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Integrated Monetary and Financial Policies for Small Open Economies

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ABSTRACT:
We develop a tractable small-open-economy framework to characterize the constrained efficient use of the policy rate, foreign exchange (FX) intervention, capital controls, and domestic macroprudential measures. The model features dominant currency pricing, shallow FX markets, and occasionally-binding external and domestic borrowing constraints. We characterize the conditions for the "traditional prescription"—relying on the policy rate and exchange rate flexibility—to be sufficient, even if externalities persist. The conditions are satisfied for world interest rate shocks if FX markets are deep. By contrast, we show that to manage non-fundamental inflow surges and taper tantrums related to local currency debt, capital inflow taxes and FX intervention should be used instead of the policy rate and exchange rate flexibility. In the realistic case where countries face both shallow FX markets and external borrowing constraints, we establish that some kinds of FX mismatch regulations may reduce the external debt limit friction but worsen FX market depth. Finally, we show that capital controls and domestic macroprudential measures cease to be perfect substitutes if there is a risk that the domestic borrowing constraint binds as a result of the transmission of the global financial cycle.

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WORKING PAPERS

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1 Introduction

Many emerging markets and developing economies (EMDEs), and also some advanced economies (AEs), have adopted inflation targeting frameworks in which the use of the monetary policy rate and exchange rate flexibility is complemented by tools such as sterilized foreign exchange (FX) intervention, capital controls, and domestic macroprudential measures. As figure 1 shows, the use of these tools may be more frequent at turning points in the global financial cycle.[1]

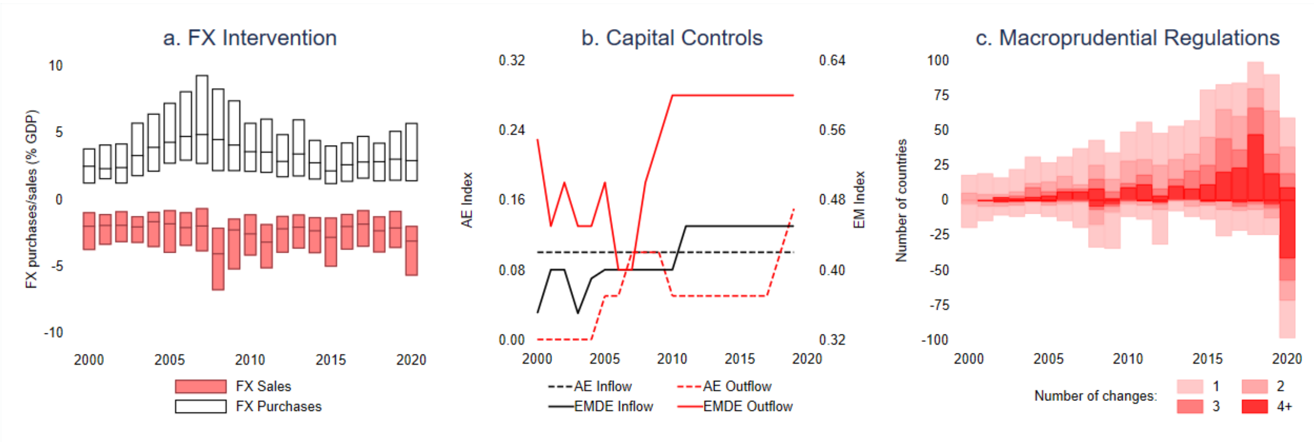
A justification for such tools may rest on the combination of the volatile external financing shocks that these countries face and the market frictions which amplify the shocks into macroeconomic destabilization. This issue is particularly salient in the current context, as several AE central banks are tightening monetary policy to bring down inflation from elevated levels. Figure 2 shows a range of shocks and ramifications of varying severity that EMDEs have had to manage in the recent past: U.S. monetary policy tightening and loosening episodes; the 2013 "taper tantrum", in which the announcement of U.S. monetary tightening led to a disruptive spike in uncovered interest parity (UIP) premia on EMDEs' *local* currency debt; the incidence of "sudden stops", more severe events which are associated with a collapse in GDP growth and typically preceded by high *foreign* currency debt inflows; and domestic banking crises.

Countries' frequent use of multiple policy tools contrasts with the lack of a systematic welfare-optimizing framework to understand the complex interactions across the tools. While several parallel literatures in international finance have recently provided careful treatments of different externalities that are salient in the external context, they typically consider one policy tool and friction at a time. As a result, there are gaps in our knowledge regarding optimal policy, including: whether multiple tools should be combined to address a specific shock; whether tools that address one friction may ease or exacerbate a separate friction; whether one friction is more likely to persist in the presence of a separate friction; and how the policy mix should evolve with different kinds of market development.

In this paper, we build a tractable framework to help answer such questions. We integrate key ingredients from the literature to embed the benefits of exchange rate flexibility while also being able to generate destabilizing taper tantrums, sudden stops, and domestic credit market crashes. We use the framework to characterize the constrained efficient configuration of the policy rate, FX

[1] Sterilized FX intervention represents changes in the central bank's FX position accompanied by open market operations in local currency bonds to stabilize the policy rate. Capital controls are taxes or restrictions on cross-border transactions, while domestic macroprudential measures regulate transactions between domestic agents. Ghosh et al. (2017) document the frequent use of these tools by EMDEs in inflow and outflow episodes; and find that the simultaneous use of multiple tools is more likely when capital flows are large.

Figure 1: Use of Selected Policy Tools



Sources: a. Adler et al. (2021). b. Fernández et al. (2016); c. Alam et al. (2019).
Notes: a. Distribution of FX purchases (monthly positive net values) and sales (monthly negative net values) as percent of GDP based on estimates that strip out valuation effects. Lines in the middle of the boxes represent the medians, box edges show the 25th and 75th percentiles. b. Median capital inflow and outflow restrictiveness indices for AEs and EMDEs. Higher values are associated with higher barriers. c. Number of countries that tightened (positive values) or loosened (negative values) macroprudential regulations, broken down by the number of policy actions.

intervention, capital controls, and domestic macroprudential measures, both before and after external financial shocks.[2]

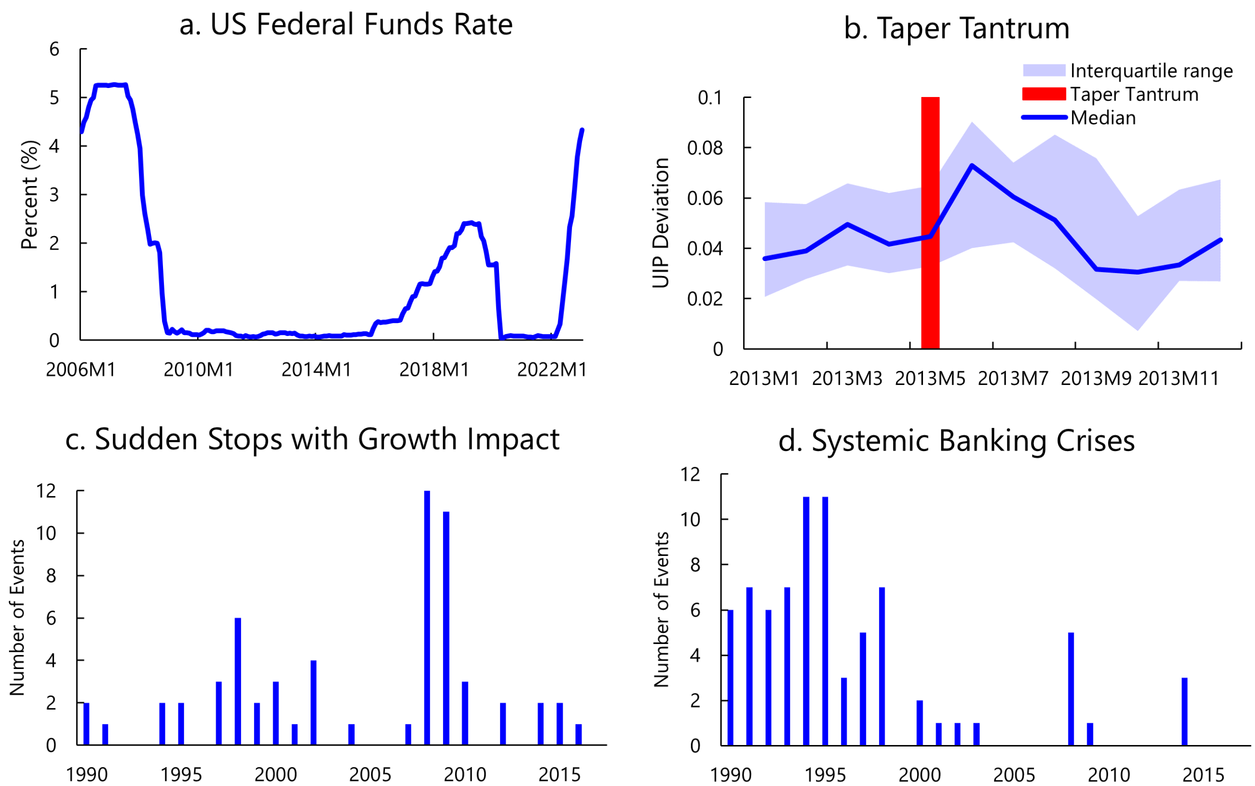
Our model features dominant currency pricing of imports and exports, which is the realistic case for most EMDEs and small AEs (following Gopinath et al., 2020). As a result, exchange rate flexibility generates expenditure-switching only via imports in the short term. Price stickiness gives rise to the *aggregate demand (AD) externality*, because households do not internalize the impact of their consumption decisions on aggregate demand.[3] Exchange rate flexibility helps address this externality, but large depreciations may generate a *pecuniary AD externality* because similarly to Farhi and Werning (2016), we incorporate an occasionally-binding external borrowing constraint which becomes salient when the FX value of domestic collateral declines. In our model, this constraint applies on domestic banks' external borrowing, and the externality is exacerbated when external debt is in FX. "Sudden stop shocks" are rare, but when the constraint binds, it can lead to a severe consumption collapse.

Banks lend to households and to the housing sector. The latter sector features an occasionally-binding domestic borrowing constraint (modified from Kiyotaki and Moore, 1997), which generates a *pecuniary production externality* because the constraint depends on the endogenous price of land.

[2]Our framework nests tools and frictions in such a way that each tool and friction can easily be removed or added.

[3]In New Keynesian models, there is also a *terms of trade externality*, but with deference to practical experience, we assume that the planner does not internalize this externality.

Figure 2: Empirics—External Financial Shocks



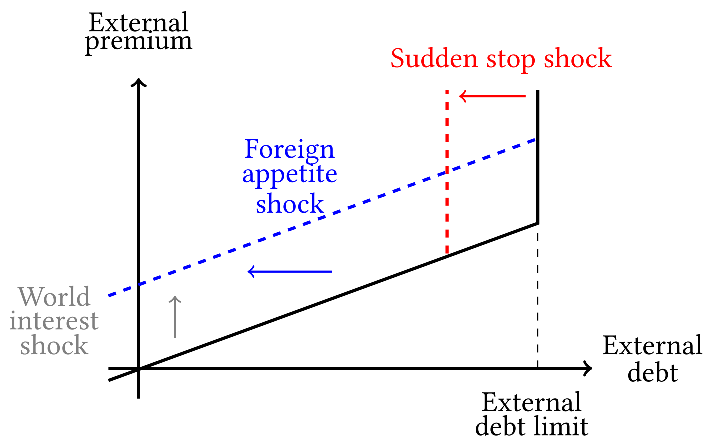
Sources: a. FRED, Federal Reserve Bank of St. Louis. b. Das, Gopinath, and Kalemli-Özcan (2021). c. Basu, Perrelli, and Xin (2023). d. Laeven and Valencia (2020).

When this constraint binds, local currency domestic transactions face a painful credit crunch.

We assume that the optimizing global financiers who lend to domestic banks have an always-binding portfolio friction, and this friction determines the size of the UIP premium they charge to absorb local currency debt (similarly to Gabaix and Maggiori, 2015, and Fanelli and Straub, 2021). FX markets are "deep" if the premium is zero, but they are shallow if the premium is positive. In the latter case, the supply of local currency funds is upward-sloping, so there is a *local currency premium externality* as households do not internalize the endogeneity of the premium, while a planner would seek to manage it. There is a separate group of non-optimizing global financiers who generate small-to-moderate non-fundamental "foreign appetite shocks", i.e., inflow surges and taper tantrums, that affect the premium.

Figure 3 shows a simple visualization of how some external financial shocks affect the economy's supply curve of external funds. The visualization is partial, because each shock affects the economy's other constraints in a different manner. An increase in the world interest rate shifts up the supply of funds curve, and also affects the economy's resource constraint. A taper tantrum shifts the curve to the left, but only if the FX markets are shallow and some of the external debt is in local currency; its effect on the resource constraint is manipulable, as the shock is non-fundamental. A sudden stop shock shifts leftward the external borrowing limit on the right end of the supply curve, and the degree of the shift depends on the amplification of the pecuniary AD externality. These shocks alter conditions in the domestic housing market in different ways.

Figure 3: Diagram—External Financial Shocks



Our integrated framework helps us characterize the general constrained efficient use of all the policy tools, and as a result, we can begin to answer some of the questions posed above.

Our first result is that the constrained efficient allocation may be implemented via the "traditional prescription", i.e., only monetary policy and exchange rate flexibility, *even if* externalities are non-zero. Capital inflow taxes are redundant if a combination of all the externalities is balanced over time. This result extends the one in Farhi and Werning (2016) which related only to the AD externality; we impose a condition including the other externalities as well, while allowing for other tools to handle them. FX intervention is redundant if the desired UIP premia are consistent with households' consumption, and there is no need for the planner to de-link consumption and the external debt position. Housing debt taxes are redundant if pecuniary production externalities are not relevant.

While the traditional prescription holds for managing world interest rate shocks in countries with deep FX markets, we next show that the result is turned on its head for foreign appetite shocks when FX markets are shallow. To manage such shocks, capital inflow taxes and FX intervention should be used jointly during the period of the shock, i.e., "ex post", and *instead of* the policy rate and exchange rate flexibility. Unlike Cavallino (2019) and Fanelli and Straub (2021), who consider FX intervention alone and show that macroeconomic destabilization is worth incurring so as to manage the carry profits/losses from these shocks, we show that adding capital inflow taxes permits the management of external premia without destabilizing the macroeconomy.[4] Capital inflow taxes and FX intervention are better targeted than the policy rate, but each of them are costly; used together, they can achieve perfect stabilization and make the policy rate redundant.

We allow for imperfect FX mismatch in external debt. Accordingly, our third result is that for EMDEs which face the *combined* frictions of shallow FX markets and external borrowing constraints, the effect of a reduction in FX mismatch on the policy mix depends on FX market depth. The normative literature on capital inflow taxes implicitly assumes that FX markets are deep.[5] Our model suggests that an FX mismatch regulation "ex ante" (i.e., before the sudden stop shock) is a useful additional tool in this context, costlessly reducing the FX mismatch and perhaps making an ex ante capital inflow tax unnecessary. By contrast, if FX markets are shallow, the regulation may exacerbate the premium externality by increasing the reliance on high-premium local currency borrowing, so the regulation would be used less. As a result, the country may retain FX mismatch and sudden stop risk, and the ex ante capital inflow tax would remain useful.

Our fourth result is that although capital inflow taxes and domestic macroprudential taxes on household borrowing may appear to be perfect substitutes for handling foreign appetite shocks when only the shallow-market friction is considered (which is consistent with our second result, above), or for handling sudden stop shocks when only the external borrowing constraint is considered (which is consistent with discussions in Erten et al., 2021), they are *no longer* perfect substitutes if the domestic borrowing constraint may bind. As Miranda-Agrippino and Rey (2020) establish and our model includes, global financial conditions are transmitted into domestic asset prices. Capital inflow taxes cut this transmission while household debt taxes do not, because the latter cushion households while letting the policy rate move with the shock.

Related literature. Our paper contributes to several parallel literatures in international finance which each focus on one of the different externalities and instruments.

First, we build on the literature on dominant currency pricing. Theoretical papers establishing the paradigm include Casas et al. (2017), Gopinath et al. (2020), and Mukhin (2022).[6] As in Egorov and Mukhin (2022), we find that dominant currency pricing alone does not justify capital inflow taxes.

Second, our work is related to the literature on pecuniary externalities related to external bor-

[4]In work subsequent to ours, Itskhoki and Mukhin (2022) shows the robustness of our result even in modified settings.
[5]See, for example: Bianchi (2011); Benigno et. al. (2013); Jeanne and Korinek (2020); and Farhi and Werning (2016).
[6]Empirical evidence is provided by Goldberg and Tille (2008, 2009), Gopinath et al. (2010), Gopinath (2015), Boz et al. (2017), Gopinath et al. (2020), Amiti et al. (2022), and Barbiero (2022).

rowing constraints, which rationalizes capital inflow taxes. Our paper is closest to Farhi and Werning (2016), who consider such constraints in a sticky-price context with AD externalities. Other papers in the sticky-price literature include Schmitt-Grohé and Uribe (2016), Korinek and Simsek (2016), and Bianchi and Coulibaly (2022). The earlier flexible-price literature includes Mendoza (2010), Bianchi and Mendoza (2010), Bianchi (2011), Benigno et. al. (2013), and Jeanne and Korinek (2020). Relative to these literatures, we add export production, imperfect FX mismatch, shallow FX markets, and domestic borrowing constraints.[7]

Third, we build on the literature on portfolio frictions of global financiers, dating back to Kouri (1976) and more recently including Gabaix and Maggiori (2015), Cavallino (2019), and Fanelli and Straub (2021). We depart from the literature by adding in capital inflow taxes; we then show that for foreign appetite shocks, neither FX intervention nor capital inflow taxes dominate each other.[8] We also study imperfect FX mismatch and combine the shallow-market friction with other frictions. Our focus on higher premia on local currency debt relative to FX debt follows the empirical evidence in Kalemli-Özcan and Varela (2021). Unlike these papers and us, Bianchi and Lorenzoni (2022) consider only premia on FX external debt; unlike us, they do not permit external debt to be in local currency.[9]

Fourth, we build on the literature on fire sales in housing markets, including Kiyotaki and Moore (1997) and Iacoviello (2005). Caballero and Krishnamurthy (2001) consider the interaction of domestic and external constraints in a flexible-price model without macroprudential policies; Korinek and Sandri (2016) consider different tools at the border versus within the economy, but not within a unified framework. We nest both constraints and tools in an integrated model that also includes shallow FX markets, and then examine the substitutability of the tools.

Fifth, we contribute to the literature on the global financial cycle, including Rey (2013), Bruno and Shin (2015), Obstfeld et al. (2019), and Miranda-Agrippino and Rey (2020). These papers establish cross-border correlations of macro-financial conditions and the global transmission of U.S. monetary policy. We consider a range of external financial shocks which could be related to the global financial

[7] Unlike Farhi and Werning (2014), we do not use terms of trade externalities to motivate capital inflow taxes. Unlike Arce et al. (2019), we do not permit the central bank to use FX intervention to absorb all the private sector debt that is subject to the external debt limit, as we consider that such an intervention would require specialist knowledge that the central bank does not possess.

[8] Unlike our modeling of capital controls as inflow taxes, Gabaix and Maggiori (2015) model them as worsening the portfolio friction of the global financiers. Amador et al. (2020) feature a different model of shallowness, where the external demand for local currency bonds is perfectly elastic up to the financiers' wealth. In their model, there are no financial TOT externalities below the debt limit; as a result, as long as capital inflow taxes are available to set the external return to the foreign interest rate, there is no need for FX intervention.

[9] Relative to this handbook chapter (which includes our work in its survey), our model also differs on other dimensions, including our price stickiness, our external borrowing constraint, and our inclusion of a domestic borrowing constraint.

cycle, without imposing a specific correlation on them. Building on but going beyond correlations in asset prices, we show that the case for deviating from the traditional prescription relates to frictions in EMDEs' domestic and external financial markets.

Outline. Section 2 lays out the model environment. Section 3 characterizes the key trade-offs in the general model and the conditions for the traditional prescription to hold. Section 4 describes the joint use of tools to manage foreign appetite shocks in shallow FX markets. Section 5 considers the joint frictions of shallow FX markets and the external borrowing constraint. Section 6 adds in the domestic borrowing constraint. Finally, section 7 concludes.

2 Model

2.1 Model Overview

We construct a three-period model of a small open economy with dominant currency pricing and a combination of domestic and external financial market frictions. It is composed of households, tradable sector firms, housing sector firms, domestic banks, and global financiers. The planner sets the monetary policy rate, capital inflow taxes, domestic debt taxes on the borrowing of households and housing sector firms, and FX intervention.

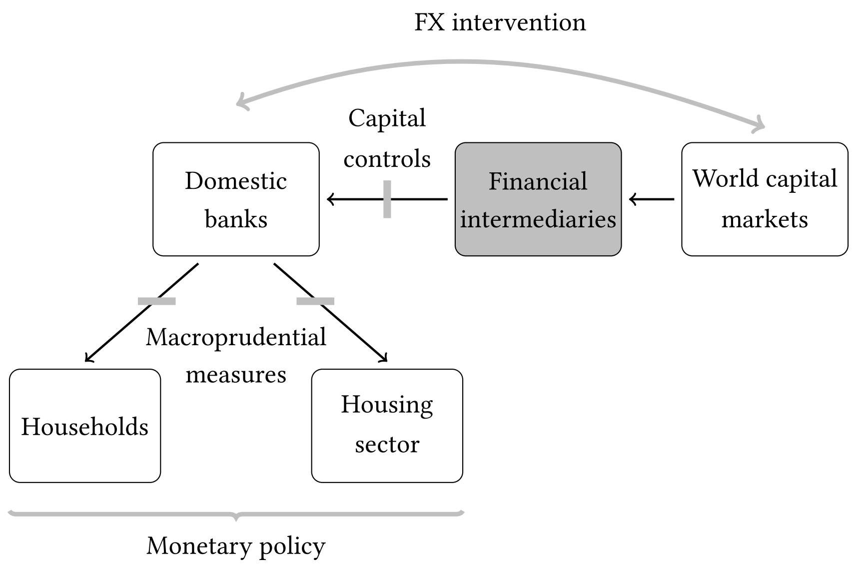
Dominant currency pricing means that prices are sticky in dollars for imports as well as for exports of home-produced tradable goods. The domestically-sold component of the latter has sticky prices set in domestic currency.

The economy's financial structure is shown in figure 4. There are two noncontingent assets—a local currency bond and a dollar bond—and asset market segmentation, i.e., domestic agents can trade only the local currency bond, while global financiers can trade in both bonds subject to a portfolio friction that always binds. These financiers borrow in dollars on the world market and lend at a premium in local currency to domestic banks, where the premium signifies FX market depth and depends on the severity of the portfolio friction. The financiers are partly owned by domestic households, which means that the representative household may have effective FX mismatch on its external borrowing.

