rho-\sigma)(1-\phi)(c_2^N)^{1-\sigma}\frac{c_2^T}{\gamma(1+i_2^*)}}{(\rho-\sigma)(1-\phi)(c_2^N)^{1-\sigma}\frac{c_2^T}{\gamma(1+i_2^*)} + C\left(1 - \frac{c_2^T}{\gamma(1+i_2^*)} - (\rho-\sigma)\right)} \tag{B.32}$$

This is exactly the counterpart of Proposition 2 Fist, if $\rho = \sigma$, then changes in the domestic rate do not impact the world interest rate since global capital flows are constant by the separability of preferences. Second, if $\gamma = +\infty$, global arbitrageurs do not face intermediation costs and changes in flows do not impact the world interest rate. It is the combination of those two ingredients that yield the spillover result, and create a need for coordination.

B.2 General Currency Mismatch

The assumption in main framework is an extreme form currency mismatch, where entrepreneurs' production at $t = 2$ is in non-tradable goods only. This implies that their net worth is given by:

$$n_2 = \eta_2 K_1 - b_1 - e_2 b_1^* \tag{B.33}$$

Meaning that the exchange rate moves only costs, not the revenues, of entrepreneurs. We can easily extend this framework and work with a general currency mismatch, by assuming that entrepreneurs' capital at $t = 2$ yields a quantity η_2 of non-tradable goods, and a quantity $\iota\eta_2$ of tradable goods, per unit of capital. In this case, their net worth becomes:

$$n_2 = \eta_2 + e_2 \iota K_1 - b_1 - e_2 b_1^* \tag{B.34}$$

and the exchange rate moves income and as well as costs. The net worth multiplier (assume constrained entrepreneurs as before) that govern balance sheet effects is then similarm but simply weakened by the presence of tradable goods:

$$\frac{dK_2}{\mathbf{i}_2} = (1-\iota)\frac{e_2 \kappa b_1^*}{s-\rho_0} \tag{B.35}$$

C The Financial Wedge in the Data

This section offers suggestive evidence that the form of the financial wedge assumed in Equation (25) is not counterfactual. In order to do so, I use data from the International Financial Statistics (IFS) provided by the IMF, for countries where two variables are available for more than 10 years: Central Bank Policy Rate, and Savings Rate in Foreign Currency. I then construct the spread between the dollar interest rate (set by the Fed) and the Savings rate in foreign currency offered in these countries, and plot in Figure 8 the relationship with the domestic policy rate. All four countries point towards a positive relationship. Note that the slope of the regression line is exactly equivalent to ψ in my model, where $i_2^* - \hat{i}_2 = \psi i_2$.

Figure 8: This figures plot the spread between the dollar interest rate (set by the Fed) and the Savings rate in foreign currency offered in four different countries, as a function of the domestic policy rate.