Domestic banks borrow from global financiers and lend to domestic agents, and these banks are subject to an occasionally-binding external borrowing constraint. Housing sector firms borrow from domestic banks subject to a separate occasionally-binding domestic borrowing constraint.

Figure 5 shows the timeline. Shocks take one of two values (high, "H", or low, "L") and strike in period 1, after which all uncertainty is resolved.[10] Some policies are implemented by the planner in period 0 in anticipation of shocks (i.e., "ex ante"), while others are implemented in periods 1 and 2 after shocks have been realized (i.e., "ex post"). We consider shocks to productivity as well as to three variables influenced by the global financial cycle: the world interest rate, the foreign appetite for domestic assets (leading to a small-to-moderate "taper tantrum"), and the external pledgability of domestic collateral (leading to a severe "sudden stop"). We generally consider one shock at a time.

Figure 4: Structure of the Financial Market



2.2 Environment

Next, we present the environment for the private sector agents. Their optimization conditions and the construction of the planner problem is detailed in appendix A.

Households maximize the welfare function:[11]

$$\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t U\left(C_{Ht}, C_{Ft}, C_{Rt}, N_t\right)\right]$$

$$\text{where } U\left(C_{Ht}, C_{Ft}, C_{Rt}, N_t\right) = \alpha_H \log C_{Ht} + \alpha_F \log C_{Ft} + (1-\alpha_H-\alpha_F)\log C_{Rt} - N_t,$$

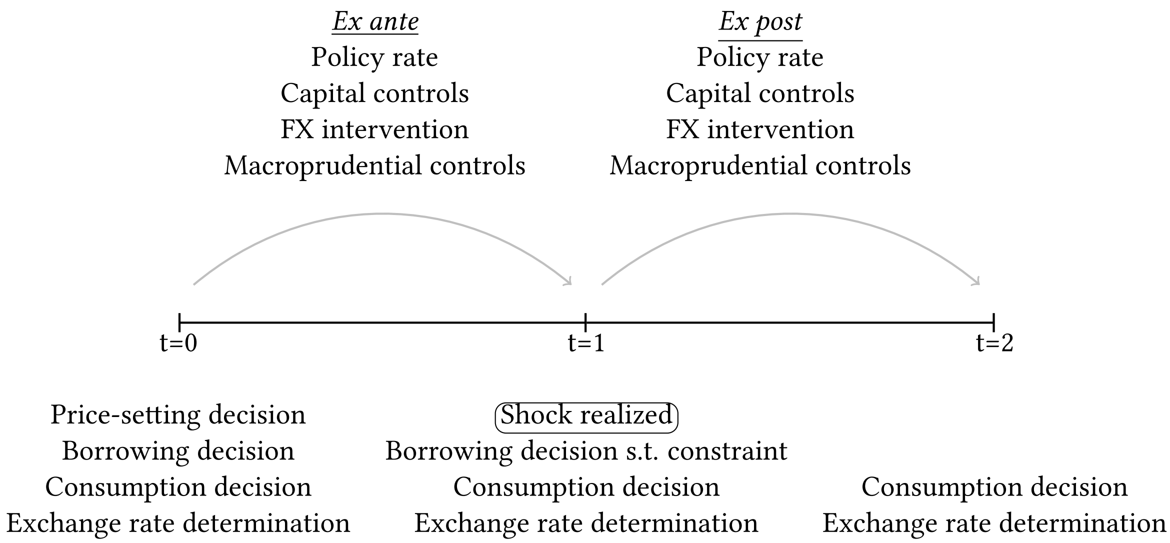
subject to the budget constraint:

$$W_t N_t + \Pi_{Tt} + \Pi_{Bt} + \lambda \Pi_{FIt} + \Pi_{Rt} + T_t + D_{HHt+1}$$

[10] We usually suppress the state of nature; when we wish to emphasize it, we use superscripts, i.e., the variable x may take the values x^H or x^L.

[11] The log preferences over consumption follow Cole and Obstfeld (1981) and the linear disutility of labor follows the special case in Galí and Monacelli (2005).

Figure 5: Timeline of Events



$$\geq P_H C_{Ht} + \mathcal{E}_t C_{Ft} + P_{Rt} C_{Rt} + \left(1 + \theta_{HHt-1}\right)\left(1 + \rho_{t-1}\right) D_{HHt}.$$

On the income side of the budget constraint, W_t is the wage, N_t is labor supply, Π_{Tt} is the profit of tradable sector firms, Π_{Bt} is the profit of domestic banks, λ is the fraction of global financiers owned by domestic households while Π_{FIt} is each financier's profit, Π_{Rt} is the transfer received from housing firms (made only in period 2), T_t is the lump-sum transfer from the planner, and D_{HHt+1} is the domestic-currency debt at the end of period t. On the expenditure side of the budget constraint, P_H and C_{Ht} are the domestic price and consumption of the home-produced tradable good, $\mathcal{E}_t$ is the exchange rate in units of local currency per dollar, the dollar price of imports is normalized to 1, C_{Ft} is the consumption of imports, P_{Rt} and C_{Rt} are the price and consumption of nontradable housing services, θ_{HHt} is the household debt tax between periods t and $t+1$, and ρ_t is the interest rate offered by domestic banks on local currency borrowing between those periods.

Tradable sector firms are monopolistically competitive and set prices at the beginning of period $t = 0$, after which prices are fully rigid.[12] They produce a variety $j \in [0, 1]$ of tradable goods $Y_{Tt}(j)$ using labor $N_t(j)$, with productivity parameter A_t. These varieties may be consumed domestically, $Y_{Ht}(j)$, or exported, $Y_{Xt}(j)$:

$$Y_{Tt}(j) = Y_{Ht}(j) + Y_{Xt}(j) = A_t N_t(j).$$

[12] Owing to this assumption, we omit time subscripts on these prices. This price-setting assumption keeps the model tractable (as in Farhi and Werning, 2016), albeit at the cost of ignoring the welfare effects of price dispersion.

Domestically-sold goods are priced $P_H(j)$ in domestic currency while exported goods are priced $P_X(j)$ in dollars, following Gopinath (2015) and Gopinath et al. (2020). The domestic and export consumption aggregators are respectively:

$$Y_{Ht} = \left(\int_0^1 Y_{Ht}(j)^{(\varepsilon-1)/\varepsilon} dj\right)^{\varepsilon/(\varepsilon-1)} \text{ and } Y_{Xt} = \left(\int_0^1 Y_{Xt}(j)^{(\varepsilon-1)/\varepsilon} dj\right)^{\varepsilon/(\varepsilon-1)}.$$

Labor is taxed at rate ϕ, and the labor market clears at the flexible wage W_t. There is market clearing in the aggregate domestically-sold tradable good, and the aggregated export good is assumed to face a unit-elastic external demand in the export price index P_X:

$$Y_{Ht} = C_{Ht} \text{ and } Y_{Xt} = \frac{C^*}{P_X},$$

where C^* is an index of foreign demand.

Housing sector firms are perfectly competitive and rental prices are flexible. Following Kiyotaki and Moore (1997), there are two housing subsectors, one with a linear production function and the other with a concave production function. Firms in subsector $h \in \{Linear, Concave\}$ purchase land, k_t^h, in period $t \in \{0,1\}$ in order to produce housing services, Y_{Rt+1}^h, in period $t+1$:

$$Y_{Rt+1}^h = \begin{cases} k_t^h & \text{for } h = Linear \\ G\left(k_t^h\right) & \text{for } h = Concave, \end{cases}$$

where G is a continuously differentiable function with $G(0) = 0$, $G' > 0$, $G'' < 0$, and $G'(0) = 1$. Housing sector firms finance their operations by borrowing from domestic banks. In each period, they maximize expected profits from production:

$$\mathbb{E}_t\left[P_{Rt+1}Y_{Rt+1}^h + q_{t+1}k_t^h\right] - \left(1+\theta_{Rt}^h\right)(1+\rho_t)\, q_t k_t^h,$$

where P_{Rt} is the rental price of housing, q_t is the price of land, θ_{Rt}^h is the debt tax, and ρ_t is the interest rate offered by domestic banks. The planner can impose debt taxes on the linear subsector, i.e., $\theta_{Rt}^{Linear} \in \mathbb{R}$, but the concave subsector is unregulated, i.e., $\theta_{Rt}^{Concave} \equiv 0$.[13] The firms receive lump-sum transfers from the planner[14], and in period 2, they remit their final assets to households.

The linear subsector has inherited debt, while the concave subsector has inherited assets: $D_{R0}^{Linear} =$

[13]This assumption is supported by our specification that the concave subsector has its own inherited savings and therefore does not need to borrow from banks. If the planner can impose separate debt taxes on both subsectors, it can render the linear subsector's borrowing constraint always slack by subsidizing the concave subsector and boosting the asset price.

[14]The planner rebates in lump sum the revenues from each housing subsector's debt taxes back to the same subsector, but cannot make additional transfers to that subsector.

$-D_{R0}^{Concave} > 0$. The linear subsector is subject to a borrowing constraint between periods 1 and 2:

$$D_{R2}^{Linear} \leq \kappa_q q_1 k_1^{Linear},$$

where D_{R2}^{Linear} is the subsector's domestic currency debt at the end of period 1, and κ_q is a parameter representing the pledgability of land. The right hand side of the constraint becomes tighter when the land price declines.[15]

Market clearing in the land market requires that the sum of the inputs into the two housing subsectors is equal to the supply, which is inelastic at unity:

$$k_t^{Linear} + k_t^{Concave} = 1,$$

while the market clearing condition for nontradable housing services yields the condition:

$$Y_{Rt}^{Linear} + Y_{Rt}^{Concave} = C_{Rt}.$$

Domestic banks lend to households and the housing sector by transferring funds in local currency from global financiers. At the end of each period t, the total debt position of the economy, D_{t+1}, sums over household and housing sector debts:

$$D_{t+1} = D_{HHt+1} + D_{Rt+1}^{Linear} + D_{Rt+1}^{Concave}.$$

Domestic banks maximize profits:

$$\Pi_{Bt+1} = (\rho_t - i_t)\, D_{t+1},$$

subject to a borrowing constraint between periods 1 and 2:

$$D_2 \leq \kappa_H P_H,$$

where i_t is the domestic policy rate, and κ_H is a parameter representing the external pledgability of domestic tradable goods. Under some circumstances, the constraint becomes tighter in dollar terms when the exchange rate depreciates. This depends on the extent of FX mismatch, which will be discussed below.[16] If banks' constraints do not bind, competition between banks ensures that house-

[15]Departing from Kiyotaki and Moore (1997), the constraint in our model features the current price of land, rather than its future price, because we focus on the externality and not the intertemporal amplification mechanism.

[16]Our implementation is different from Farhi and Werning (2016) so that we can incorporate traded production and imperfect FX mismatch. In subsection 5.3 of Farhi and Werning (2016), all production is nontradable, and households can borrow in foreign currency up to a fraction of the rigid local currency price of the nontradable good. Instead, in our model, households borrow from banks, which in turn can borrow externally up to a fraction of the rigid local currency price of the

holds and the housing sector can borrow and lend at the policy rate: $\rho_t = i_t$. If banks' constraints do bind, the borrowing rate ρ_t rises above the policy rate i_t in order to clear the domestic debt market. A reduction of κ_H in the period-1 L state represents a "sudden stop shock".

Global financiers come in two categories. Optimizing financiers take positions of Q_{t+1} in local currency bonds and $-\frac{Q_{t+1}}{E_t}$ in dollar bonds in period $t \in \{0,1\}$ in order to maximize their dollar profits, subject to a balance sheet friction similar to that in Gabaix and Maggiori (2015):[17]

$$\max_{q_{t+1}} \frac{1}{(1+i_t^*)} \frac{Q_{t+1}}{\mathcal{E}_t} \mathbb{E}_t \left[(1-\varphi_t)(1+i_t) \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} - (1+i_t^*) \right]$$

$$\text{subject to } \frac{1}{(1+i_t^*)} \frac{Q_{t+1}}{\mathcal{E}_t} \mathbb{E}_t \left[(1-\varphi_t)(1+i_t) \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} - (1+i_t^*) \right] \geq \frac{1}{(1+i_t^*)} \Gamma \left(\frac{Q_{t+1}}{\mathcal{E}_t} \right)^2,$$

where i_t^* is the dollar interest rate, φ_t is the capital inflow tax announced in period t and applies to the repayments made to the financial intermediaries in period $t+1$. We assume that in the absence of shocks, $i_t^* = \frac{1}{\beta} - 1$ for all $t \in \{0,1\}$; world interest rate shocks shift i_1^* away from this value. $\Gamma \geq 0$ is a parameter capturing the severity of the balance sheet friction. The constraint always binds, yielding the intermediaries' demand for local currency bonds. To economize on notation, we also use Q_{t+1} to denote the aggregate quantity of local currency bonds. $\Gamma = 0$ represents "deep FX markets" while $\Gamma > 0$ represents "shallow FX markets".

There is a separate group of non-optimizing financiers who have exogenous stochastic demands for local currency debt in period 1. They are not subject to the balance sheet friction described above, and their decision to purchase local currency debt does not depend on expected returns.[18] They hold F_2 in local currency bonds, which is equal to $S_1 = \frac{F_2}{\mathcal{E}_1}$ in dollar value. We label variations in S_1 across period-1 states as "foreign appetite shocks"; a positive value in the H state represents a "surge", while a negative value in the L state represents a "taper tantrum".

FX intervention involves the planner taking a position of O_{t+1} in local currency bonds and $FXI_t = -\frac{O_{t+1}}{\mathcal{E}_t}$ in dollar bonds, with all carry profits and losses rebated to households. In this paper, whether or not unrestrained FX intervention is available depends on the shock.[19] Market

home-produced tradable good. In our model, the representative household's external debt may be effectively partly in local currency and partly in foreign currency, owing to domestic ownership of some global financiers.

[17]Our model concerns a small open economy which is not the dominant global economy. Recognizing that global financiers may reside primarily outside this small open economy, we depart from Gabaix and Maggiori (2015), and assume that financiers maximize profits in dollar value, not in local currency. Owing to this assumption, the financiers' uncovered interest parity condition can be written in a form that parallels the households' Euler condition in the case when balance sheet frictions are absent (i.e., if $\Gamma = 0$).

[18]In practice, such financiers' behavior may be explained by frictions unlike those captured above, e.g., they are subject to irrational herding such that they cannot be induced to hold local currency assets even if offered higher returns.

[19]The planner's FX intervention circumvents the global financiers. This assumption appears to be appropriate for the

clearing in the local currency debt market requires:

$$Q_{t+1} + F_{t+1} + O_{t+1} = D_{t+1}.$$

FX Mismatch. A fraction $\lambda \in (0,1)$ of the global financiers are owned by domestic households and the remaining fraction $(1-\lambda)$ are owned by foreigners. The upshot is that although households borrow only in local currency, they own financiers which purchase a fraction λ of that debt by issuing dollar bonds. Therefore, for the representative household, a fraction λ of its external debt is effectively in FX, as the repayments follow the dollar interest rate, while $(1-\lambda)$ of the external debt is effectively in local currency and repaid at the domestic policy rate. The FX mismatch parameter λ determines the response of macroeconomic variables to any shocks.

Lump-sum transfers to households. The planner rebates in lump sum the revenues from taxes on labor, capital inflows, and household debt, and also the carry profits from FX intervention:

$$\begin{aligned} T_t &= \phi W_t N_t + \varphi_{t-1}\left(1+i_{t-1}\right)\left(Q_t + F_t\right) + \theta_{HHt-1}\left(1+\rho_{t-1}\right) D_{HHt} \\ &\quad + O_t\left[\left(1+i_{t-1}\right) - \left(1+i^*_{t-1}\right)\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right]. \end{aligned}$$

2.3 Planner Problem

The competitive equilibrium can be defined as a function of the initial and terminal conditions and the planner's choice of policy instruments.

Definition (Competitive Equilibrium) A competitive equilibrium for this economy is a set of quantities $\left\{C_{Ht}, C_{Ft}, C_{Rt}, N_t, k_t^{Linear}, k_t^{Concave}, Y_{Ht}, Y_{Xt}, Y_{Rt}^{Linear}, Y_{Rt}^{Concave}, Q_{t+1}, D_{t+1}\right\}_{t=0}^{2}$ and prices $\left\{P_H, P_X, \{\rho_t\}_{t=0}^{1}, \{W_t, \mathcal{E}_t, P_{Rt}, q_t\}_{t=0}^{2}\right\}$ that satisfy the optimization conditions and constraints of households, tradable sector firms, housing sector firms, domestic banks, and global financiers, as well as the market clearing conditions for tradable goods, nontradable housing services, labor, land, and local currency bonds, taking as given the dollar values of all initial and terminal debt stocks and the terminal land price, as well as the values of the policy instruments $\{i_t, \varphi_t, \theta_{HHt},\ \theta_{Rt}^{Linear}, FXI_t\}_{t=0}^{1}$.[20]

foreign appetite shocks in our model, which correspond in practice to hot money flows into and out of local currency government debt. During such shocks, central banks in practice can typically draw on their FX reserves at the opportunity cost of the dollar interest rate, without exhausting the reserves. On the other hand, it does not appear to be appropriate for the planner to use FX intervention to absorb a positive steady-state level of private debt, which in practice is intermediated by banks with specialist knowledge about private sector firms (i.e., knowledge that the planner does not have) and at volumes that would in practice exhaust the central bank's FX reserves.

[20]The set of equations characterizing the competitive equilibrium is provided in subsection 2.2 and in appendix A.1.

We define four wedges which summarize the distance of any allocation from the frictionless first-best frontier. We identify the key externalities related to each wedge, with the proviso that in our integrated framework, the wedges are jointly determined as a result of all the externalities. In this paper, we mainly restrict our focus to the first three wedges.

The first wedge relates to home consumption, as in Farhi and Werning (2016), and arises in the New Keynesian literature owing to the stickiness of the price of domestically-sold tradable goods:

$$\tau_{Ht} = 1 + \frac{1}{A_t}\frac{U_{Nt}}{U_{Ht}} = 1 - \frac{1}{A_t}\frac{C_{Ht}}{\alpha_H}.$$

This "aggregate demand (AD) wedge" is positive if the pre-set domestic price, P_H, is inappropriately high in a particular state of nature, i.e., the domestic demand for home-produced tradable goods is excessively low relative to their cost of production. There is an *AD externality* because households do not internalize the impact of their consumption decisions on the time path of aggregate demand, which determines the appropriateness of the pre-set price, P_H. There may also be a *pecuniary AD externality* because households do not internalize the impact of their decisions on the level of the exchange rate $\mathcal{E}_1$ which affects the domestic banks' external borrowing constraint.

The second wedge measures the expected marginal utility of the consumption loss owing to the external premium on local currency bonds relative to dollar bonds, η_t:

$$\tau_{\Gamma t+1} = (1-\lambda)\,\mathbb{E}_t\left[\left[\eta_{t+1} - (1+i_t^*)\right]\frac{\alpha_F}{C_{Ft+1}}\right], \text{ where } \eta_{t+1} = (1-\varphi_t)\,(1+i_t)\,\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}.$$

This "uncovered interest parity (UIP) wedge" is only non-zero if some global financiers are foreign-owned, i.e., $\lambda < 1$. If the wedge is positive, there is a net reduction in welfare owing to the transfer of resources from the domestic economy to foreign-owned intermediaries. If the FX market is shallow, i.e., $\Gamma > 0$, the premium η_{t+1} is endogenous to the external debt level. In this case, there is what we call a *local currency premium externality* because each household does not internalize that its borrowing decision affects the external premium. By contrast, given the friction generating FX market shallowness and the endogeneity of the premium, the planner would seek to set the wedge at a non-zero level to maximize welfare.

The third wedge measures the marginal utility of the consumption loss owing to the deviation of housing services production from its first-best level:

$$\tau_{Rt} = \left[1 - G'\left(1 - k_{t-1}^{Linear}\right)\right]\frac{\alpha_R}{C_{Rt}}$$

This "housing wedge" is positive if land usage is shifted from the linear to the concave subsector of the housing market. The production of housing services is maximized when the linear subsector uses all of the land in the economy for its production, but production may be reduced if this subsector faces macroprudential taxes and/or binding borrowing constraints. There is a *pecuniary production externality* because housing sector firms do not internalize the impact of their land usage decisions in periods 0 and 1 on the land price q_1 which enters their borrowing constraint.

The fourth wedge relates to export production, and arises from the stickiness of the price of exported tradable goods:

$$\tau_{Xt} = \left(1 - \frac{1}{\gamma}\right) + \frac{1}{P_X}\frac{1}{A_t}\frac{U_{Nt}}{U_{Ft}} = -\frac{1}{P_X}\frac{1}{A_t}\frac{C_{Ft}}{\alpha_F}, \text{ where } \gamma \equiv \frac{1}{P_X Y_{Xt}}\frac{dY_{Xt}}{d\left(\frac{1}{P_X}\right)}.$$

This "terms of trade wedge" arises throughout the standard New Keynesian literature. There is a *terms of trade externality* because while firms do take into account that the demand curve for their own export variety is downward-sloping, they do not internalize that the demand curve for the aggregate export good is also downward-sloping. Under the unit elastic demand assumption for export demand, $1 - \frac{1}{\gamma}$ is zero, and the wedge is always negative.[21] This externality does not appear to be a focus of policymakers in practice. Accordingly, throughout this paper, we define the constrained efficient allocation in a manner that the planner does not internalize this externality.

Definition (Constrained Efficient Allocation) A constrained efficient allocation is a set of quantities $\left\{C_{Ht}, C_{Ft}, C_{Rt}, N_t, k_t^{Linear}, k_t^{Concave}, Y_{Ht}, Y_{Xt}, Y_{Rt}^{Linear}, Y_{Rt}^{Concave}, Q_{t+1}, D_{t+1}\right\}_{t=0}^{2}$ and prices $\left\{P_H, P_X, \{\rho_t\}_{t=0}^{1}, \{W_t, \mathcal{E}_t, P_{Rt}, q_t\}_{t=0}^{2}\right\}$ which maximizes household welfare under full commitment, subject to the restriction that the allocation can be implemented via policy instruments $\left\{i_t, \varphi_t, FXI_t, \theta_{HHt}, \theta_{Rt}^{Linear}\right\}_{t=0}^{1}$ in a competitive equilibrium, and the additional constraint that the planner ignores the impact of its policies on the pre-set export price, P_X.[22]

The Ramsey planner problem takes the following form, integrating the various frictions:

$$V^P = \max_{\left\{C_{Ft}, P_H, \mathcal{E}_t, \eta_{t+1}, FXI_t, k_{t-1}^{Linear}\right\}} \mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t V\left(C_{Ft}, \frac{\mathcal{E}_t}{P_H}, k_{t-1}^{Linear}, A_t\right)\right] \tag{1}$$

subject to the following constraints:

$$\left(1 + i_{-1}^*\right) B_0 = \left[C^* - C_{F0}\right] + \frac{\left[C^* - C_{F1}\right] - (1 - \lambda)\, FXI_0\left[\eta_1 - (1 + i_0^*)\right]}{I_0}$$

[21] With unit elastic export demand, dollar export revenues are invariant to the pre-set export price, P_X, so welfare would be improved with a higher level of P_X than that selected by firms, and a lower level of exports.

[22] The set of equations characterizing the constrained efficient allocation is provided below and in appendix A.2.

$$+\frac{\left[C^{*}-C_{F2}\right]-(1-\lambda)\,FXI_{1}\left[\eta_{2}-(1+i_{1}^{*})\right]}{I_{0}I_{1}}\text{ for }s\in\{L,H\}\tag{2}$$

$$B_{1}I_{0}+\left[C_{F1}-C^{*}\right]+(1-\lambda)\,FXI_{0}\left[\eta_{1}-(1+i_{0}^{*})\right]\leq\kappa_{H}\frac{P_{H}}{\mathcal{E}_{1}}\text{ for }s\in\{L,H\}\tag{3}$$

$$\Gamma\left(B_{1}+FXI_{0}\right)=\mathbb{E}_{0}\left[\eta_{1}-(1+i_{0}^{*})\right]\tag{4}$$

$$\Gamma\left(B_{2}+FXI_{1}-S_{1}\right)=\eta_{2}-\left(1+i_{1}^{*}\right)\text{ for }s\in\{L,H\}\tag{5}$$

$$\begin{aligned}&\chi_{1}\left[\left(1+i_{-1}^{*}\right)B_{R0}^{Linear}-\widehat{P}_{R0}\right]+\chi_{1}\widehat{q}_{0}\left(k_{0}^{Linear}-1\right)-\widehat{P}_{R1}k_{0}^{Linear}+\widehat{q}_{1}\left(k_{1}^{Linear}-k_{0}^{Linear}\right)\\ \leq\;&\kappa_{q}\widehat{q}_{1}k_{1}^{Linear}\text{ for }s\in\{L,H\}\end{aligned}\tag{6}$$

$$\mathcal{E}_{1}\eta_{1}\text{ is equalized across period-1 states }s\in\{L,H\}\,.\tag{7}$$

The indirect utility function V^{P} is defined over imports C_{Ft}, the relative price of imports to domestically-sold tradable goods $\frac{\mathcal{E}_t}{P_H}$, the land usage by the linear housing subsector k_{t-1}^{Linear}, and productivity A_t.

All constraints are written in dollar terms. Equation (2) is the resource constraint, one for each state of nature $s\in\{L,H\}$. $B_{t+1}\equiv\frac{D_{t+1}}{\mathcal{E}_t}$ is the economy-wide dollar debt at the end of period t, and we fix the dollar value of initial economy-wide debt repayments at $\left(1+i_{-1}^{*}\right)B_0$,[23] and the dollar value of final debt $B_3=0$. If $\lambda<1$, there may be carry profits or losses from FX intervention. $I_t\equiv\lambda\left(1+i_t^{*}\right)+(1-\lambda)\,\eta_{t+1}$ is the representative household's effective interest rate on external borrowing between periods t and $t+1$, and reflects the fact that a fraction λ of that debt is effectively in FX while a fraction $(1-\lambda)$ is effectively in local currency.

Equation (3) is the occasionally-binding external borrowing constraint, one for each state of nature s. If $\lambda>0$, the representative household has effective FX mismatch, and the constraint may become tighter as the exchange rate depreciates, because the right hand side of the constraint becomes smaller while the dollar component of the repayments on the left hand side do not.

Equations (4)-(5) are the always-binding "Gamma equations" which relate the external premium on local currency bonds to external borrowing, FX intervention, and foreign appetite shocks. The first of these equations is a single equation, while the second applies state by state.

Equation (6) is the occasionally-binding domestic housing sector borrowing constraint, one for each state of nature, where $B_{Rt+1}^{Linear}\equiv\frac{D_{Rt+1}^{Linear}}{\mathcal{E}_t}$ is the dollar value of the linear housing subsector's local currency debt at the end of period t, $\chi_{t+1}\equiv\left(1+\rho_t\right)\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}$ is the dollar value of domestic repay-

[23] This assumption avoids the artefact of the planner distorting period-0 allocations to reduce the dollar value of repayments on inherited local currency debt.

ments on that debt, and $\widehat{P}_{Rt} \equiv \frac{P_{Rt}}{\mathcal{E}_t}$ and $\widehat{q}_t \equiv \frac{q_t}{\mathcal{E}_t}$ are respectively the dollar values of the rents and price of land in period t. We fix the dollar value of initial debt repayments for linear subsector firms at $\left(1+i_{-1}^*\right) B_{R0}^{Linear} = -\left(1+i_{-1}^*\right) B_{R0}^{Concave}$, the dollar value of final debts of all housing sector firms $B_{R3}^{Linear} = B_{R3}^{Concave} = 0$, the initial land allocation $k_{-1}^{Linear} = 1$, and the dollar value of the final land price at $\widehat{q}_2 = 0$.[24]

Equation (7) imposes that since the external premia on local currency bonds are affected by the exchange rate, the fluctuations in exchange rates and external premia must match each other across period-1 states.

In the absence of shocks, consumption is flat over time and across states, and external debt decreases smoothly from B_0 to 0. Each of our shocks of interest—i.e., productivity shocks, world interest rate shocks, taper tantrums, and sudden stops—may alter the tightness of multiple constraints, thereby affecting macroeconomic allocations and welfare via changing the levels of multiple externalities. Similarly, any policies to address the shocks also affect all the externalities.

The planner problem establishes how each shock is transmitted and the nuances related to the visualization in figure 3. Productivity shocks affect the indirect utility function V^P via the AD wedge. In figure 3, an increase in the world interest rate shifts up the supply of funds curve irrespective of FX market depth, and changes the fundamental cost of external borrowing in the resource constraint (2) and the Gamma equations (4)-(5). The supply curve has slope $(1-\lambda)\,\Gamma$, which is positive only if some of the representative household's external debt is effectively in local currency, i.e., $\lambda < 1$, and the FX markets are shallow, i.e., $\Gamma > 0$. A non-fundamental taper tantrum shifts up the supply curve only if $(1-\lambda)\,\Gamma > 0$. Unlike the world interest rate shock, the taper tantrum's impact on carry profits/losses and external borrowing costs is manipulable by the planner, as shown by equation (5). A sudden stop shock shifts leftward the external borrowing limit of the supply curve, and as shown by equation (3), the magnitude of the shift depends on the effective FX mismatch and the exchange rate depreciation. All shocks that alter financing conditions end up causing volatility in domestic asset prices, and in some circumstances, the housing constraint (6) may bind.

The full integrated model can be used in a variety of ways to zoom in on different policy trade-offs. In the following sections, we first explore the general set of trade-offs, and then we highlight the flexibility of our framework by highlighting some key interactions between different sets of externalities and policy tools.

[24]Fixing the dollar values of initial debts avoids the artefact of the planner depreciating the exchange rate in all periods to an arbitrary magnitude so as to multiply the local currency value of all asset prices and circumvent the sector's borrowing constraint.

3 Key Trade-Offs

In this section, we first characterize the key trade-offs between wedges and externalities for the general model at the constrained efficient allocation. We then establish the conditions under which this allocation can be achieved using the traditional policy prescription, i.e., only monetary policy and exchange rate flexibility. We present some examples of shocks and country characteristics to help illustrate these conditions. These results help fix ideas, so that when we introduce different shocks in the following sections, we can see how the conditions may be violated—and as a result, why there may be a case for using additional instruments such as capital inflow taxes, FX intervention, and domestic debt taxes.

3.1 General Conditions

As in Farhi and Werning (2016), we solve the planner problem via the first order approach, and we explain the first order conditions (FOCs) here. While the FOCs can be derived for any combination of policy instruments, in this section we assume that all instruments are available, and we assume that if any borrowing constraints bind, they do so only in the L state.[25]

Exchange rate flexibility has no adverse effects in the initial and terminal periods when there is no possibility of shocks. Correspondingly, the FOCs for $\mathcal{E}_0$ and $\mathcal{E}_2$ establish that if exchange rates are flexible, the AD wedges are set to zero in these periods:

$$\tau_{H0} = \tau_{H2} = 0. \tag{8}$$

The consumption of home-produced tradable goods is equal to $C_{Ht} = \frac{\alpha_H}{\alpha_F}\mathcal{E}_t C_{Ft}$. Therefore, for any given level of import consumption C_{Ft}, policy rate and exchange rate flexibility can exploit the traditional expenditure-switching mechanism to set C_{Ht} to its desired level and eliminate the AD externality.

By contrast, exchange rate flexibility can potentially generate or reduce other macro distortions in period 1, when shocks strike. Combining the FOCs for $\mathcal{E}_1$ and η_1, the following tradeoff must be satisfied in each period-1 state:

$$\tau_{H1} = \frac{\Psi_B \kappa_H}{\beta I_0 \alpha_H \mathcal{E}_1} - \frac{(1-\lambda)\left(B_1 + FXI_0\right)\eta_1}{\alpha_H}\left[z_1 - \frac{\mathbb{E}_0\left[z_1 \eta_1\right]}{\mathbb{E}_0 \eta_1}\right] + y_{\mathcal{E}1}. \tag{9}$$

[25] Since the FOC for P_H turns out to be redundant, we normalize $P_H = 1$. To save space, we suppress the long-form expressions for some terms; the full expressions are provided in appendix A.3. We assume in this section that when capital controls are perfect substitutes with household debt taxes, the former are used; we return to this issue in section 6. All proofs of results throughout the paper are contained in appendix B.

We next explain one by one the terms on the right hand side. Each of them can cause a deviation of the AD wedge from zero.

The first term reflects the pecuniary AD externality, with Ψ_B denoting the multiplier on the period-1 external borrowing constraint. If the constraint binds, it reduces C_{F1}; and a depreciation tightens the external constraint, reducing C_{F1} further. The existence of this term means that the planner does not depreciate the exchange rate all the way until the AD wedge is set to zero, and as a result the period-1 AD wedges become destabilized. When there is full effective FX mismatch in our model, i.e., $\lambda = 1$ and $I_0 = (1 + i_0^*)$, the term is similar to the one in subsection 5.3 of Farhi and Werning (2016).

The second term reflects the impact of depreciation on external debt repayments and thereby on the economy's dollar wealth. z_t is the marginal value of a dollar in period t, and it may vary across states if a shock affects the economy's dollar wealth and the planner's policy tools cannot perfectly stabilize that wealth. If some of the representative household's external debt is effectively in local currency, i.e., $\lambda < 1$, and the economy's external debt position at the start of period 1 is positive, i.e., $(B_1 + FXI_0)$, the planner can reduce the dollar value of its external debt repayments via depreciation. The term in $\left[z_1 - \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1}\right]$ indicates that depreciation in one state must be offset by appreciation in the other state to ensure that the planner's repayment commitment is satisfied and global financiers' period-0 expected returns are fulfilled. As a result, the planner wishes to depreciate more in the high-z_1 period-1 state, even if it pushes the AD wedge in that state below zero; and appreciate more in the low-z_1 state.

The marginal value of a dollar is defined as follows:

$$z_1 = \frac{1}{\beta I_0}\left[\Phi + \Psi_B + \frac{\Phi}{I_1}(1-\lambda)\Gamma(B_2 + FXI_1) + \Gamma I_0 y_{\eta 2}\right] \text{ and } z_2 = \frac{\Phi}{\beta^2 I_0 I_1}. \tag{10}$$

In each period and state, z_t includes the marginal value of relaxing the resource constraint—captured by Φ, which represents the multiplier on that constraint. In period-1 states, z_1 also includes the marginal value of relaxing the external borrowing constraint, the Gamma equation, and the housing constraint. The third term in the square bracket shows that the shallow-market friction from the Gamma equation is welfare-relevant if $(1-\lambda)\Gamma > 0$, because premia are paid to foreigners if $\lambda < 1$, and premia exceed the world interest rate in expected terms if $\Gamma > 0$. The last term in the square bracket shows that if FX markets are shallow, relaxing the Gamma equation and thereby reducing premia helps support land prices and relax the housing constraint. The sensitivity of this constraint to the premium is captured by $y_{\eta t}$; in the above equation, $y_{\eta 2}$ is non-zero if this constraint is binding, and not otherwise.

The $y_{\mathcal{E}1}$ term in equation (9) reflects the impact of a depreciation on the credit conditions in the domestic housing market. By reducing the dollar value of external debt repayments, the planner is able to ease the effective dollar interest rate for the housing market, and thereby partially insulate land prices from external financial conditions. The rationale to do so would be to relax a binding domestic borrowing constraint for the housing sector; correspondingly, $y_{\mathcal{E}1}$ is non-zero if this constraint is binding, and not otherwise.

The FOCs for $\{C_{Ft}\}_{t=0}^{2}$ are as follows:[26]

$$\frac{\alpha_F}{C_{F0}} = \frac{\beta \mathbb{E}_0 \left[I_0 z_1\right] + \beta \left(1-\lambda\right) \Gamma \left(B_1 + FXI_0\right) \frac{\mathbb{E}_0[z_1 \eta_1]}{\mathbb{E}_0 \eta_1} + y_{F0}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{H0}} \tag{11}$$

$$\frac{\alpha_F}{C_{Ft}} = \frac{z_t + y_{Ft}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{Ht}} \text{ for } t \in \{1, 2\} \,. \tag{12}$$

In periods $t \in \{1, 2\}$, the marginal utility from import consumption should be balanced against the marginal value of the dollar z_t, the AD wedge τ_{Ht}, and the term y_{Ft}, which is only non-zero if the housing sector constraint is binding and represents the incentive to boost import consumption in different periods to push up housing rents and land prices, and/or to change the domestic policy rate, so as to relax that constraint. In period 0, the marginal utility from imports should be balanced against a combination of the following: the expected period-1 marginal value of the dollar; the period-1 temptation to depreciate away the dollar value of repayments on external debt incurred in period 0; and the impact of period-0 import consumption on the period-1 housing sector constraint.

The constrained efficient ex ante and ex post capital inflow taxes are derived by comparing the FOCs for C_{Ft} against the Euler conditions of households:

$$(1-\varphi_0) \frac{\beta \mathbb{E}_0 \left[I_0 z_1\right] + \beta \left(1-\lambda\right) \Gamma \left(B_1 + FXI_0\right) \frac{\mathbb{E}_0[z_1 \eta_1]}{\mathbb{E}_0 \eta_1} + y_{F0}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{H0}} = \beta \mathbb{E}_0 \left[\eta_1 \frac{z_1 + y_{F1}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{H1}}\right] \tag{13}$$

$$(1-\varphi_1) \frac{z_1 + y_{F1}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{H1}} = \beta \eta_2 \frac{z_2 + y_{F2}}{1 + \frac{\alpha_H}{\alpha_F} \tau_{H2}}. \tag{14}$$

Capital inflow taxes may be justified because households do not internalize the externalities which generate the various wedges. As in Farhi and Werning (2016), macroprudential taxes on inflows may be needed to help stabilize AD wedges over time. In our model, capital inflow taxes may also

[26] Even though we have shown above that exchange rate flexibility closes some AD wedges, we keep the below equations fully general by allowing for those AD wedges to be non-zero, so that the equations remain valid even for policy experiments where the reader may choose to impose constraints on exchange rate flexibility.

be needed to address additional externalities, i.e., the role of local currency debt in determining the marginal value of a dollar, the expected period-1 temptation to depreciate away the dollar value of period-0 local currency external debt, and the pecuniary production externality in the housing sector.

In equation (13), the first terms in the numerators of the left hand side and the right hand side may be valued differently because of the difference in the interest rate faced by households, η_1, and by the representative household, I_0. The second term in the numerator of the left hand side reflects that the period-0 debt level must be such that representative household's period-1 temptation to depreciate it away is balanced against its repayment commitment, and it only applies if the shallow-market friction is welfare-relevant, i.e., $(1-\lambda)\,\Gamma > 0$. The final terms in the numerators of both sides of the equation reflect the incentives to boost import consumption in different periods to relax the housing constraint, and it only applies if the housing sector constraint is binding.

Unlike Farhi and Werning (2014), we do not use terms of trade externalities to motivate capital inflow taxes; correspondingly, the conditions above do not include any terms in τ_{Xt}. This result holds despite the fact that under our dominant currency pricing setup, terms of trade externalities may be destabilized by exchange rate movements. As in Egorov and Mukhin (2022), dominant currency pricing alone does not justify capital inflow taxes, as long as the AD wedges are stabilized at zero. Relative to their work, we allow for several frictions which could move the AD wedges away from zero.

The constrained efficient ex ante and ex post FX intervention respectively satisfy the following conditions which combine the FOCs for $\{FXI_t, \eta_{t+1}\}_{t=0}^{1}$:

$$(1-\lambda)\left[\frac{\mathbb{E}_0\left[\eta_1-(1+i_0^*)\right]\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1}+\mathbb{E}_0\left[z_1\left\{\eta_1-(1+i_0^*)\right\}\right]\right]+\frac{\Gamma\mathbb{E}_0\left\{y_{\eta 1}\eta_1\right\}}{\mathbb{E}_0\eta_1}=0 \tag{15}$$

$$(1-\lambda)\left[\left[\eta_2-(1+i_1^*)\right]+\frac{\Gamma S_1}{2}\right]+\Gamma y_{\eta 2}\frac{I_0 I_1}{2\Phi}=0. \tag{16}$$

In the absence of FX intervention, the economy-wide external debt position is related only to import consumption; as a result, consumption must be distorted if the planner wishes to alter the external debt position and thereby affect the UIP wedge. FX intervention enables the planner to move the external debt position without altering consumption. Smoothing external premia is a common justification for FX intervention in recent papers, including Gabaix and Maggiori (2015), Cavallino (2019), and Fanelli and Straub (2021). Our framework allows for a policy mix of both FX intervention and capital inflow taxes to smooth these premia, bearing in mind that different policy mixes have different effects on domestic consumption and on the domestic housing sector.

Equation (15) states that FXI_0 should be set such that the external debt position at the end of period-0 allows the appropriate dollar wealth transfers (via depreciations) across the period-1 states. Equation (16) states that FXI_1 should be set such that the premium between periods 1 and 2 is equal to the world interest rate, unless the non-fundamental foreign appetite shock generates carry profit/loss considerations, or the housing constraint binds.

Finally, the constrained efficient levels of ex ante and ex post housing debt taxes are derived from the FOCs for $\{k_t^{Linear}\}_{t=0}^{1}$:

$$\tau_{R1} = \frac{\Psi_R^L \pi_1^L}{\beta} \left\{ \left[\chi_1^L \widehat{q}_0 - \widehat{P}_{R1}^L - \widehat{q}_1^L \right] + \frac{\partial \left(\chi_1^L \widehat{q}_0 \right)}{\partial k_0^{Linear}} \left(k_0^{Linear} - 1 \right) - \frac{\partial \widehat{P}_{R1}^L}{\partial k_0^{Linear}} k_0^{Linear} \right\} \tag{17}$$

$$\tau_{R2} = \frac{\Psi_R}{\beta^2} \left\{ \begin{array}{c} \left[\widehat{q}_1 + \frac{\partial \widehat{q}_1}{\partial k_1^{Linear}} \left(k_1^{Linear} - k_0^{Linear} \right) \right] - \kappa_q \left[\widehat{q}_1 + \frac{\partial \widehat{q}_1}{\partial k_1^{Linear}} k_1^{Linear} \right] \\ + \frac{\partial (\chi_1 \widehat{q}_0)}{\partial k_1^{Linear}} \left(k_0^{Linear} - 1 \right) \end{array} \right\}, \tag{18}$$

where Ψ_R is the multiplier on the housing constraint, and we can establish the signs $\left\{ \frac{\partial (\chi_1 \widehat{q}_0)}{\partial k_0^{Linear}}, \frac{\partial \widehat{q}_1}{\partial k_1^{Linear}}, \frac{\partial (\chi_1 \widehat{q}_0)}{\partial k_1^{Linear}} \right\} > 0$ and $\frac{\partial \widehat{P}_{R1}^L}{\partial k_0^{Linear}} = 0$ at $k_0^{Linear} = k_1^{Linear} = 1$, and $\frac{\partial \widehat{P}_{R1}^L}{\partial k_0^{Linear}} < 0$ for $k_0^{Linear} < 1$.

Working backward, we first explain equation (18). The housing wedge τ_{R2} exceeds zero in the period-1 L state if shocks have caused $k_1^{Linear} < 1$, i.e., the linear housing subsector is borrowing-constrained and cannot hold all the land, so some of it must be held by the concave subsector. The first square bracket on the right hand side includes the pecuniary production externality: housing firms do not internalize that this shift in land usage reduces its price, i.e., $\frac{\partial \widehat{q}_1}{\partial k_1^{Linear}} > 0$, and thereby tightens the borrowing constraint further. The second square bracket indicates that the planner would like to relax the constraint. Unfortunately, reducing housing debt taxes alone has no effect on the linear subsector's borrowing capacity when it is constrained, but the motive may rationalize distorting other macroeconomic allocations so as to boost land prices. The third term on the right hand side captures the impact of the binding constraint on the wedge via the period-0 land price.[27]

Since ex post housing debt taxes are ineffective when the constraint binds, equation (17) indicates that ex ante housing debt taxes may be a more effective instrument. The first square bracket on the right hand side represents a hedging motive. It is positive if the rent and/or land price are lower than interest payments in the period-1 state when the constraint binds. In that case, the housing constraint would be relaxed in that state if the subsector were holding less land and less inherited debt from the

[27]The restriction $k_1^{Linear} \leq 1$ ensures that $\tau_{R2}^H = 0$ even if $\tau_{R2}^L > 0$: even though the planner wishes to increase $k_1^{Linear,H}$ above 1 in order to support the period-0 land price and relax the housing constraint in the period-1 L state, it is not feasible to do so.

previous period. The planner can implement this outcome by imposing a ex ante housing debt tax on that subsector in period 0, and thereby shift land usage from the linear to the concave subsector in that period, increasing τ_{R1} above zero. The second and third terms indicate that such a shift in land usage would respectively affect the period-0 land price and period-1 rents; both of those terms are zero at $k_0^{Linear} = 1$.

In our model, shocks to other sectors spill over into the housing sector, cause volatility in land prices, and may make the constraint bind. However, in the absence of a binding housing constraint, the constrained efficient allocation of the remainder of the system is unaffected by the presence of the housing sector.

Given this set of FOCs, we are now ready to draw conclusions on the constrained efficient policy mix for different shocks and country characteristics. We start with the case when the traditional prescription is sufficient.

3.2 Traditional Prescription

The constrained efficient allocation may be implemented via the traditional prescription, i.e., only monetary policy and exchange rate flexibility, even if wedges are non-zero and externalities persist. The full set of conditions is as follows. Each of the conditions applies to a designated policy tool, so if any condition is violated, the corresponding policy tool would be used in addition to the traditional prescription.

Proposition 1 (Traditional prescription). *The constrained efficient allocation can be achieved using only the policy rate and exchange rate flexibility iff it jointly satisfies the following conditions (19)-(23):*
(i) capital inflow taxes are zero, when:

$$\frac{\beta \mathbb{E}_0\left[I_0 z_1\right] + \beta\left(1-\lambda\right)\Gamma\left(B_1 + FXI_0\right)\frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1} + y_{F0}}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H0}} = \beta \mathbb{E}_0\left[\eta_1 \frac{z_1 + y_{F1}}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}}\right] \tag{19}$$

$$\frac{z_1 + y_{F1}}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}} = \beta\eta_2 \frac{z_2 + y_{F2}}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H2}} \; \textit{for each state } \{L, H\}\,; \tag{20}$$

(ii) FX intervention can be set to zero, when:

$$\left(1-\lambda\right)\left[\Gamma B_1 \frac{\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1} + \mathbb{E}_0\left[z_1\left\{\eta_1 - \left(1 + i_0^*\right)\right\}\right]\right] = 0 \; \textit{at}\; FXI_0 = 0 \tag{21}$$

$$\tau_{\Gamma 2} = \frac{\alpha_F}{C_{F2}}\left(1-\lambda\right)\Gamma\left(B_2 - S_1\right) \; \textit{for each state } \{L, H\} \tag{22}$$

(iii) housing debt taxes are zero, when:

$$\tau_{R1} = 0, \textit{ and } \tau_{R2} = 0 \textit{ for each state } \{L, H\}, \tag{23}$$

Conditions (19) and (20) respectively ensure that ex ante and ex post capital inflow taxes are not required. The conditions require a balance over time of a combination of AD wedges, the temptation to depreciate away local currency external debt via the UIP wedge, and the incentive to reduce the housing wedge.

Farhi and Werning's (2016) result that macroprudential taxes are not required if the AD wedges are balanced over time continues to apply if we eliminate the shallow market friction (i.e., $(1-\lambda)\Gamma = 0$), assume that the housing sector constraint is not binding (which ensures that $y_{Ft} = 0$), and assume that households borrow at the world interest rate (i.e., $\eta_{t+1} = (1 + i_t^*)$). In this paper, we have extended the conditions to incorporate more frictions, while keeping them tractable. Our extended environment also establishes that capital inflow taxes may not be needed if the use of other tools ensures that conditions (19)-(20) are satisfied.

The two conditions (21) and (22) respectively ensure that ex ante and ex post FX intervention are not required. As mentioned before, the shallow-market friction is welfare-relevant if $(1-\lambda)\Gamma > 0$, because premia are paid to foreigners if $\lambda < 1$, and premia exceed the world interest rate in expected terms if $\Gamma > 0$. Condition (21) states that ex ante FX intervention is zero if there is no need to use it to change the average premia (represented by the first term inside the square brackets) or to redistribute income across period-1 states (represented by the second term). Condition (22) states that ex post FX intervention is not required if other policy tools ensure that the constrained efficient UIP wedge (the left hand side of the equation) can be achieved by the economy having an external debt position that solely reflects the constrained efficient import consumption level, adjusting for any foreign appetite shock (the right hand side of the equation).

Finally, the condition (23) ensures that housing debt taxes are not required. If the housing constraint is not binding ex post, i.e., the ex post housing wedge is zero, there is no need to use debt taxes to distort housing production and create a non-zero housing wedge ex ante.

3.3 Examples of Shocks

For several combinations of shocks and country characteristics, all or most of the conditions in Proposition 1 are satisfied. We assume that $B_0 = 0$ and that $\{\kappa_H, \kappa_q\}$ are sufficiently large that the constraints (3) and (6) are slack.

Lemma 1 (Productivity shock: A_1**).** *Suppose that* $\lambda \in [0,1]$ *and* $\Gamma \in [0,\infty)$. *The policy rate and exchange rate flexibility are sufficient to achieve the constrained efficient allocation. They are set as follows:*

$$(1+i_0) = \frac{1}{\beta A_0}\frac{A_1^L A_1^H}{\pi_1^H A_1^L + \pi_1^L A_1^H},\ (1+i_1) = \frac{1}{\beta},\ \textit{and}\ \mathcal{E}_t = \frac{\alpha_F A_t}{C^*}\ \textit{for}\ t \in \{0,1,2\}\,.$$

The consumption of imports is stabilized at C^*. *The period-1 dollar price of land does not vary across states. AD, UIP, and housing wedges are stabilized, i.e.,* $\left\{\{\tau_{Ht}\}_{t=0}^2, \{\tau_{\Gamma t}\}_{t=1}^2, \{\tau_{Rt}\}_{t=1}^2\right\} = 0$*; and terms of trade wedges are not stabilized:* $\tau_{Xt} = -\frac{1}{\alpha_F P_X}\frac{1}{A_t}C^*$.

Irrespective of effective FX mismatch and FX market depth, the traditional prescription is sufficient to manage productivity shocks. After a positive shock, the exchange rate depreciates to incentivize households to consume more of the domestically-produced tradable goods which are now in greater supply. The dollar price and volume of exports are both static under dominant currency pricing, so there is no change in external dollar wealth, and subsequently no change in import consumption. Our extended setting allows for more policy tools and frictions than in the dominant currency paradigm of Gopinath et al. (2020) and Casas et al. (2017). Nevertheless, their key results are preserved after productivity shocks: the exchange rate depreciates proportionally to the shock; and the planner can stabilize the AD wedge but not overall output wedges—specifically, the terms of trade wedge is destabilized across states by the productivity shock.

Lemma 2 (World interest rate shock: i_1^***).** *Suppose that* $\lambda = 1$ *and* $\Gamma = 0$. *The policy rate and exchange rate flexibility alongside ex ante capital controls are sufficient to achieve the constrained efficient allocation. They are set as follows:*

$$(1+i_0) = \frac{\mathbb{E}_0\left[\frac{\eta_1 C_{F0}}{(C_{F1})^2}\right]}{\beta\mathbb{E}_0\left[\frac{\eta_1}{C_{F1}}\right]},\ (1+i_1) = \frac{1}{\beta},\ \textit{and}\ \mathcal{E}_t = \frac{\alpha_F A}{C_{Ft}}\ \textit{for}\ t \in \{0,1,2\}\,.$$

$$\varphi_0 = 1 - \beta\mathbb{E}_0\left[\frac{\eta_1 C_{F0}}{C_{F1}}\right],$$

The consumption of imports follows $\frac{1}{C_{F0}} = \mathbb{E}_0\left[\frac{1}{C_{F1}}\right]$ *and* $\frac{C_{F2}}{C_{F1}} = \beta\left(1+i_1^*\right)$. *The period-1 dollar price of land follows* $\widehat{q}_1 = \beta\frac{\alpha_R}{\alpha_F}C_{F1}$. *AD, UIP, and housing wedges are stabilized, i.e.,* $\left\{\{\tau_{Ht}\}_{t=0}^2, \{\tau_{\Gamma t}\}_{t=1}^2, \{\tau_{Rt}\}_{t=1}^2\right\} = 0$*; and terms of trade wedges are not stabilized:* $\tau_{Xt} = -\frac{1}{\alpha_F P_X}\frac{1}{A}C_{Ft}$.

For full FX mismatch and deep FX markets, world interest rate shocks can be handled using a combination of capital inflow taxes ex ante and the traditional prescription ex post. An increase in the world interest rate could be one subcomponent of a tightening of the global financial cycle. After such a shock, import consumption declines and the exchange rate depreciates. The ex ante capital inflow taxes help insure the economy against future shocks to dollar wealth. Consistent with the empirical evidence in Rey (2013) and Miranda-Agrippino and Rey (2020), global financial conditions are transmitted into domestic asset markets, and the dollar price of land decreases. However, additional frictions need to be binding before there is a case for the ex post use of tools. Unlike in Farhi and Werning (2014), ex post capital inflow taxes do not vary with the world interest rate, because in our framework, the tool is not used to stabilize terms of trade externalities.[28] Unlike in Fanelli and Straub (2021), there are no distributional concerns in our model for ex post FX intervention to address after a world interest rate shock.

In the following sections, we will use different specifications of our model to zoom in on combinations of frictions where the use of capital inflow taxes, FX intervention, and domestic debt taxes may be desirable.

4 Stabilizing Surges and Tantrums

In this section, we show that to manage destabilizing foreign appetite shocks, capital inflow taxes and FX intervention should be used jointly ex post, and *instead of* the policy rate and exchange rate flexibility.

Foreign appetite shocks in our model correspond to "surges" into and "taper tantrums" out of local currency debt. Such shocks may be small-to-moderate in size, and are relevant for EMDEs with foreign participation in domestic asset markets. We analyze the interaction of the shocks with FX market depth, while abstracting for now from the external and domestic borrowing constraints. In line with what we sometimes observe in practice, and departing from most of the literature, we use our framework to allow for the use of *multiple* tools, rather than just one tool at a time, to manage these shocks.

4.1 Externalities and Policy Tools

We consider non-fundamental local currency "surges", i.e., $S_1^H > 0$, and "taper tantrums", i.e., $S_1^L < 0$. As in the previous section, we assume that $B_0 = 0$ and that $\{\kappa_H, \kappa_q\}$ are sufficiently large that the constraints (3) and (6) are slack. Making these constraints slack means that the pecuniary AD

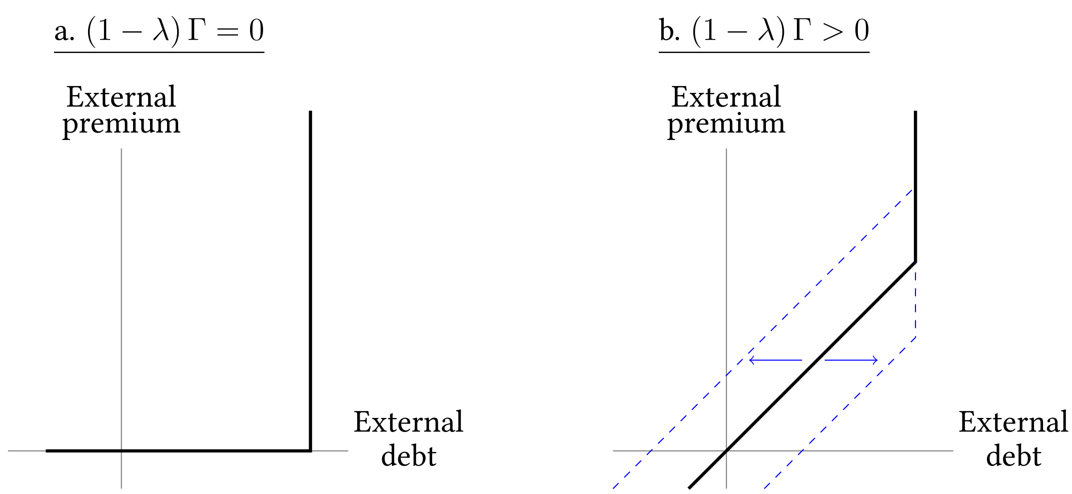
[28] Their paper considers shocks to risk premia that affect the interest rate on external transactions for the economy as a whole even under deep FX markets; these shocks would encompass the world interest rate shocks in our model.

and pecuniary production externalities are not salient, and that domestic debt taxes are not needed, i.e., $\Psi_B = \{\tau_{Rt}\}_{t=1}^{2} = \{\theta_{Rt}\}_{t=0}^{1} = \{\theta_{HHt}\}_{t=0}^{1} = 0$. These assumptions help simplify the analysis for now, but we revisit the external borrowing constraint and housing market later in the paper.[29]

Correspondingly, in this section, the relevant externalities for the planner to handle are the AD and local currency premium externalities, and the set of tools comprises FX intervention and capital inflow taxes alongside the policy rate and exchange rate flexibility. Allowing FX intervention appears to be appropriate for foreign appetite shocks. In practice, these shocks constitute hot money flows into and out of local currency government debt at various points of the global financial cycle. Central banks can typically draw on their FX reserves, at the opportunity cost of the dollar interest rate, to manage such shocks without exhausting the reserves. No specialist knowledge is required for the central bank to conduct such intermediation. Capital inflow controls can also be applied at the border and take the form of taxes or subsidies, depending on the shock.

Section 2 established that the impact of foreign appetite shocks depends on whether $(1-\lambda)\,\Gamma$ is zero or positive. As shown in panel a of figure 6, the supply of external funds is perfectly elastic up to the external debt limit if $(1-\lambda)\,\Gamma = 0$, and foreign appetite shocks do not shift the supply curve. Panel b of the figure shows that if $(1-\lambda)\,\Gamma > 0$, the supply curve is upward-sloping up to the external debt limit, and foreign appetite shocks horizontally shift the upward-sloping portion of the supply curve.

Figure 6: Foreign appetite shocks



[29]Foreign appetite shocks can affect the housing market, and the policy mix used to handle the shocks is important in determining the impact on land prices. We return to this issue in section 6.

4.2 Perfect Stabilization Result

The policy response depends on whether $(1-\lambda)\,\Gamma$ is zero or positive. The following lemma applies if there is no local currency component of external debt, i.e., $\lambda = 1$, or if FX markets are deep, i.e., $\Gamma = 0$.

Lemma 3 (Elastic external supply). *Suppose that $(1-\lambda)\,\Gamma = 0$. Irrespective of foreign appetite shocks, AD and UIP wedges are stabilized, i.e., $\left\{\{\tau_{Ht}\}_{t=0}^{2}, \{\tau_{\Gamma t}\}_{t=1}^{2}\right\} = 0$; imports are stabilized, i.e., $\{C_{Ft}\}_{t=0}^{2} = C^*$; FX intervention is indeterminate and can be set to zero, i.e., $\{FXI_t\}_{t=0}^{1} = 0$; capital inflow taxes are zero except for $\{\lambda = 1, \Gamma > 0\}$, in which case they are set $\{\varphi_0 = 0, \varphi_1 = \beta\Gamma S_1\}$; the policy rate and exchange rate do not vary across states, i.e., $\left\{(1+i_t) = \frac{1}{\beta}\right\}_{t=0}^{1}$ and $\{\mathcal{E}_t\}_{t=0}^{2} = \frac{\alpha_F A}{C_F}$.*

If FX markets are deep, i.e., $\Gamma = 0$, foreign appetite shocks and FX intervention both have no macroeconomic impact, so FX intervention is indeterminate and can be set to zero. Since there is no macroeconomic destabilization, there is no need to alter the setting of any other policy tools. If there is full effective FX mismatch alongside shallow FX markets—i.e., $\lambda = 1$ and $\Gamma > 0$, and both the optimizing and non-optimizing global financiers are fully owned by domestic households—the foreign appetite shock is effectively no longer an external shock but a domestic one. FX intervention remains indeterminate, while capital inflow taxes are transformed into a domestic financial instrument which addresses the non-fundamental disruption; they no longer manage the economy's external premia.

The more interesting specification in this section is $(1-\lambda)\,\Gamma > 0$, in which case foreign appetite shocks do shift the supply curve of external funds. In the special case of symmetric foreign appetite shocks, we obtain closed-form solutions and a perfect stabilization result.

Proposition 2 (Perfect stabilization). *Suppose that $(1-\lambda)\,\Gamma > 0$ and $S_1^H = -S_1^L > 0$. AD wedges and imports are stabilized, but the UIP wedges between periods 1 and 2 are not. FX intervention and capital inflow taxes are jointly used ex post while the policy rate and exchange rate do not vary across states. Ex ante capital inflow taxes are set to zero.*

$$\tau_{Ht} = 0 \textit{ for } t \in \{0,1,2\}$$

$$\tau_{\Gamma 1} = 0 \textit{ and } \tau_{\Gamma 2} = -\frac{(1-\lambda)\,\Gamma S_1}{2}\frac{\alpha_F}{C_F}$$

$$\varphi_0 = 0 \textit{ and } \varphi_1 = \frac{\beta\Gamma S_1}{2}$$

$$FXI_0 = -B_1 \textit{ and } FXI_1 = \frac{S_1}{2} - B_2$$

$$(1+i_t)=\frac{1}{\beta}\ \textit{for}\ t\in\{0,1\}\,,\ \textit{and}\ \mathcal{E}_t=\frac{\alpha_F A}{C_F}\ \textit{for}\ t\in\{0,1,2\}\,,$$

where $B_1=\frac{(1-\lambda)\Gamma(S_1)^2}{4\left(1+\frac{1}{\beta}+\frac{1}{\beta^2}\right)}$, $B_2=\left(1+\frac{1}{\beta}\right)B_1$ *and* $C_{Ft}=C_F=C^*+B_1$ *for* $t\in\{0,1,2\}$.

The planner aims to stabilize the AD wedge while also manipulating the UIP wedge to expand the economy's resource constraint at the expense of the non-optimizing global financiers. According to the above proposition, the joint use of FX intervention and capital inflow taxes ensures that both objectives are achieved.

During inflow shocks, the planner accumulates FX reserves and imposes an inflow tax, while during outflow shocks, the planner borrows FX reserves and imposes an inflow subsidy. From section 3, equation (14) shows that ex post capital inflow taxes balance AD wedges τ_{Ht} and the marginal value of a dollar z_t between periods 1 and 2, adjusting for the local currency premium η_2; while equation (16) shows that ex post FX intervention maintains a non-zero UIP wedge between these periods to maximize carry profits when there is a foreign appetite shock.[30] Through a combination of inflow tax revenues and carry profits from FXI, the planner augments the resource constraint in each state by $\frac{1}{4}(1-\lambda)\Gamma(S_1)^2$.

In the case of symmetric shocks, this revenue is identical across period-1 states, so z_1 is identical across states, indicating that import consumption is stabilized across states. Inserting these findings into equation (9), we obtain that $\tau_{H1}=0$ in both states, indicating that there is no movement in the policy rate or exchange rate across states.

In period 0, the economy borrows externally to pull forward a portion of the revenues from future FX intervention and capital inflow taxes. Ex ante FX intervention is used to fully absorb this debt position, i.e., $(B_1+FXI_0)=0$, because there is no carry gain from maintaining a non-zero UIP wedge in period 0. As a result, equation (19) is satisfied, and the ex ante capital inflow tax is zero.

While there seems to be three policy tools (i.e., the policy rate, FX intervention, and capital inflow taxes) to handle two externalities (i.e., AD and premium), each tool is not equivalent as it tackles different margins. FX intervention and capital inflow taxes are each costly tools which together can manage the premium externality ex post. Once the UIP wedges are set appropriately, there is no more destabilization of the AD externality, so the policy rate no longer needs to move to address foreign appetite shocks.[31]

[30] From equation (5), the planner can potentially use FX intervention to absorb the foreign appetite shocks entirely, i.e., $FXI_1=S_1$. However, this policy would stabilize the AD wedge at the expense of carry profits, which is not constrained efficient.

[31] In work that is subsequent to ours, Itskhoki and Mukhin (2022) show that our result also holds even in modified

FX intervention and capital inflow taxes must be jointly used ex post if perfect stabilization is to be achieved. The following corollary characterizes the outcome when one of these tools is not available, as is more common in the literature.

Corollary 1 (Missing tools). *Suppose that* $(1-\lambda)\,\Gamma > 0$. *If either FX intervention or capital inflow taxes are not available ex post, there is imperfect stabilization of AD wedges, import consumption, policy rates, and exchange rates across period-1 states and over time.*

In the absence of FX intervention or capital inflow taxes ex post, it is no longer possible for the planner to achieve all of its objectives, and stabilization is imperfect. The policy rate cannot simply replace the missing tool because it tackles a different margin. In the absence of capital inflow taxes, the external premium is connected to the policy rate. FX intervention cannot stabilize AD wedges without also eliminating carry profits. In the absence of FX intervention, the economy-wide external debt position is connected to the level of import consumption. Capital inflow taxes cannot earn revenues at the expense of the non-optimizing financiers without also distorting imports and AD wedges.

Under imperfect stabilization, surges push down the cost of external borrowing and boost imports, while taper tantrums have the opposite effect. The case when only FX intervention is available is related to Cavallino (2019) and Fanelli and Straub (2021). The case when only capital inflow taxes are available is related to Bianchi and Lorenzoni (2022), although they consider a shock to Γ instead, and in their model the premium externalities apply to FX external borrowing (while they do not permit local currency external borrowing).

Rey (2013) proposed capital controls as one option to prevent the transmission of the global financial cycle to domestic credit conditions. Our results show that both FX intervention and capital inflow taxes should be used when the shallow-market friction leaves a country vulnerable to the foreign appetite component of the global cycle. EMDEs sometimes use the full range of tools in such circumstances (see, e.g., Ghosh et al., 2017); our model provides frictions-based guidance by identifying circumstances in which the traditional prescription is not constrained efficient.

Our integrated framework can also be used to show that foreign appetite shocks may generate more adverse consequences when additional frictions are considered. Specifically, beyond the considerations described in this section, the foreign appetite component of the global cycle may also be transmitted into domestic credit conditions in such a manner that the domestic housing constraint (6)

settings; in their example, they use a log-linearized approach and they assume that Γ is related via a specific functional form to exchange rate volatility. We use a nonlinear approach and we are neutral on Γ, as its relation to exchange rate volatility may be ambiguous.

binds. In such a case, the welfare impact of these shocks should include the cost of a domestic credit crunch, and the optimal policy considerations may be altered. We return to this issue in section 6.

4.3 Sign of the Ex Ante Capital Inflow Tax

Figures 7 and 8 show qualitative simulations to explore how moving from symmetric to asymmetric shocks, i.e., moving away from Proposition 2's assumption that $S_1^H / \left|S_1^L\right| = 1$, affects the use of the ex ante capital inflow tax and the ex post policy mix of capital inflow taxes and FX intervention.

Figure 7 shows the allocations when the ex post use of these tools is permitted. Their use continues to follow equations (14) and (16), and panels (a) and (b) show that the tools remain jointly used. However, since these tools cannot augment the economy-wide resource constraint by the same amount in both states, z_1 varies across period-1 states. Following equation (9), the policy rate and exchange rates also vary across states, but they never become the main policy tools to handle the foreign appetite shocks: they simply seek to exploit any period-0 external debt position (which is necessarily small, as $B_0 = 0$) in order to shift a little of the FX value of external debt repayments from the low-wealth to the high-wealth state.

Panel (c) shows that the ex ante capital inflow tax deviates from zero as soon as there is imperfect stabilization ex post (although here, it remains small relative to the ex post tax). The planner acts to manage the period-0 external debt position owing to the potential for future externalities that it generates once foreign appetite shocks strike, as well as the potential for some redistribution of the FX value of external debt repayments ex post.

Figure 7: Asymmetric Shocks: Capital Inflow Taxes and FX Intervention

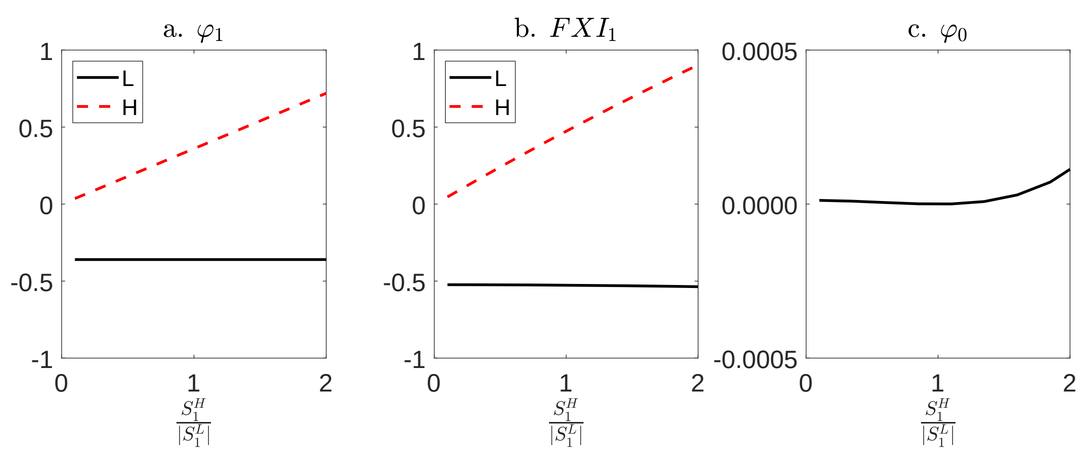
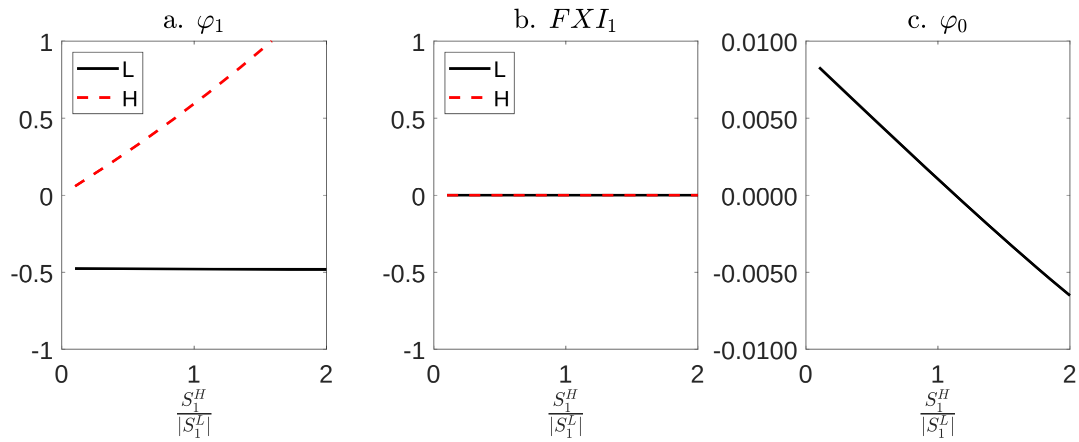


Figure 8 shows that the sign of the ex ante capital inflow tax also depends on whether a tool is

Figure 8: Asymmetric Shocks: Only Capital Inflow Taxes



missing. In this figure, FX intervention is not permitted. In panel (c), the ex ante capital inflow tax is positive if the expected taper tantrum is large relative to the expected inflow surge, while the ex ante capital inflow tax is negative if the expected inflow surge is large relative to the expected taper tantrum. The reason is that the constrained efficient level of period-0 debt depends on the expected period-1 cost of external financing (and hence, local currency premium externalities). In practice, such expectations can differ widely over time, depending on country-specific conditions and the stage in the global financial cycle.

The take-away is that if the main shock facing a country is a non-fundamental foreign appetite shock into local currency external debt, the joint ex post use of capital inflow taxes and FX intervention appears to be a robust result, while the sign of the ex ante capital inflow tax depends on expectations about future capital flows and on whether FX intervention is permitted.

5 Managing Sudden Stop Risks

While the frictions are typically treated separately in the literature, many EMDEs face the *combined* frictions of shallow FX markets and an occasionally-binding external borrowing constraint. In this section, we show that these countries' constrained efficient policy mix includes an ex ante capital inflow tax and ex post policy rate loosening, with the relative role of the two tools determined by the FX mismatch in external debt and by FX market depth. If available, ex ante FX mismatch regulations reduce the ex post pecuniary AD externality; whether or not they reduce ex ante capital inflow taxes depends on FX market depth. Such regulations may not be calibrated to eliminate all FX mismatch, because doing so may aggravate the local currency premium externalities associated with shallow

FX markets. As a result, the economy retains FX mismatch and remains exposed to a "sudden stop".

A sudden stop shock makes the external borrowing constraint bind. Such episodes are typically rare and severe, and may generate a domestic credit crunch and a collapse in consumption. Here we analyze the interaction of a sudden stop shock with the effective FX mismatch of external debt and the depth of the FX market, while abstracting for now from the housing sector's borrowing constraint.

5.1 Externalities and Policy Tools

We consider a sudden stop shock, i.e., a reduction of κ_H in the period-1 L state which makes the external borrowing constraint (3) bind, with $\Psi_B^L > 0$. We assume that $B_0 > 0$, so that there is external debt subject to the shock; specifically, in the absence of the shock, $B_0 > B_1 > B_2 > B_3 = 0$, and we consider a shock that alters debt levels $\left\{B_1, B_2^L, B_2^H\right\}$, maintains the debt inequalities, and causes $C_{F1}^L < C_{F1}^H$. We assume that κ_q is sufficiently large that the housing constraint (6) is slack. As a result, pecuniary production externalities are not salient, and housing debt taxes are not needed, i.e., $\{\tau_{Rt}\}_{t=1}^2 = \{\theta_{Rt}\}_{t=0}^1 = \{\theta_{HHt}\}_{t=0}^1 = 0$.[32]

Correspondingly, in this section, the relevant externalities for the planner to handle are the AD, pecuniary AD, and local currency premium externalities. We focus on a set of tools comprising capital inflow taxes, the policy rate, and exchange rate flexibility; and in subsection 5.4, ex ante FX mismatch regulations. We rule out FX intervention for sudden stop shocks, i.e., we set $\{FXI_t\}_{t=0}^1 = 0$ and remove conditions (15)-(16). In practice, sudden stop shocks limit private-sector external debt. The central bank does not typically have the specialist knowledge about the creditworthiness of private-sector firms that would be necessary to easily circumvent the global financiers and absorb the private-sector debt.[33]

Ex post capital inflow taxes are redundant in the period-1 L state. The reason is that when the constraint (3) binds, the domestic borrowing rate must be higher than the policy rate, to prevent households' debt from exceeding the external debt limit. The households' Euler condition is as follows:

$$\frac{C_{F2}^L}{C_{F1}^L} = \beta \left(1 + \rho_1^L\right) \frac{\mathcal{E}_1^L}{\mathcal{E}_2^L} \text{ where } \left(1 + \rho_1^L\right) > \left(1 + i_1^L\right) = \frac{\eta_2^L}{\left(1 - \varphi_1^L\right)} \frac{\mathcal{E}_2^L}{\mathcal{E}_1^L}.$$

While the ex post capital inflow tax φ_1^L can alter the policy rate i_1^L, the latter does not affect domestic activity, so there is no welfare cost to anchoring the policy rate as follows: $\left(1 + i_1^L\right) = \eta_2^L \frac{\mathcal{E}_2^L}{\mathcal{E}_1^L}$ and

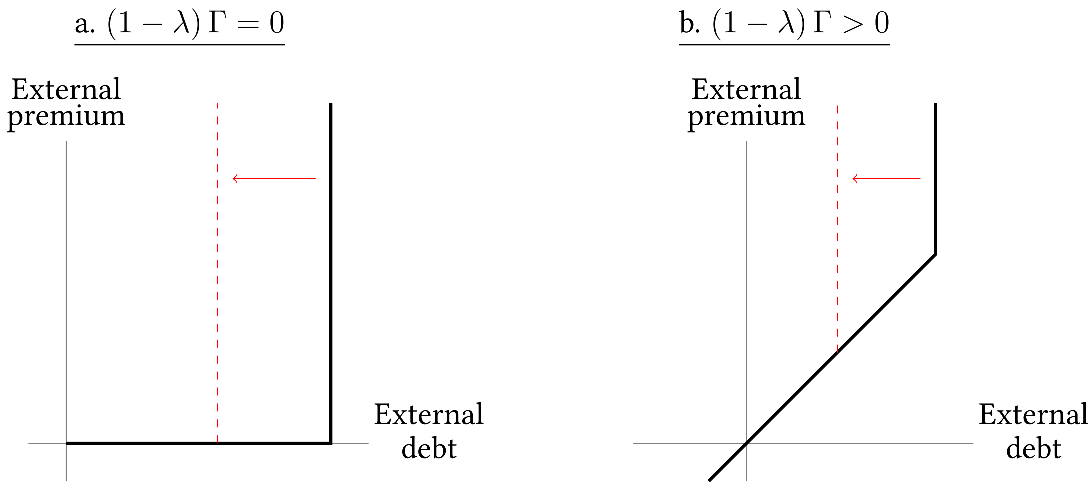
[32] Sudden stop shocks can affect the housing market, and the policy mix used to handle the shocks is important in determining the impact on land prices. We return to this issue in section 6.

[33] In this respect, and in allowing for shallow FX markets, our approach differs from that of Arce et al. (2019).

$\varphi_1^L = 0$.

As described in section 2, a sudden stop shock shifts leftward the external borrowing limit of the supply curve. The degree of effective FX mismatch λ can play a distinct role independent of FX market depth, while the welfare-relevance of the shallow-market friction continues to depend on the product term $(1-\lambda)\,\Gamma$ as in section 4. Equation (3) establishes that the size of the shift is the outcome of an amplification mechanism, depending on the effective FX mismatch λ and the exchange rate depreciation.[34] Figure 9 shows that there may also be an effect on the external premium. Panel a shows that if $(1-\lambda)\,\Gamma = 0$, a sudden stop shock does not generate any change in the external premium; by contrast, panel b shows that if $(1-\lambda)\,\Gamma > 0$, a reduction in external debt reduces the premium.

Figure 9: Sudden stop shocks



5.2 Ex Post Macroeconomic Destabilization

As equation (10) indicates, if a sudden stop shock causes $\Psi_B^L > 0$, the marginal value of a dollar varies across period-1 states. Combining with equations (9) and (12), we obtain the following result.

Lemma 4 (Marginal value of a dollar). *The marginal value of a dollar satisfies* $z_1^L > \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1} > z_1^H$.

Import consumption declines in the period-1 L state, which requires an exchange rate depreciation to eliminate the AD externality, but that motive must be balanced against the other externalities.

[34] Amador et al. (2020) present a model where the supply of funds is elastic up to the wealth of foreign intermediaries. The rationale for capital controls and/or FX intervention in their framework differs from ours, and relates to the maintenance of a non-zero UIP wedge due to a zero lower bound on the policy rate, combined with an external debt limit constraint because the wealth of the intermediaries is binding. Another difference is that our functional form for the external debt limit allows for amplification via FX mismatch and the exchange rate.

Inserting the second part of the lemma into equation (9), and since $B_1 > 0$, we can derive the following signs for the AD wedges in period-1 states:

$$\tau_{H1} = \frac{\Psi_B \kappa_H}{\alpha_H \beta I_0 \mathcal{E}_1} - \frac{(1-\lambda) B_1 \eta_1}{\alpha_H} \left[z_1 - \frac{\mathbb{E}_0 [z_1 \eta_1]}{\mathbb{E}_0 \eta_1} \right] = \begin{cases} \tau_{H1}^L > 0, \tau_{H1}^H = 0 \text{ if } \lambda = 1 \\ \tau_{H1}^L \lesseqqgtr 0, \tau_{H1}^H > 0 \text{ if } \lambda \in [0,1) \, . \end{cases} \tag{24}$$

If there is full effective FX mismatch, i.e., $\lambda = 1$, exchange rate movements do not change the FX value of external debt repayments, so the second term is zero and the sign of the AD wedge depends only on whether the pecuniary AD externality is present or not. As a result, the AD wedge is positive in the period-1 L state, indicating depressed domestic consumption of home-produced tradable goods, and zero in the H state.

Allowing for less-than-full FX mismatch alters this result. If some of the external debt is effectively in local currency, i.e., $\lambda < 1$, the second term is non-zero. The policy rate is loosened to depreciate the exchange rate more in the period-1 L state, reducing the AD wedge and making it ambiguous in sign: if λ is low, it is possible that the incentive to depreciate away the FX value of local currency external debt dominates the strength of the pecuniary AD externality, and the AD wedge becomes negative. To satisfy the planner's repayment commitment and fulfill global financiers' period-0 expected returns, the planner appreciates the exchange rate in the period-1 H state such that the AD wedge is unambiguously above zero in that state.

Throughout section 5, we make the following assumption, which means that the exchange rate depreciates when the sudden stop shock strikes. In practice, this case accords with EMDEs' experience; in our qualitative simulations, it holds true when the decrease in import consumption is severe.

Assumption 1 (Ex post depreciation). *At $t = 1$, the exchange rate is more depreciated in the L state than in the H state, i.e., $\mathcal{E}_1^L > \mathcal{E}_1^H \Leftrightarrow \eta_1^L < \eta_1^H$.*

Combining Lemma 4 and Assumption 1, we establish that the local currency premium is lower precisely when the marginal value of a dollar is higher:

$$Cov(z_1, \eta_1) < 0.$$

5.3 Case for an Ex Ante Capital Inflow Tax

Next, we focus one by one on different parameterizations of $\{\lambda, \Gamma\}$, to show how the case for an ex ante capital inflow tax depends on FX mismatch and FX market depth.

Proposition 3 (Special case). *Suppose that* $\{\lambda = 1, \Gamma = 0\}$*. The ex ante capital inflow tax is positive, i.e.,* $\varphi_0 > 0$*; ex post capital inflow taxes are zero, i.e.,* $\varphi_1 = 0$*; AD wedges follow* $\left\{\tau_{H1}^L > 0, \tau_{H1}^H = 0, \{\tau_{Ht}\}_{t=0,2} = 0\right\}$*; and UIP wedges are zero, i.e.,* $\{\tau_{\Gamma t}\}_{t=1}^2 = 0$*.*

In the special case of full effective FX mismatch and deep FX markets, there are no local currency premium externalities to consider. Since the AD wedge is positive in the period-1 L state and zero in the H state, the marginal-utility-weighted AD wedge in that period is positive. Recognizing this problem, it is constrained efficient for the planner to impose a capital inflow tax in period 0 to induce households to consume and borrow less in that period, and instead shift their demand into period 1. This case accords with the finding in subsection 5.3 of Farhi and Werning (2016), as they assume full FX mismatch and deep FX markets.[35]

Departing from this case, the effect of reducing FX mismatch λ depends on the shallow-market friction Γ.

Lemma 5 (Welfare and FX mismatch). *Starting at a constrained efficient allocation, consider a marginal change in* λ*. The planner values the associated welfare change as follows:*

$$\beta B_1 Cov\left(z_1, \eta_1\right) + \Gamma\left\{\beta\left(B_1\right)^2 \mathbb{E}_0 z_1 + \beta^2 \mathbb{E}_0\left[z_2\left(B_2\right)^2\right]\right\} \tag{25}$$

This valuation comes from the envelope condition of the Ramsey planner problem.[36] Only the first term applies if FX markets are deep, and it is negative, indicating that the planner prefers FX mismatch λ to be lower. The reason is that in this case, equation (4) indicates that the average local currency return across period-1 states is equal to the world interest rate, so given Assumption 1, the return in the L state is lower than the world interest rate. As a result, if more of the external debt is effectively in local currency rather than in FX, the FX value of external debt repayments declines in the period-1 L state, so there is a relaxation of the economy's constraints in that state.

If FX markets are shallow, the second term applies too, and it is positive. In this case, the average local currency premium across period-1 states exceeds the world interest rate. As a result, if more of the external debt is effectively in local currency, the average FX value of external debt repayments increases, which hurts welfare and makes the expression (25) ambiguous.

Going from this welfare effect to the impact on the constrained efficient ex ante capital inflow tax is not trivial. A marginal reduction in FX mismatch λ mechanically changes the FX value of

[35]There is a difference between our proof and theirs because their model has only FX debt, while in our framework, households base their decisions on the local currency borrowing rate even when the representative household's external debt is effectively entirely in FX. Assumption 1 is sufficient to take care of that disconnect.

[36]Consistent with our statement of the constrained efficient allocation, the planner ignores the impact of its policy decisions on the pre-set export price, P_X.

repayments in the period-1 states, and may relax the economy's constraints in the period-1 L state. However, this outcome is not sufficient for the ex ante capital inflow tax to be lower, for two reasons. First, the rationale for the tax is based on the time path of the AD wedge, not import consumption. In the extreme, relaxing the external borrowing constraint while increasing the AD wedge may increase the constrained efficient level of the tax; away from the extreme, the desired change in the tax may be too cumbersome to be intuitive. Since the form of equation (9) is complicated, so is the marginal movement in the AD wedge. Second, local currency premium externalities also need to be considered.

Our framework offers us an alternative approach to theoretically decompose the various effects, which we then illustrate via simulations. For the remainder of this subsection, we consider the following *feasible* perturbation associated with a marginal change in the exogenous parameter λ.

Perturbation 1 (Lower λ). *Starting at a constrained efficient allocation, consider a marginal reduction in λ. Suppose that the planner reoptimizes all policy tools according to the FOCs in subsection 3.1, except that $\left\{\mathcal{E}_1^L, \mathcal{E}_1^H\right\}$ are held fixed (alongside $\{FXI_t\}_{t=0}^1 = 0$).*

The rationale for such a perturbation approach is twofold. First, fixing the exchange rates $\left\{\mathcal{E}_1^L, \mathcal{E}_1^H\right\}$ ensures that any increase in import consumption in the period-1 L state feeds directly through to a reduction in the AD wedge, while removing equation (9) from consideration. Second, the approach is equally valid for a range of formulations of the borrowing constraint, because it ensures that the external debt limit on the right hand side of the borrowing constraint (3) remains unchanged.[37]

We consider this perturbation first for deep FX markets and then for shallow FX markets.

Proposition 4 (Deep FX markets). *Suppose that $\Gamma = 0$. After Perturbation 1, the planner achieves a preferred allocation. It also sets a lower ex ante capital inflow tax φ_0, provided that the following sufficient condition holds:*

$$\frac{I_0^L}{\left(C_{F1}^L\right)^2}\left[\beta \frac{\left(C_{F2}^H\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)+1\right] - \frac{I_0^H}{\left(C_{F1}^H\right)^2} > 0. \tag{26}$$

Given the sufficient condition, the usefulness of the ex ante capital inflow tax to the planner decreases as the effective FX mismatch decreases and more of the external debt is effectively in local currency. The sufficient condition is trivially satisfied with inequality at $\lambda = 1$, because that parameterization implies that $I_0^L = I_0^H$, while the sudden stop shock by definition pushes down C_{F1}^L relative to C_{F1}^H. The condition may be satisfied for all $\lambda \in [0, 1]$, or violated for some low values of λ.

[37] The approach remains valid as long as the right hand side of equation (3) takes the form of κ_H multiplied by an *arbitrary* function of $\frac{P_H}{\mathcal{E}_1}$.

The intuition is as follows. From equation (4) and Assumption 1, setting $\Gamma = 0$ implies that:

$$\eta_1^L < (1 + i_0^*) < \eta_1^H.$$

Therefore, if more of the external debt is effectively in local currency, the FX value of the external debt repayment decreases in the period-1 L state and increases in the H state. The relaxation of the resource and external borrowing constraints, (2)-(3), in the L state is allocated entirely to higher import consumption in that state, and via Perturbation 1, a lower AD wedge. The tightening of the resource constraint in the H state leads to lower import consumption that is smoothed over periods 1 and 2, since there is no binding borrowing constraint in that state. It causes a higher AD wedge in the H state, but because of the smoothing, it is weighted less; correspondingly, the term in square brackets in equation (26) weights the L state more.

Households consume more in period 0 because of the relaxation of the external borrowing constraint in the period-1 L state. The planner is willing to let them consume more, and indeed to reduce the ex ante capital inflow tax, if the marginal-utility-weighted reduction of the AD wedge in the L state offsets the marginal-utility-weighted increase in the AD wedge in the H state, taking into account that the latter is mitigated by the feasibility of smoothing. Equation (26) encompasses this trade-off.

Proposition 5 (Shallow FX markets). *Suppose that $\Gamma > 0$. After Perturbation 1, the planner achieves a preferred allocation provided that:*

$$B_1 \begin{bmatrix} z_1^L \pi_1^L \left[(1+i_0^*) - \eta_1^L\right] \\ -z_1^H \left[\pi_1^L \left[(1+i_0^*) - \eta_1^L\right] + \Gamma B_1\right] \end{bmatrix} > \left[\beta \pi_1^L \frac{\alpha_F}{C_{F2}^L} \Gamma \left(\frac{\kappa_H}{\overline{E}_1^L}\right)^2 + \beta \pi_1^H \frac{\alpha_F}{C_{F2}^H} \Gamma \left(B_2^H\right)^2\right]. \tag{27}$$

It also sets a lower ex ante capital inflow tax φ_0, provided that the following set of sufficient conditions (28)-(31) holds:

$$\begin{gathered} \pi_1^L \left[(1+i_0^*) - \eta_1^L\right] \frac{1}{\left(C_{F1}^L\right)^2} \left[I_0^L + (1-\lambda)\,\Gamma B_1 \frac{\eta_1^L}{\mathbb{E}_0 \eta_1}\right] \omega_1 \\ - \left[\pi_1^L \left[(1+i_0^*) - \eta_1^L\right] + \Gamma B_1\right] \frac{1}{\left(C_{F1}^H\right)^2} \left[I_0^H + (1-\lambda)\,\Gamma B_1 \frac{\eta_1^H}{\mathbb{E}_0 \eta_1}\right] > 0 \end{gathered} \tag{28}$$

$$z_1^L \pi_1^L \left[(1+i_0^*) - \eta_1^L\right] - z_1^H \left[\pi_1^L \left[(1+i_0^*) - \eta_1^L\right] + \Gamma B_1\right] - \Gamma B_1 \frac{\mathbb{E}_0\left[z_1 \eta_1\right]}{\mathbb{E}_0 \eta_1} > 0 \tag{29}$$

$$\Gamma \begin{bmatrix} \left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H + (1-\lambda)\,\Gamma B_1 \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0 \eta_1}\right] \\ -2\,(1-\lambda)\,\mathbb{E}_0\left[z_1 \eta_1\right] \end{bmatrix} \geq 0 \tag{30}$$

$$\Gamma \beta B_2^H \left[R_1^H B_2^H + 2 C_{F2}^H\right] \omega_2 \geq 0, \tag{31}$$

where $\omega_1 = \frac{\frac{\left(C_{F2}^H\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)+\beta\left[\left(R_1^H\right)^2+2(1-\lambda)\Gamma C_{F2}^H\right]}{\beta\left[\left(R_1^H\right)^2+2(1-\lambda)\Gamma C_{F2}^H\right]}$, $R_1^H = \frac{1}{\beta} + 2\left(1-\lambda\right)\Gamma B_2^H$, *and* ω_2 *is a function contained in appendix B.*

The set of sufficient conditions is larger and more likely to be violated than the condition from Proposition 4. The usefulness of the ex ante capital inflow tax to the planner may not decrease as the effective FX mismatch decreases, because as more of the external debt is effectively in local currency, the salience of the UIP wedge and the local currency premium externality increases. The planner needs the ex ante capital inflow tax to address this externality.[38]

We explain the conditions one by one. The criterion for a preferred allocation, condition (27), is trivially satisfied when $\Gamma = 0$, because of Lemma 4 and Assumption 1. However, it must be checked when $\Gamma > 0$. The condition establishes that a redistribution of the FX value of external debt repayments from the period-1 L state to the H state is desirable because the marginal value of a dollar is higher in the L state. If $\Gamma > 0$, the condition additionally needs to take into account that the shallow-market friction increases the external repayments in both states. From equation (4), setting $\Gamma > 0$ implies that:

$$\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = \Gamma B_1 > 0 \text{ and } \pi_1^H\left[\eta_1^H - (1+i_0^*)\right] = \pi_1^L\left[(1+i_0^*) - \eta_1^L\right] + \Gamma B_1.$$

For the reduction in FX mismatch to reduce the FX value of external debt repayments and relax the constraints in the period-1 L state, we require $\eta_1^L < (1+i_0^*)$; this requirement is reflected in the first term in the square bracket on the left hand side of condition (27). As Γ and/or B_0 (and consequently, B_1) get larger, the expected external premium increases. For moderate Γ, $\eta_1^L < (1+i_0^*)$ is still satisfied, but the side-effect of reducing external repayments in the L state is to increase them substantially in the H state; this insight is reflected in the second term in the square bracket. For large Γ, it may even be that $\eta_1^L < (1+i_0^*)$ is not satisfied in the L state.

The right hand side of condition (27) additionally takes into account that if $\Gamma > 0$, a reduction in FX mismatch leads to higher local currency external debt, and therefore higher external premia to be paid on that debt, between periods 1 and 2.

Condition (28) is an amended version of condition (26), and is less likely to be satisfied because of the shallow-market friction. The first reason is that as described above, the shallow-market fric-

[38]Conditions (27)-(30) are sufficient and not necessary conditions, so it is possible for a preferred allocation to be achieved and capital inflow taxes to be reduced even if some conditions hold and others do not, as long as any violations of the conditions are small. The proof of the proposition in appendix B contains the full (albeit rather cumbersome) expressions needed to derive both necessary and sufficient conditions.

tion increases the external repayments in both states, which modifies both terms in condition(28). The second reason is that if $(1-\lambda)\,\Gamma > 0$, both terms are further modified with the square brackets $\left[I_0 + (1-\lambda)\,\Gamma B_1 \frac{\eta_1}{\mathbb{E}_0 \eta_1}\right]$; these terms incorporate the fact that the period-0 debt decision must ensure that the planner's period-1 temptation to depreciate away the FX value of external debt is balanced against its repayment commitment. Given Assumption 1, this second modification makes the condition less likely to be satisfied.

Like condition (27), condition (29) is trivially satisfied when $\Gamma = 0$ as a result of Lemma 4 and Assumption 1; however, it must be checked when $\Gamma > 0$. The condition includes the benefit of redistribution of the FX value of external debt repayments from the period-1 L state to the H state, but also takes into account that the shallow-market friction amplifies the increase in external repayments in the H state, and in addition, it worsens the planner's period-1 depreciation temptation.

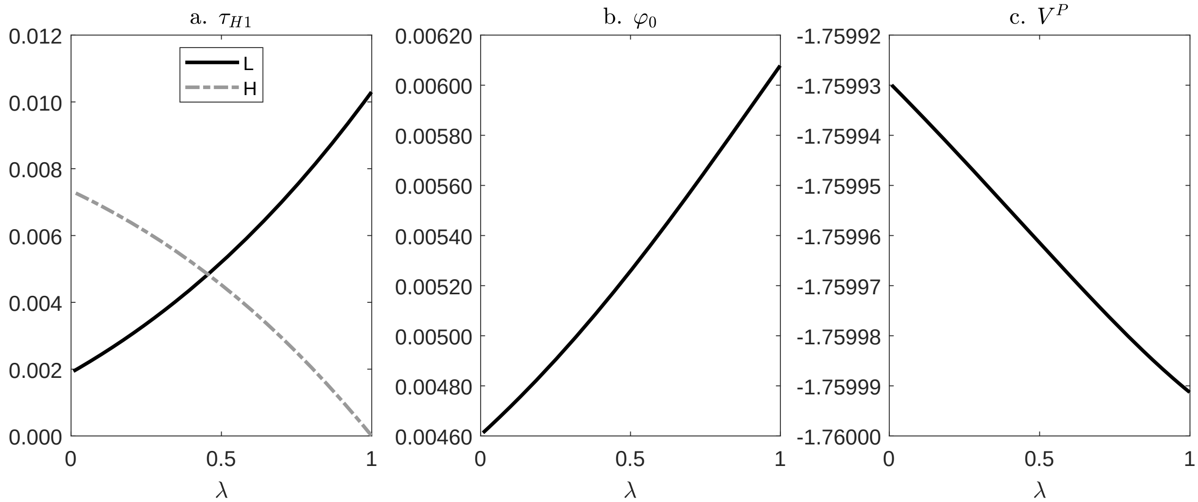
Conditions (30) and (31) are also trivially satisfied when $\Gamma = 0$, but must be checked when $\Gamma > 0$. Condition (30) reflects how the planner views any increase in households' consumption in period 0 arising from households anticipating that constraints are relaxed in the future. There are two competing effects on the constrained efficient ex ante capital inflow tax. On the one hand, households face a higher expected local currency borrowing rate than the representative household does, i.e., $\mathbb{E}_0 \eta_1 > \mathbb{E}_0 I_0$; as a result, households may consume too little, and this is reflected in the positive terms in the square bracket. On the other hand, households do not internalize the premium externality; as a result, they may consume too much, and this is reflected in the negative terms in the square bracket. If λ is high, the first effect dominates the second, so the ex ante capital inflow tax has less of a role and condition (30) is satisfied. If λ is low, however, the second effect dominates the first, and the conclusions are reversed.

Finally, condition (31) relates to a similar trade-off related to households' consumption and external borrowing in the period-1 H state, via the Gamma equation (5). While figure 9 shows that the external borrowing constraint reduces debt and premia in the L state, premia remain high in the H state.

Relaxing the restrictions of Perturbation 1 and applying the full set of FOCs in subsection 3.1, figures 10 and 11 show simulations of the constrained efficient allocations as a function of FX mismatch.[39] The above results help us understand these simulation results. Figure 10 sets $\Gamma = 0$. Panel (a) shows that as FX mismatch λ decreases, the AD wedge in the period-1 L state decreases, while the AD wedge in the H state increases. Panels (b) and (c) show that as FX mismatch λ decreases, the

[39] The parameterization of the simulations is contained in appendix C.

Figure 10: FX Mismatch in Deep FX Markets



ex ante capital inflow tax decreases and welfare increases.

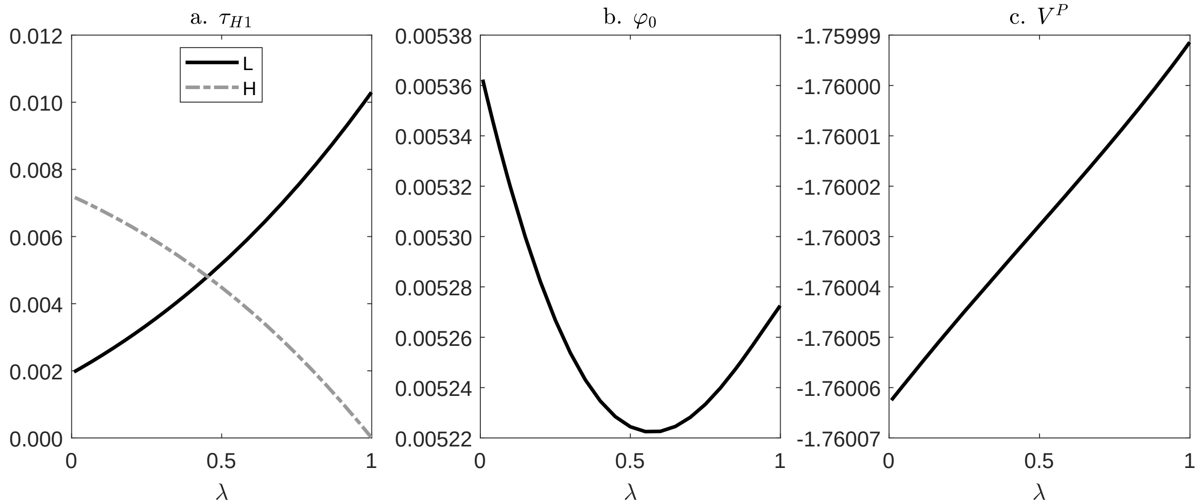
Figure 11 sets $\Gamma > 0$ but otherwise maintains the same parameterization. Having shallow FX markets alters the constrained efficient allocations. Panel (b) shows that starting from full FX mismatch, i.e., $\lambda = 1$, a decrease in λ is associated with first a decrease but then an increase in the ex ante capital inflow tax, as the premium externalities become more salient. Panel (c) shows that welfare decreases as λ decreases.

These results show how the case for an ex ante capital inflow tax depends on FX mismatch and FX market depth. Bianchi and Lorenzoni (2022) rationalize such a tax in a model with nominal rigidities where all external debt is in FX, this FX debt incurs an external premium, and there is a reduced-form "fear of floating" during sudden stops. Our model differs on several dimensions, including our occasionally-binding external borrowing constraint, the inclusion of a domestic borrowing constraint, and our incorporation of imperfect FX mismatch in external debt, with local currency debt incurring a higher premium than FX debt as in the empirical literature (e.g., Kalemli-Özcan and Varela, 2021). As a result, in this section we can reveal that FX mismatch and FX market depth combined help determine the nature of the ex post policy mix and the role of the ex ante capital inflow tax.

5.4 Ex Ante FX Mismatch Regulation

So far, we have assumed that the effective FX mismatch is exogenous. However, while the normative literature on external borrowing constraints typically focuses on capital control taxes on borrowers, many countries actually impose FX mismatch regulations on financial institutions. With a small

Figure 11: FX Mismatch in Shallow FX Markets



extension to the framework, we can analyze such a regulation.

In this subsection, we assume that the planner has jurisdiction over the domestically-owned fraction, λ, of the global financiers. These are the financiers responsible for representative household's FX mismatch. Suppose that the planner can reduce FX mismatch ex ante by shutting down a fraction $\xi \in [0,1]$ of the domestically-owned financiers, while allowing the rest of them to operate. Such a policy forces the FX mismatch onto the foreign-owned fraction of the financiers. The following lemma describes the amended system.[40]

Lemma 6 (FX mismatch regulation). *Suppose that $\lambda \in (0,1)$. Definitions 2.3 and 2.3 continue to apply, subject to the following changes: (i) the exogenous parameter λ is replaced by the new choice variable, $\widehat{\lambda} \equiv \frac{(1-\xi)\lambda}{(1-\xi)\lambda+(1-\lambda)} \in [0,\lambda]$; (ii) the exogenous parameter Γ is replaced by $\widehat{\Gamma} \equiv \frac{\Gamma}{(1-\xi)\lambda+(1-\lambda)} \in \left[\Gamma, \frac{\Gamma}{(1-\lambda)}\right]$; and (iii) the constrained efficient allocation includes an additional equation describing the FOC with respect to $\widehat{\lambda}$:*

$$\frac{dV^{Planner}}{d\widehat{\lambda}} = \beta B_1 Cov\left(z_1,\eta_1\right) + \Gamma\left\{\beta\left(B_1\right)^2\mathbb{E}_0 z_1 + \beta^2\mathbb{E}_0\left[z_2\left(B_2\right)^2\right]\right\}$$
$$+\Gamma\frac{1-\widehat{\lambda}}{1-\lambda}\left\{\beta\left(B_1\right)^2\left[\frac{Cov\left(z_1,\eta_1\right)}{\mathbb{E}_0\eta_1}+\mathbb{E}_0 z_1\right]+\beta^2\mathbb{E}_0\left[z_2\left(B_2\right)^2\right]\right\}, \quad (32)$$

where $\frac{d\widehat{\lambda}}{d\xi} < 0$ and $\frac{d\widehat{\Gamma}}{d\xi} > 0$.

[40] An increase in ξ is a tighter regulation. We impose $\lambda \in (0,1)$ in Lemma 6: for the regulation to be defined, we require $\lambda > 0$; and for an equilibrium to exist even when ξ is set to 1, there must remain some participants in the FX market, i.e., we require $\lambda < 1$.

From items (i) and (ii), the regulation can reduce the effective FX mismatch, but if the FX markets are shallow, i.e., $\Gamma > 0$, the regulation has side-effects: it makes markets even shallower by removing a subset of an already-constrained set of global financiers; and it shifts premium payments on local currency debt from domestically-owned to foreign-owned financiers. These side-effects exacerbate the local currency premium externality.

Item (iii) of the lemma establishes how the planner sets the regulation. If FX markets are deep, i.e., $\Gamma = 0$, only the first term on the right hand side of equation (32) applies. Since Assumption 1 ensures that $Cov(z_1, \eta_1) < 0$, the planner chooses at the margin to shut down domestically-owned financiers and thereby reduce $\widehat{\lambda}$. The regulation can be tightened until one of two outcomes is reached: either the FX mismatch is eliminated; or the allocation changes such that Assumption 1 no longer holds, and $Cov(z_1, \eta_1) = 0$ instead because $\mathcal{E}_1^L = \mathcal{E}_1^H$.

If FX markets are shallow, i.e., $\Gamma > 0$, we already know from Lemma 5 that the planner may not prefer a lower FX mismatch. On top of the considerations in that lemma, the tool available to the planner in this subsection has an additional cost in terms of worsening FX market depth and shifting premium payments on local currency debt from domestically-owned to foreign-owned financiers. This cost is captured by the third term on the right hand side of equation (32). If Γ is sufficiently large, the second and third terms on the right hand side may offset the first term. In such a case, the planner would prefer to only partially reduce FX mismatches, or not to regulate them at all.

The above insights are collected in the proposition below.

Proposition 6 (Tightness of regulation). *If $\Gamma = 0$, the planner chooses to reduce $\widehat{\lambda}$ until either the FX mismatch is eliminated or the economy reaches $Cov(z_1, \eta_1) = 0$. Denote this value of $\widehat{\lambda}$ as $\widehat{\lambda}_{\Gamma=0}$. For sufficiently high Γ and B_0, the planner selects $\widehat{\lambda} \in \left(\widehat{\lambda}_{\Gamma=0}, \lambda\right]$.*

The normative literature on ex ante capital inflow taxes (e.g., Bianchi, 2011; Benigno et. al., 2013; and Jeanne and Korinek, 2020) implicitly assumes that FX markets are deep. Our model suggests that an ex ante FX mismatch regulation is a useful additional tool precisely in this context, perhaps costlessly substituting for those capital inflow taxes. By contrast, introducing the shallow-market friction from a separate literature (e.g., Gabaix and Maggiori, 2015) into the model helps us understand that ex ante FX mismatch regulations may not be used so comprehensively that they eliminate pecuniary AD externalities, because their use also exacerbates premium externalities. Therefore, countries with shallow FX markets are more likely to retain FX mismatch and remain exposed to a sudden stop shock, rationalizing ex ante capital inflow taxes as well.

The model also suggests that policy reforms to improve FX market depth, i.e., reduce Γ, can have both direct and indirect benefits: not only do they directly reduce the shallow-market friction and external premia, but they also make the planner more likely to tighten ex ante FX mismatch regulations and thereby reduce pecuniary AD externalities.

6 Insulating the Domestic Asset Market

In this section, we show that if domestic credit markets are large and leveraged, the planner may have to *recalibrate* the mix of policy tools used to handle external shocks. Tools that appear to similarly stabilize external borrowing when handling foreign appetite shocks may actually have divergent effects on the risk of a binding domestic borrowing constraint; while the mix of ex ante and ex post tools used to manage sudden stops also affects whether such a constraint binds.

The housing market in our model corresponds broadly to domestic credit markets with local currency lending where domestic assets are used as collateral. Such markets have grown in size in a range of EMDEs with varying degrees of the shallow-market and sudden-stop frictions. These markets are not immune from the global financial cycle; as Rey (2013) and Miranda-Agrippino and Rey (2020) establish, global financial conditions are transmitted into domestic asset prices. We show that in the real-world environment of multiple frictions, the case for deviating from the traditional prescription and the constrained efficient policy mix both depend on how the domestic and external frictions *interact* after shocks.

6.1 Externalities and Policy Tools

In this section, we consider the spillovers from foreign appetite and sudden stop shocks to the housing market. We assume that the housing constraint is slack in the period-1 H state, and may possibly bind in the L state. For the housing constraint to have a chance of binding, we make the following assumption throughout this section, which ensures that the linear housing subsector has positive debt remaining at the end of period 1.

Assumption 2 (Positive housing debt). *It is not possible for the linear housing subsector to repay all its inherited debt by the end of period 1:* $\frac{1}{\beta}\left[\left(1+i^*_{-1}\right)B^{Linear}_{R0}-\widehat{P}_{R0}\right]-\widehat{P}_{R1}>0.$

The relevant externalities for the planner to handle are the AD, pecuniary AD, premium, and pecuniary production externalities.

In the literature on external borrowing constraints, it is understood that capital inflow taxes are isomorphic to a range of domestic and external regulations that increase the cost of borrowing for domestic households (see, e.g., Bianchi, 2011, and Erten et al., 2021). Similarly, in our model, in the absence of a binding domestic borrowing constraint, capital inflow taxes φ_t and household debt taxes θ_{HHt} are perfect substitutes, with the following equivalence:

$$(1-\varphi_0)\,\frac{\alpha_F}{C_{F0}} = (1+\theta_{HH0})\,\beta\mathbb{E}_0\left[\eta_1\frac{\alpha_F}{C_{F1}}\right] \text{ and } (1-\varphi_1)\,\frac{\alpha_F}{C_{F1}} = (1+\theta_{HH1})\,\beta\eta_2\frac{\alpha_F}{C_{F2}}. \tag{33}$$

As a result, in the previous sections, we focused solely on capital inflow taxes and set household debt taxes to zero.

Capital inflow taxes and household debt taxes are no longer perfect substitutes in the period-1 L state if the housing constraint binds in that state. The capital inflow tax disconnects global financial conditions from all domestic borrowing interest rates, for both households and the housing sector. By contrast, in the absence of the capital inflow tax, the domestic policy rate is equated to external returns. The use of the household debt tax can stabilize the borrowing rate for households, but land prices and returns in the housing sector are tied to the policy rate. The reason is that land is priced by the marginal productivity of the unregulated concave subsector. Variation in land prices is not welfare-relevant if the housing constraint is slack; but if it binds, i.e., $\Psi_R^L > 0$, welfare is affected, and the perfect substitutability result is broken. The separate housing debt tax θ_{R1}^{Linear} can be used to attempt to alter the borrowing rate for the linear housing subsector, but it is ineffective if the housing constraint binds.

If the external borrowing constraint also binds, the capital inflow tax φ_1 becomes redundant. As a result, if a sudden stop shock causes both the external and domestic borrowing constraints to bind, neither the capital inflow tax nor the housing debt tax are effective (nor are they perfect substitutes for each other, but that now becomes a moot point).

6.2 Foreign Appetite Shocks and Housing Markets

We consider symmetric foreign appetite shocks, which can take the form of surges or taper tantrums. Proposition 2 in subsection 4.2 established that for a country with shallow FX markets but no binding borrowing constraints, it should use capital inflow taxes and FX intervention jointly ex post, without any need for an ex ante capital inflow tax. If the country additionally faces the possibility of a domestic borrowing constraint, the following proposition applies.

Proposition 7 (Substitutability). *Suppose that $(1-\lambda)\,\Gamma > 0$ and $S_1^H = -S_1^L > 0$. There exists $\overline{\kappa}_q > 0$ such that:*

(i) For $\kappa_q \in [\overline{\kappa}_q, \infty)$, capital inflow taxes and household debt taxes are perfect substitutes in welfare

terms, achieving zero housing wedges and housing debt taxes, i.e., $\left\{\{\tau_{Rt}\}_{t=1}^{2}, \{\theta_{Rt}^{Linear}\}_{t=0}^{1}\right\} = 0.$

(ii) For $\kappa_q \in [0, \overline{\kappa}_q)$*, capital inflow taxes and household debt taxes are not perfect substitutes. The use of capital inflow taxes achieves zero housing wedges and housing debt taxes. However, the use of household debt taxes is associated with a binding housing constraint, non-zero AD wedges, and the violation of conditions (19) and (23) (except the knife-edge case where* y_{E1} *is zero and the* $\{y_{Ft}\}_{t=0}^{1}$ *terms balance in condition (19)).*

If the land pledgability parameter κ_q is above a threshold value $\overline{\kappa}_q$, FX intervention can be combined with household debt taxes instead of capital inflow taxes without any welfare impact.

If the planner uses capital inflow taxes alongside FX intervention as in Proposition 2, all the terms in the housing constraint (6) are identical across period-1 states: the dollar value of rents $\widehat{P}_{R1} = \frac{\alpha_R}{\alpha_F} C_F$; the housing sector returns $\left\{\chi_1 = \chi_2 = \frac{1}{\beta}\right\}$; and the dollar price of land $\widehat{q}_1 = \beta \frac{\alpha_R}{\alpha_F} C_F$. Therefore, if the housing constraint does not bind in the period-1 H state, it does not bind in the L state either.

If the planner replaces capital inflow taxes with household debt taxes in the policy mix, it would set $\varphi_0 = \varphi_1 = 0$, while calibrating the ex post policy rate to offer the necessary external premia to global financiers and varying the ex post household debt tax to stabilize the borrowing rate for households:

$$\chi_1 = (1 + i_0) = \frac{1}{\beta} \text{ and } \chi_2 = (1 + i_1) = \frac{1}{\beta} - \frac{\Gamma S_1}{2}$$
$$\theta_{HH0} = 0 \text{ and } \theta_{HH1} = \frac{\beta \Gamma S_1}{2 - \beta \Gamma S_1},$$

which are calculated by combining Proposition 2 and equation (33). Rents are still stabilized across period-1 states at $\widehat{P}_{R1} = \frac{\alpha_R}{\alpha_F} C_F$, and housing sector repayments between periods 0 and 1, χ_1, are stabilized as well. However, given the destabilization of the policy rate across period-1 states, the expected housing sector returns are also similarly destabilized. As a result, non-fundamental foreign appetite shocks destabilize the dollar price of land price across period-1 states:

$$\widehat{q}_1 = \frac{2\beta \frac{\alpha_R}{\alpha_F} C_F}{2 - \beta \Gamma S_1}.$$

The dollar price of land increases with the inflow surge and decreases with the taper tantrum. The decrease in the land price during the taper tantrum reduces the right hand side of equation (6) without changing the value of the left hand side. Nevertheless, $\kappa_q \in [\overline{\kappa}_q, \infty)$ ensures that the housing constraint does not bind in the period-1 L state; consequently, the movement in domestic asset prices is not associated with a change in allocations, so there is no rationale for further use of policy tools beyond the ex post FX intervention and household debt taxes. Conditions (19) and (23) from subsection 3.2 hold, indicating no role for any ex ante household or housing debt tax.

By contrast, if $\kappa_q \in [0, \overline{\kappa}_q)$, capital inflow taxes and household debt taxes are no longer perfect substitutes in welfare terms. Using capital inflow taxes alongside FX intervention continues to stabilize the dollar price of land across period-1 states, ensuring that the housing constraint never binds. However, if capital inflow taxes are replaced with household debt taxes in the policy mix, the reduction in the dollar price of land during the taper tantrum is sufficient to make the housing constraint (6) bind in the period-1 L state.

A binding constraint means that condition (23) from Proposition 1 is violated. Moreover, if the housing constraint binds, the terms $\{y_{\mathcal{E}t}, y_{\eta t}, y_{Ft}\}$ enter the FOCs for the constrained efficient allocation in subsection 3.1. From equation (9), the AD wedge is destabilized across states, as the planner attempts to support land prices in the period-1 L state by depreciating the exchange rate and easing the effective dollar interest rate for the housing market in that state. In addition, the condition (19) from Proposition 1 is violated, and an ex ante household debt tax becomes useful.[41]

Moving beyond the above proposition, the sign of the ex ante housing debt tax can be derived by characterizing the constrained efficient allocation for $\Psi_R^L > 0$. For illustration, we consider values of κ_q in the neighborhood of $\overline{\kappa}_q$. When the housing constraint is just binding, i.e., $\kappa_q = \overline{\kappa}_q$, $\Psi_R^L = 0$, and $\left\{k_t^{Linear} = 1\right\}_{t=0}^{1}$, the condition $\frac{1-\kappa_q}{\kappa_q}\widehat{q}_1 > \frac{\partial \widehat{q}_1}{\partial k_1^{Linear}}$ is required for the term multiplying $\frac{\Psi_R}{\beta^2}$ on the right hand side of equation (18) to be positive. Evaluated at the same allocation, the term multiplying $\frac{\Psi_R^L \pi_1^L}{\beta}$ on the right hand side of equation (17) is of the same sign as the hedging motive, which in turn is equal to the deviation of the dollar land price in the period-1 L state from its average:

$$\left[\chi_1^L \widehat{q}_0 - \widehat{P}_{R1}^L - \widehat{q}_1^L\right] = \mathbb{E}_0 \widehat{q}_1 - \widehat{q}_1^L > 0.$$

Given that G is continuously differentiable, we can then establish that for κ_q marginally below $\overline{\kappa}_q$:

$$\tau_{R2} > 0 \text{ and } \tau_{R1} > 0,$$

where the first inequality indicates that $k_1^{Linear,L} < 1$, while the second inequality indicates a positive ex ante housing debt tax.

Our multiple-friction framework reveals that the constrained efficient level of ex ante macroprudential measures to manage domestic credit markets depends not just on domestic considerations

[41] In knife-edge cases, it is theoretically possible (but, given any statistical distribution of country characteristics, almost surely false) that: (i) $y_{E1} = 0$, so the AD wedges are stabilized; or (ii) the $\{y_{Ft}\}_{t=0}^{1}$ terms balance in condition (19), so that the ex ante household debt tax is zero.

(e.g., Kiyotaki and Moore, 1997), but also on global foreign appetite shocks and FX market depth (e.g., Gabaix and Maggiori, 2015; Cavallino, 2019; Fanelli and Straub, 2021). We establish that two tools—capital inflow taxes and household debt taxes—which appear equally adept at managing these shocks when only the shallow-market friction is considered, in fact have divergent effects on the transmission of global financial conditions into domestic asset prices. If domestic leverage is sufficiently high relative to collateral value that there is a risk of the domestic borrowing constraint binding, the tools are no longer perfect substitutes in welfare terms, and there is a case for additional ex ante debt taxes. Finally, the welfare impact of non-fundamental foreign appetite shocks should include the cost of any domestic credit crunch on top of any inflow tax revenues and carry profits/losses from the shocks.

6.3 Sudden Stops and Housing Markets

As in section 5, a sudden stop shock that generates a binding external borrowing constraint (3) in the period-1 L state causes the domestic borrowing rate to exceed the policy rate in that state: $\left(1+\rho_1^L\right) > \left(1+i_1^L\right)$. As a result, the expected returns on housing jump in the L state relative to the H state, causing the dollar price of land to be lower in the L state: $\chi_2^L > \chi_2^H$ and $\widehat{q}_1^L < \widehat{q}_1^H$. Caballero and Krishnamurthy (2001) have a similar mechanism in a model of collateral shortages without nominal rigidities, and they show that when external borrowing constraints bind, these forces may cause domestic borrowing constraints to bind as well.

Our model has an additional mechanism that pushes in this direction: lower import consumption in the L state reduces the dollar value of rents: $\widehat{P}_{R1}^L < \widehat{P}_{R1}^H$. All these mechanisms combined make the linear housing subsector's borrowing constraint *more* likely to bind in the period-1 L state than in the H state.

However, there is also a countervailing force which makes the final outcome ambiguous in our framework. Assumption 1 states that the exchange rate depreciates when the external borrowing constraint binds, which accords with EMDEs' experience in practice. The depreciation of the exchange rate generates expenditure-switching from import consumption to the consumption of nontradable housing services, and thereby increases the value of housing rents and land prices relative to the value of past debt repayments. This mechanism makes the linear housing subsector's borrowing constraint *less* likely to bind in the period-1 L state than in the H state. As a result, the introduction of nominal rigidities makes it ambiguous as to whether external borrowing constraints trigger domestic borrowing constraints or not.

As section 5 establishes, the severity of the ex post sudden stop and the constrained efficient ex post depreciation depends on the effective FX mismatch λ as well as the shallow-market friction Γ. Policy reforms to improve FX market depth were argued in the previous section to enable the direct reduction of premium externalities; and by inducing the planner to impose stricter ex ante FX mismatch regulations, they could indirectly reduce pecuniary AD externalities as well. If reducing FX mismatch results in more ex post depreciation in a sudden stop and/or a smaller ex post jump in the domestic borrowing rate above the policy rate, it could also result in lower pecuniary production externalities in the housing sector. As a result, actions to reduce external FX market frictions also affect the incidence and severity of frictions in domestic credit markets.

7 Conclusion

Policy advice to small open economies should take into account that their heterogeneous financial market characteristics make each country vulnerable in different ways to a turn in the global financial cycle. Moreover, as EMDEs undertake reforms to develop different markets, and as some AE markets may function less efficiently in the aftermath of crises, the transmission of external financial shocks to the domestic macroeconomy may exhibit structural breaks over time.

Our systematic welfare-optimizing framework, featuring dominant currency pricing and a combination of domestic and external financial market frictions, shows how the constrained efficient policy mix should depend on the configuration of different frictions in each country. By allowing the joint use of multiple policy tools to manage individual frictions, and by considering how each tool may simultaneously ease some frictions while exacerbating others, our model comes one step closer to providing integrated optimal policy advice, relative to the existing literature.

Despite the existence of multiple externalities, the model does recommend the traditional prescription, i.e., only monetary policy and exchange rate flexibility, to handle some kinds of shocks. To manage other shocks, and/or in the presence of particular configurations of frictions, it may recommend the use of FX intervention, capital inflow taxes, and taxes on housing sector debt in addition to, or even instead of, the policy rate. Moreover, the existence of each friction may alter the calibration of the policy tools used to handle other frictions.

Translating these findings into practice rests on careful judgments on a variety of issues, including: measurement of the various wedges described in the paper; credible communication to markets about the joint use of policy tools; coordination between different government agencies; the endogeneity of market development to how the tools are used; and spillovers to other countries. On all these issues, we intend that our model provides a possible starting point for further research.

References

[1] Adler, Gustavo, Kyun Suk Chang, Rui C. Mano, and Yuting Shao, 2021, "Foreign Exchange Intervention: A Dataset of Public Data and Proxies," IMF Working Paper No. 2021/047.

[2] Alam, Zohair, Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang, 2019, "Digging Deeper—Evidence on the Effects of Macroprudential Policies from a New Database," IMF Working Paper No. 2019/066.

[3] Amador, Manuel, Javier Bianchi, Luigi Bocola, and Fabrizio Perri, 2020, "Exchange Rate Policies at the Zero Lower Bound," *The Review of Economic Studies,* Vol. 87 (4), pp. 1605-1645.

[4] Amiti, Mary, Oleg Itskhoki, and Jozef Konings, 2022, "Dominant Currencies: How Firms Choose Currency Invoicing and Why it Matters," *Quarterly Journal of Economics*, Vol. 137 (3), pp. 1435–1493.

[5] Arce, Fernando, Julien Bengui, and Javier Bianchi, 2019, "A Macroprudential Theory of Foreign Reserve Accumulation," NBER Working Paper No. 26236.

[6] Barbiero, Omar, 2022, "The Valuation Effects of Trade," mimeo.

[7] Basu, Suman S., Roberto A. Perrelli, and Weining Xin, 2023, "External Crisis Prediction Using Machine Learning: Evidence from Three Decades of Crises Around the World," IMF Working Paper (forthcoming).

[8] Benigno, Gianluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R. Young, 2013, "Financial Crises and Macro-Prudential Policies," *Journal of International Economics*, Vol. 89 (2), pp. 453-470.

[9] Bianchi, Javier, 2011, "Overborrowing and Systemic Externalities in the Business Cycle," *American Economic Review*, Vol. 101 (7), pp. 3400-3426.

[10] Bianchi, Javier, and Louphou Coulibaly, 2022, "Liquidity Traps, Prudential Policies, and International Spillovers," NBER Working Paper No. 30038.

[11] Bianchi, Javier, and Guido Lorenzoni, 2022, "The Prudential Use of Capital Controls and Foreign Currency Reserves," Chapter 6 in *Handbook of International Economics*, Vol. 6, pp. 237-289.

[12] Bianchi, Javier, and Enrique Mendoza, 2010, "Overborrowing, Financial Crises, and 'Macro-Prudential' Taxes," NBER Working Paper No. 16091.

[13] Boz, Emine, Gita Gopinath, and Mikkel Plagborg-Møller, 2017, "Global Trade and the Dollar," NBER Working Paper No. 23988.

[14] Bruno, Valentina, and Hyun Song Shin, 2015, "Cross-Border Banking and Global Liquidity," *The Review of Economic Studies,* Vol. 82 (2), pp. 535–564.

[15] Caballero, Ricardo, and Arvind Krishnamurthy, 2001, "International and Domestic Collateral Constraints in a Model of Emerging Market Crises," *Journal of Monetary Economics,* Vol. 48 (3), pp. 513-548.

[16] Casas, Camila, Federico J. Díez, Gita Gopinath, and Pierre-Olivier Gourinchas, 2017, "Dominant Currency Paradigm: A New Model for Small Open Economies" IMF Working Paper No. 2017/264.

[17] Cavallino, Paolo, 2019, "Capital Flows and Foreign Exchange Intervention," *American Economic Journal: Macroeconomics*, Vol. 11 (2), pp. 127-170.

[18] Cole, Harold, and Maurice Obstfeld, 1991, "Commodity Trade and International Risk Sharing," *Journal of Monetary Economics*, Vol. 28 (1), pp. 3-24.

[19] Das, Mitali, Gita Gopinath, and Sebnem Kalemli-Özcan, 2021, "Preemptive Policies and Risk-Off Shocks in Emerging Markets," NBER Working Paper No. 29615.

[20] Egorov, Konstantin, and Dmitry Mukhin, 2022, "Optimal Monetary Policy Under Dollar Pricing," *American Economic Review* (forthcoming).

[21] Erten, Bilge, Anton Korinek, and José Antonio Ocampo, 2021, "Capital Controls: Theory and Evidence," *Journal of Economic Literature,* Vol. 59 (1), pp. 45-89.

[22] Farhi, Emmanuel, and Ivan Werning, 2014, "Dilemma not Trilemma? Capital Controls and Exchange Rates with Volatile Capital Flows," *IMF Economic Review*, Vol. 62, pp. 569-605.

[23] Farhi, Emmanuel, and Iván Werning, 2016, "A Theory of Macroprudential Policies in the Presence of Nominal Rigidities," *Econometrica*, Vol. 84 (5), pp. 1645-1704.

[24] Fanelli, Sebastián, and Ludwig Straub, 2019, "A Theory of Foreign Exchange Interventions," *The Review of Economic Studies,* Vol. 88 (6), pp. 2857–2885.

[25] Fernández, Andrés, Michael W. Klein, Alessandro Rebucci, Martin Schindler, and Martín Uribe, 2016, "Capital Control Measures: A New Dataset," *IMF Economic Review*, Vol. 64 (3), pp. 548–574.

[26] Gabaix, Xavier, and Matteo Maggiori, 2015, "International Liquidity and Exchange Rate Dynamics," *The Quarterly Journal of Economics*, Vol. 130 (3), pp. 1369-1420.

[27] Galí, Jordi and Tommaso Monacelli, 2005, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *The Review of Economic Studies,* Vol. 72 (3), pp. 707-34.

[28] Ghosh, Atish R., Jonathan D. Ostry, and Mahvash S. Qureshi, 2017, "Managing the Tide: How do Emerging Markets Respond to Capital Flows?" IMF Working Paper No. 2017/069.

[29] Goldberg, Linda S., and Cédric Tille, 2008, "Vehicle Currency Use in International Trade." *Journal of International Economics*, 76 (2), pp. 177–192.

[30] Goldberg, Linda S., and Cédric Tille, 2009, "Macroeconomic Interdependence and the International Role of the Dollar." *Journal of Monetary Economics*, 56 (7), pp. 990–1003.

[31] Gopinath, Gita, 2015, "The International Price System," in *Jackson Hole Symposium*, Vol. 27, Federal Reserve Bank at Kansas City.

[32] Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller, 2020, "Dominant Currency Paradigm," *American Economic Review*, Vol. 110 (3), pp. 677-719.

[33] Gopinath, Gita, Oleg Itskhoki, and Roberto Rigobon, 2010, "Currency Choice and Exchange Rate Pass-Through." *American Economic Review*, 100 (1), pp. 304–36.

[34] Iacoviello, Matteo, 2005, "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle," *American Economic Review*, Vol. 95 (3), pp. 739-764.

[35] Itskhoki, Oleg, and Dmitry Mukhin, 2022, "Optimal Exchange Rate Policy," mimeo.

[36] Jeanne, Olivier, and Anton Korinek, 2020, "Macroprudential Regulation versus Mopping up After the Crash," *The Review of Economic Studies,* Vol. 87 (3), pp. 1470–1497.

[37] Kalemli-Özcan, Sebnem, and Liliana Varela, 2021, "Five Facts About the UIP Premium," NBER Working Paper No. 28923.

[38] Kiyotaki, Nobuhiro, and John Moore, 1997, "Credit Cycles," *Journal of Political Economy*, Vol. 105 (2), pp. 211-248.

[39] Korinek, Anton, and Damiano Sandri, 2016, "Capital Controls or Macroprudential Regulation?," *Journal of International Economics,* Vol. 99, 27-42.

[40] Korinek, Anton, and Alp Simsek, 2016, "Liquidity Trap and Excessive Leverage," *American Economic Review,* Vol. 106 (3), pp. 699-738.

[41] Kouri, Pentti J. K., 1976, "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run: A Monetary Approach," *Scandinavian Journal of Economics*, Vol. 78, pp. 280–304.

[42] Laeven, Luc, and Fabian Valencia, 2020, "Systemic Banking Crises Database II," *IMF Economic Review*, Vol. 68 (2), pp. 307-361.

[43] Mendoza, Enrique, 2010, "Sudden Stops, Financial Crises, and Leverage," *American Economic Review*, Vol. 100 (5), pp. 1941-1966.

[44] Miranda-Agrippino, Silvia, and Hélène Rey, 2020, "U.S. Monetary Policy and the Global Financial Cycle," *The Review of Economic Studies,* Vol. 87 (6), pp. 2754–2776.

[45] Mukhin, Dimitry, 2022, "An Equilibrium Model of the International Price System," *American Economic Review*, Vol. 112 (2), pp. 650-688.

[46] Obstfeld, Maurice, Jonathan D. Ostry, and Mahvash S. Qureshi, 2019, "A Tie That Binds: Revisiting the Trilemma in Emerging Market Economies," *The Review of Economics and Statistics,* Vol. 101 (2), pp. 279-293.

[47] Rey, Hélène, 2013, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," in *Jackson Hole Symposium*, Vol. 25, Federal Reserve Bank at Kansas City.

[48] Schmitt-Grohé, Stephanie, and Martín Uribe, 2016, "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment," *Journal of Political Economy*, Vol. 124 (5), pp. 1466-1514.

ONLINE APPENDIX

A Model Details and Planner FOCs

A.1 Competitive Equilibrium

The conditions in this subsection complement those in subsection 2.2.

Households' first order conditions (FOCs) yield the following intratemporal conditions:

$$C_{Ht} = \frac{\alpha_H}{\alpha_F}\frac{\mathcal{E}_t}{P_H}C_{Ft},\, C_{Rt} = \frac{\alpha_R}{\alpha_F}\frac{\mathcal{E}_t}{P_{Rt}}C_{Ft}, \text{ and } W_t = \frac{1}{\alpha_F}\mathcal{E}_t C_{Ft} \text{ for } t \in \{0,1,2\}$$

and the following Euler conditions:

$$\frac{1}{\mathcal{E}_0 C_{F0}} = \beta\left(1+\theta_{HH0}\right)\left(1+\rho_0\right)\mathbb{E}_0\left[\frac{1}{\mathcal{E}_1 C_{F1}}\right] \text{ and } \frac{1}{\mathcal{E}_1 C_{F1}} = \beta\left(1+\theta_{HH1}\right)\left(1+\rho_1\right)\frac{1}{\mathcal{E}_2 C_{F2}}.$$

Tradable sector firms set prices in period 0 to maximize expected profits:

$$\max_{\{P_H(j),P_X(j)\}} \mathbb{E}_0\left[\sum_{t=0}^{2}\sigma_t \Pi_{Tt}(j)\right],$$

where $\sigma_t \equiv \beta^t \frac{\alpha_F}{\mathcal{E}_t C_{Ft}}$ is the household's stochastic discount factor, profits are defined as $\Pi_{Tt}(j) = \Pi_{Ht}(j) + \Pi_{Xt}(j)$ subject to:

$$\Pi_{Ht}(j) = \left[P_H(j) - (1+\phi)\frac{W_t}{A_t}\right]Y_{Ht}(j) \text{ and } \Pi_{Xt}(j) = \left[\mathcal{E}_t P_X(j) - (1+\phi)\frac{W_t}{A_t}\right]Y_{Xt}(j),$$

and the variety-level demand functions and aggregate price indices are as follows:

$$Y_{Ht}(j) = Y_{Ht}\left(\frac{P_H(j)}{P_H}\right)^{-\varepsilon} \text{ and } Y_{Xt}(j) = Y_{Xt}\left(\frac{P_X(j)}{P_X}\right)^{-\varepsilon}$$

$$P_H = \left(\int_0^1 P_H(j)^{1-\varepsilon}dj\right)^{\frac{1}{1-\varepsilon}} \text{ and } P_X = \left(\int_0^1 P_X(j)^{1-\varepsilon}dj\right)^{\frac{1}{1-\varepsilon}}.$$

The FOCs for price-setting establish the following expressions:

$$P_H(j) = (1+\phi)\frac{\varepsilon}{\varepsilon-1}\frac{\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t\frac{1}{\mathcal{E}_t C_{Ft}}\frac{W_t}{A_t}Y_{Ht}\right]}{\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t\frac{1}{\mathcal{E}_t C_{Ft}}Y_{Ht}\right]} \text{ and } P_X(j) = (1+\phi)\frac{\varepsilon}{\varepsilon-1}\frac{\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t\frac{1}{\mathcal{E}_t C_{Ft}}\frac{W_t}{A_t}Y_{Xt}\right]}{\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t\frac{1}{C_{Ft}}Y_{Xt}\right]}.$$

Since all firms are identical, $P_H(j) = P_H$, $P_X = P_X(j)$, and $N_t = N_t(j)$. Incorporating the market clearing condition for the home-produced tradable good Y_{Ht}, the demand function for exports Y_{Xt}, and the households' intratemporal condition between home-produced tradable goods and imports, we obtain the following relation:

$$\frac{P_X}{P_H} = \frac{\frac{1}{A_0} + \beta\mathbb{E}_0\left[\frac{1}{A_1}\right] + \beta^2\mathbb{E}_0\left[\frac{1}{A_2}\right]}{\frac{1}{C_{F0}} + \beta\mathbb{E}_0\left[\frac{1}{C_{F1}}\right] + \beta^2\mathbb{E}_0\left[\frac{1}{C_{F2}}\right]}\frac{1+\beta+\beta^2}{\frac{\mathcal{E}_0 C_{F0}}{A_0} + \beta\mathbb{E}_0\left[\frac{\mathcal{E}_1 C_{F1}}{A_1}\right] + \beta^2\mathbb{E}_0\left[\frac{\mathcal{E}_2 C_{F2}}{A_2}\right]}.$$

The planner can use the labor tax ϕ to set P_H to any desired value. The value of P_X is determined by the value of P_H and the realizations of productivity, the exchange rate, and import consumption.

Housing sector firms. The local currency debt of each housing subsector $h \in \{Linear, Concave\}$ evolves as follows:

$$D^h_{Rt+1} = \begin{cases} \left(1+\theta^h_{Rt-1}\right)\left(1+\rho_{t-1}\right) D^h_{Rt} + q_t L^h_t - \left[P_{Rt} Y^h_{Rt} + q_t L^h_{t-1}\right] - T^h_{MPMt} & \text{for } t \in \{0,1\} \\ \left(1+\theta^h_{Rt-1}\right)\left(1+\rho_{t-1}\right) D^h_{Rt} - P_{Rt} Y^h_{Rt} - T^h_{MPMt} + \Pi^h_{Rt} & \text{for } t = 2, \end{cases}$$

where the first term on the right hand side is the accumulated debt including interest payments and housing sector debt taxes, the second term is the financing of land purchases via additional debt, the third term is the repayment of debt using rental income and the resale value of the land purchased in the previous period, the fourth term T^h_{MPMt} is the lump sum transfer from the planner to each subsector h, and the final term Π^h_{Rt} is the asset transfer made by the subsector to the households. The lump sum transfer from the planner to each subsector is equal to the revenues from that subsector's debt taxes:

$$T^h_{MPMt} = \theta^h_{Rt-1}\left(1+\rho_{t-1}\right) D^h_{Rt},$$

while the asset transfer term is only non-zero in period 2 and satisfies: $\Pi_{R2} = \Pi^{Linear}_{R2} + \Pi^{Concave}_{R2}$. The linear subsector's optimality conditions are:

$$\frac{\mathbb{E}_0\left[P_{R1} + q_1\right]}{\left(1+\theta^{Linear}_{R0}\right)\left(1+\rho_0\right)} = q_0 \text{ and } \frac{P_{R2} + q_2}{\left(1+\theta^{Linear}_{R1}\right)\left(1+\rho_1\right)} \begin{cases} = q_1 & \text{if } D^{Linear}_{R2} < \kappa_q q_1 k^{Linear}_1 \\ \geq q_1 & \text{if } D^{Linear}_{R2} = \kappa_q q_1 k^{Linear}_1. \end{cases}$$

The concave subsector does not face a borrowing constraint. It satisfies the FOCs:

$$\frac{G'\left(k^{Concave}_0\right)\mathbb{E}_0\left[P_{R1}\right] + \mathbb{E}_0\left[q_1\right]}{\left(1+\theta^{Concave}_{R0}\right)\left(1+\rho_0\right)} = q_0 \text{ and } \frac{G'\left(k^{Concave}_1\right) P_{R2} + q_2}{\left(1+\theta^{Concave}_{R1}\right)\left(1+\rho_1\right)} = q_1.$$

Global financiers. The optimizing financiers' constraints always bind, yielding their demand for local currency bonds:

$$\Gamma \frac{Q_{t+1}}{\mathcal{E}_t} = \mathbb{E}_t\left[\left(1-\varphi_t\right)\left(1+i_t\right)\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} - \left(1+i^*_t\right)\right].$$

Their realized profit in local currency in period $t+1$ is:

$$\Pi_{FIt+1} = Q_{t+1}\left[\left(1-\varphi_t\right)\left(1+i_t\right) - \left(1+i^*_t\right)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right].$$

A.2 Constrained Efficient Allocation

The conditions in this subsection complement those in subsection 2.3.

Given the definition of the competitive equilibrium, and the restriction that the planner ignores the impact of its policy decisions on P_X, the period-t indirect utility function can be written:

$$V\left(C_{Ft}, \frac{\mathcal{E}_t}{P_H}, k^{Linear}_{t-1}, A_t\right) = U\left(\frac{\alpha_H}{\alpha_F}\frac{\mathcal{E}_t}{P_H} C_{Ft}, C_{Ft}, k^{Linear}_{t-1} + G\left(1-k^{Linear}_{t-1}\right), \frac{1}{A_t}\left[\frac{\alpha_H}{\alpha_F}\frac{\mathcal{E}_t}{P_H} C_{Ft} + \frac{C^*}{P_X}\right]\right)\Bigg|_{P_X \text{ fixed}},$$

and the partial derivatives relevant to the planner are:

$$\frac{\partial V}{\partial C_{Ft}} = \frac{\alpha_F}{C_{Ft}}\left[1 + \frac{\alpha_H}{\alpha_F}\tau_{Ht}\right], \quad \frac{\partial V}{\partial\left(\frac{\mathcal{E}_t}{P_H}\right)} = \alpha_H \frac{P_H}{\mathcal{E}_t}\tau_{Ht}, \text{ and } \frac{\partial V}{\partial k^{Linear}_{t-1}} = \tau_{Rt},$$

where consistent with our statement of the constrained efficient allocation, the planner ignores the impact of its policy decisions on the pre-set export price, P_X.

Equations (2)-(7) distill the competitive equilibrium definition into a smaller system defined by the set of variables $\left\{C_{Ft}, P_H, \mathcal{E}_t, \eta_{t+1}, FXI_t, k_t^{Linear}\right\}$. Equation (2) combines the households' budget constraint with the expressions for the profits of private sector agents, the market clearing conditions, and lump sum transfers from the planner. Equation (3) combines the domestic banks' external borrowing constraint with those expressions. Equations (4)-(5) combine the optimizing global financiers' demand for local currency bonds with the market clearing condition for these bonds. Equation (6) combines the linear housing subsector's domestic borrowing constraint with the FOCs of the concave subsector, the market clearing condition for land, and the households' intratemporal condition between nontradable housing services and imports. The term $\chi_1\widehat{q}_0$ in the constraint is defined as follows in the period-1 L state:

$$\chi_1^L\widehat{q}_0 = \frac{G'\left(k_0^{Concave}\right)}{Y_{R1}}\frac{\alpha_R}{\alpha_F}\mathbb{E}_0\left[\frac{\mathcal{E}_1}{\mathcal{E}_1^L}C_{F1}\right] + \mathbb{E}_0\left[\frac{\mathcal{E}_1}{\mathcal{E}_1^L}\widehat{q}_1\right].$$

Finally, equation (7) captures the relation between exchange rates and external premia across period-1 states:

$$\eta_t = \left(1-\varphi_{t-1}\right)\left(1+i_{t-1}\right)\frac{\mathcal{E}_{t-1}}{\mathcal{E}_t} \Rightarrow \mathcal{E}_1^L\eta_1^L = \mathcal{E}_1^H\eta_1^H.$$

Once the constrained efficient allocation is characterized in terms of $\left\{C_{Ft}, P_H, \mathcal{E}_t, \eta_{t+1}, FXI_t, k_t^{Linear}\right\}$, the remaining variables listed in the competitive equilibrium and constrained efficient allocation definitions can be derived as follows:

$$C_{Ht} = Y_{Ht} = \frac{\alpha_H}{\alpha_F}\frac{\mathcal{E}_t}{P_H}C_{Ft} \text{ and } Y_{Xt} = \frac{C^*}{P_X} \text{ for } t\in\{0,1,2\}$$

$$W_t = \frac{1}{\alpha_F}\mathcal{E}_tC_{Ft} \text{ and } N_t = \frac{1}{A_t}\left[\frac{\alpha_H}{\alpha_F}\frac{\mathcal{E}_t}{P_H}C_{Ft} + \frac{C^*}{P_X}\right] \text{ for } t\in\{0,1,2\}$$

$$P_X = P_H\frac{\frac{1}{A_0}+\beta\mathbb{E}_0\left[\frac{1}{A_1}\right]+\beta^2\mathbb{E}_0\left[\frac{1}{A_2}\right]}{\frac{1}{C_{F0}}+\beta\mathbb{E}_0\left[\frac{1}{C_{F1}}\right]+\beta^2\mathbb{E}_0\left[\frac{1}{C_{F2}}\right]}\frac{1+\beta+\beta^2}{\frac{\mathcal{E}_0C_{F0}}{A_0}+\beta\mathbb{E}_0\left[\frac{\mathcal{E}_1C_{F1}}{A_1}\right]+\beta^2\mathbb{E}_0\left[\frac{\mathcal{E}_2C_{F2}}{A_2}\right]}$$

$$\left(1-\varphi_0\right) = \left(1+\theta_{HH0}\right)\beta\mathbb{E}_0\left[\eta_1\frac{C_{F0}}{C_{F1}}\right] \text{ and } \left(1-\varphi_1\right) = \left\{\begin{array}{ll}\left(1+\theta_{HH1}\right)\beta\eta_2\frac{C_{F1}}{C_{F2}} & \text{if } \Psi_B=0\\ \left(1+\theta_{HH1}\right)=1 & \text{if } \Psi_B>0\end{array}\right.$$

$$\left(1+i_t\right) = \frac{\eta_{t+1}}{\left(1-\varphi_t\right)}\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \text{ for } t\in\{0,1\}$$

$$\left(1+\rho_0\right) = \frac{1}{\beta\left(1+\theta_{HH0}\right)\mathbb{E}_0\left[\frac{\mathcal{E}_0C_{F0}}{\mathcal{E}_1C_{F1}}\right]} \text{ and } \left(1+\rho_1\right) = \frac{\mathcal{E}_2C_{F2}}{\beta\left(1+\theta_{HH1}\right)\mathcal{E}_1C_{F1}}$$

$$\chi_{t+1} = \left(1+\rho_t\right)\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \text{ for } t\in\{0,1\}$$

$$Y_{Rt+1}^h = \left\{\begin{array}{ll}k_t^h & \text{for } h = Linear\\ G\left(k_t^h\right) & \text{for } h = Concave\end{array}\right\}, \text{ where } k_t^{Concave} = 1-k_t^{Linear} \text{ for } t\in\{0,1\}$$

$$C_{Rt} = Y_{Rt} = Y_{Rt}^{Linear} + Y_{Rt}^{Concave} \text{ and } P_{Rt} = \frac{\alpha_R}{\alpha_F}\frac{\mathcal{E}_tC_{Ft}}{Y_{Rt}} \text{ for } t\in\{0,1\}$$

$$q_t = \left\{\begin{array}{ll}\frac{1}{(1+\rho_0)}\left[\frac{G'\left(k_0^{Concave}\right)}{Y_{R1}}\frac{\alpha_R}{\alpha_F}\mathbb{E}_0\left[\mathcal{E}_1C_{F1}\right]+\mathbb{E}_0\left[q_1\right]\right] & \text{if } t=0\\ \frac{1}{(1+\rho_1)}\left[\frac{G'\left(k_1^{Concave}\right)}{Y_{R2}}\frac{\alpha_R}{\alpha_F}\mathcal{E}_2C_{F2}+q_2\right] & \text{if } t=1\\ \mathcal{E}_2\widehat{q}_2 = 0 & \text{if } t=2\end{array}\right.$$

$$\left(1+\theta_{R0}^{Linear}\right)=\frac{\frac{1}{Y_{R1}}\frac{\alpha_R}{\alpha_F}\mathbb{E}_0\left[\mathcal{E}_1 C_{F1}\right]+\mathbb{E}_0\left[q_1\right]}{\frac{G'\left(k_0^{Concave}\right)}{Y_{R1}}\frac{\alpha_R}{\alpha_F}\mathbb{E}_0\left[\mathcal{E}_1 C_{F1}\right]+\mathbb{E}_0\left[q_1\right]} \text{ and } \left(1+\theta_{R1}^{Linear}\right)=1$$

$$Q_{t+1}+F_{t+1}+O_{t+1}=D_{t+1} \text{ for } t\in\{0,1,2\}.$$

The evolution of the external debt is as follows:

$$B_1=\left(1+i_{-1}^*\right)B_0+\left[C_{F0}-C^*\right]$$

$$B_2=B_1 I_0+\left[C_{F1}-C^*\right]+(1-\lambda)FXI_0\left[\eta_1-(1+i_0^*)\right]\le\kappa_H\frac{P_H}{\mathcal{E}_1}$$

$$B_3=0=B_2 I_1+\left[C_{F2}-C^*\right]+(1-\lambda)FXI_1\left[\eta_2-(1+i_1^*)\right].$$

The evolution of the domestic housing sector debt is as follows:

$$B_{R1}^h=\left(1+i_{-1}^*\right)B_{R0}^h-\widehat{P}_{R0}Y_{R0}^h+\widehat{q}_0\left(k_0^h-1\right) \text{ for } h\in\{Linear,Concave\}$$

$$B_{R2}^h=\chi_1 B_{R1}^h-\widehat{P}_{R1}Y_{R1}^h+\widehat{q}_1\left(k_1^h-k_0^h\right) \text{ for } h\in\{Linear,Concave\} \text{ with } B_{R2}^{Linear}\le\kappa_q\widehat{q}_1 k_1^{Linear}$$

$$B_{R3}^h=0=\chi_2 B_{R2}^h-\widehat{P}_{R2}Y_{R2}^h+\widehat{\Pi}_{R2}^h \text{ for } h\in\{Linear,Concave\}$$

$$B_{R1}=-\widehat{P}_{R0}Y_{R0}$$

$$B_{R2}=\chi_1 B_{R1}-\widehat{P}_{R1}Y_{R1}$$

$$B_{R3}=0=\chi_2 B_{R2}-\widehat{P}_{R2}Y_{R2}+\widehat{\Pi}_{R2},$$

where $B_{Rt}\equiv\sum_{h\in\{Linear,Concave\}}B_{Rt}^h$, $\widehat{\Pi}_{R2}^h\equiv\frac{\Pi_{R2}^h}{\mathcal{E}_2}$, and $\widehat{\Pi}_{R2}\equiv\sum_{h\in\{Linear,Concave\}}\widehat{\Pi}_{R2}^h$.

We assume that either capital inflow taxes or household debt taxes are used, i.e., either $\{\varphi_t\in\mathbb{R},\ \theta_{HHt}\equiv 0\}$ or $\{\varphi_t\equiv 0,\theta_{HHt}\in\mathbb{R}\}$. We assume that the occasionally-binding constraints are slack in all periods and states except the period-1 L state, when these constraints may or may not bind. If the banks' external borrowing constraint binds in the period-1 L state, i.e., $\Psi_B^L>0$, capital inflow taxes become ineffective and household debt taxes become redundant, so they are both set to zero. If the linear housing subsector's domestic borrowing constraint binds in the period-1 L state, i.e., $\Psi_R^L>0$, housing debt taxes become ineffective, so they are set to zero; while if the constraint does not bind in that state, i.e., $\Psi_R^L=0$, there is no need to use housing debt taxes, so they are optimally zero. In the period-1 H state, it is not feasible to increase $k_1^{Linear,H}$ above 1, so the housing debt tax is also zero.

A.3 Planner FOCs

The conditions in this subsection complement those in subsection 3.1.

The FOCs for $\mathcal{E}_0$ and $\mathcal{E}_2$ are already provided as equation (8) in the main text. The FOC for $\mathcal{E}_1^s$ is as follows:

$$\tau_{H1}^s=\frac{\Psi_B^s\kappa_H^s}{\beta I_0^s\alpha_H\mathcal{E}_1^s}+\frac{\pi_1^L}{\beta\pi_1^s\alpha_H}\Psi_R^L\left[\begin{array}{c}\mathcal{E}_1^s\frac{\partial\chi_1^L}{\partial\mathcal{E}_1^s}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear}-\widehat{P}_{R0}\right]\\+\mathcal{E}_1^s\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\mathcal{E}_1^s}\left(k_0^{Linear}-1\right)\end{array}\right]+\Theta^s\Lambda\mathcal{E}_1^s\eta_1^s \text{ for } s\in\{L,H\},$$

where Ψ_B is the multiplier on constraint (3), Ψ_R is the multiplier on constraint (6), Λ is the multiplier on constraint (7), and $\left\{\Theta^H=-1,\Theta^L=1\right\}$. The FOC for $\{\eta_{t+1}\}_{t=0}^1$ are as follows:

$$\eta_1^s:\Omega_0=\beta(1-\lambda)\left(B_1+FXI_0\right)z_1^s+\beta y_{\eta 1}^s+\frac{\Theta^s\Lambda\mathcal{E}_1^s}{\pi_1^s} \text{ for } s\in\{L,H\}$$

$$\eta_2^s:\Omega_1^s=(1-\lambda)\Phi^s\frac{B_2^s+FXI_1^s}{I_0 I_1^s}+y_{\eta 2}^s \text{ for } s\in\{L,H\},$$

where we define $z_1 = \frac{1}{\beta}\left[\frac{\Phi+\Psi_B}{I_0} + \Gamma\Omega_1\right]$ and $z_2 = \frac{\Phi}{\beta^2 I_0 I_1}$, which are solved to produce equation (10) in the main text; Φ is the multiplier on constraint (2); and $\{\Omega_0, \Omega_1\}$ are the multipliers on constraints (4)-(5). The FOCs for η_1^L and η_1^H together determine the value of the period-0 multiplier:

$$\Omega_0 = \beta\left(1-\lambda\right)\left(B_1 + FXI_0\right)\frac{\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1} + \beta\frac{\mathbb{E}_0\left[y_{\eta1}\eta_1\right]}{\mathbb{E}_0\eta_1},$$

while the FOCs for $\mathcal{E}_1$ and η_1 can be combined by substituting out $\Lambda\mathcal{E}_1^s\eta_1^s$ to produce equation (9) in the main text.

The FOCs for $\{C_{Ft}\}_{t=0}^2$ and $\left\{k_t^{Linear}\right\}_{t=0}^1$ are already provided in the main text as equations (11)-(12) and (17)-(18). The FOCs for $\{FXI_t\}_{t=0}^1$ are as follows:

$$FXI_0 : \Gamma\Omega_0 = -\beta\left(1-\lambda\right)\mathbb{E}_0\left[z_1\left\{\eta_1 - \left(1+i_0^*\right)\right\}\right]$$

$$FXI_1^s : \Gamma\Omega_1^s = -\Phi^s\frac{\left(1-\lambda\right)\left[\eta_2^s - \left(1+i_1^*\right)\right]}{I_0 I_1^s} \text{ for } s \in \{L, H\}.$$

They are combined with the FOCs for $\{\eta_{t+1}\}_{t=0}^1$ to produce equations (15)-(16) in the main text. Finally, the FOC for P_H is as follows:

$$\mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t\alpha_H\tau_{Ht}\right] - \mathbb{E}_0\left[\frac{1}{I_0}\frac{P_H}{\mathcal{E}_1}\Psi_B\kappa_H\right] = 0.$$

This FOC turns out to be redundant given the FOCs for $\mathcal{E}_t$, so we normalize $P_H = 1$.

Next, we turn to the long-form expressions related to the housing sector that we suppressed in the main text, capturing the impact of macroeconomic variables on the housing sector constraint. For ease of interpretation, we first define them in terms of the partial derivatives of the housing sector variables $\left\{\chi_1^L, \chi_1^L\widehat{q}_0, \widehat{q}_1^L, \widehat{P}_{R0}, \widehat{P}_{R1}^L\right\}$:

$$\begin{aligned} y_{\mathcal{E}1}^s =& \frac{\pi_1^L}{\beta\pi_1^s\alpha_H}\Psi_R^L\left[\mathcal{E}_1^s\frac{\partial\chi_1^L}{\partial\mathcal{E}_1^s}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear} - \widehat{P}_{R0}\right] + \mathcal{E}_1^s\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\mathcal{E}_1^s}\left(k_0^{Linear}-1\right)\right] \\ & - \frac{1}{\alpha_H}\eta_1^s\left[y_{\eta1}^s - \frac{\mathbb{E}_0\left[y_{\eta1}\eta_1\right]}{\mathbb{E}_0\eta_1}\right] \text{ for } s \in \{L, H\} \end{aligned}$$

$$y_{\eta1}^s = \begin{cases} \frac{1}{\beta}\Psi_R^L\frac{\partial\chi_1^L}{\partial\eta_1^L}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear} - \widehat{P}_{R0}\right] & \text{for } s = L \\ 0 & \text{for } s = H \end{cases}$$

$$y_{\eta2}^s = \begin{cases} \Psi_R^L\left[\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\eta_2^L}\left(k_0^{Linear}-1\right) + \frac{\partial\widehat{q}_1^L}{\partial\eta_2^L}\left(\left(1-\kappa_q\right)k_1^{Linear,L} - k_0^{Linear}\right)\right] & \text{for } s = L \\ \frac{\pi_1^L}{\pi_1^H}\Psi_R^L\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\eta_2^H}\left(k_0^{Linear}-1\right) & \text{for } s = H \end{cases}$$

$$y_{F0} = \pi_1^L\Psi_R^L\left[\frac{\partial\chi_1^L}{\partial C_{F0}}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear} - \widehat{P}_{R0}\right] - \chi_1^L\frac{\partial\widehat{P}_{R0}}{\partial C_{F0}}\right] + \beta\Gamma\frac{\mathbb{E}_0\left\{y_{\eta1}\eta_1\right\}}{\mathbb{E}_0\eta_1}$$

$$y_{F1}^s = \begin{cases} \frac{1}{\beta}\Psi_R^L\left[\begin{array}{c}\frac{\partial\chi_1^L}{\partial C_{F1}^L}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear} - \widehat{P}_{R0}\right] + \frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F1}^L}\left(k_0^{Linear}-1\right) \\ -\frac{\partial\widehat{P}_{R1}^L}{\partial C_{F1}^L}k_0^{Linear} + \frac{\partial\widehat{q}_1^L}{\partial C_{F1}^L}\left(\left(1-\kappa_q\right)k_1^{Linear,L} - k_0^{Linear}\right)\end{array}\right] & \text{for } s = L \\ \frac{\pi_1^L}{\beta\pi_1^H}\Psi_R^L\left[\frac{\partial\chi_1^L}{\partial C_{F1}^H}\left[\left(1+i_{-1}^*\right)B_{R0}^{Linear} - \widehat{P}_{R0}\right] + \frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F1}^H}\left(k_0^{Linear}-1\right)\right] & \text{for } s = H \end{cases}$$

$$y_{F2}^{s}=\begin{cases}\frac{1}{\beta^2}\Psi_R^L\left[\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F2}^L}\left(k_0^{Linear}-1\right)+\frac{\partial\widehat{q}_1^L}{\partial C_{F2}^L}\left(\left(1-\kappa_q\right)k_1^{Linear,L}-k_0^{Linear}\right)\right] & \text{for } s=L\\ \frac{\pi_1^L}{\beta^2\pi_1^H}\Psi_R^L\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F2}^H}\left(k_0^{Linear}-1\right) & \text{for } s=H.\end{cases}$$

The values of some variables in the period-1 H state can affect the housing constraint in the L state because they affect the period-0 interest rate and/or land price, which enter the housing constraint in the L state via χ_1^L and/or $\chi_1^L\widehat{q}_0$. Next, we present the functional forms of the partial derivatives in the above expressions and those in equations (17)-(18):

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F1}^s}=\frac{\mathcal{E}_1^s}{\mathcal{E}_1^L}\pi_1^s\begin{bmatrix}\frac{G'\left(k_0^{Concave}\right)}{Y_{R1}^s}\frac{\alpha_R}{\alpha_F}\\ -\frac{1}{(\chi_2^s)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial C_{F1}^s}\end{bmatrix}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial C_{F2}^s}=\frac{\mathcal{E}_1^s}{\mathcal{E}_1^L}\pi_1^s\begin{bmatrix}-\frac{1}{(\chi_2^s)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial C_{F2}^s}\\ +\frac{1}{\chi_2^s}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}\end{bmatrix}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\mathcal{E}_1^s}=\begin{cases}-\frac{\mathcal{E}_1^H}{\left(\mathcal{E}_1^L\right)^2}\pi_1^H\left[\frac{G'\left(k_0^{Concave}\right)}{Y_{R1}}\frac{\alpha_R}{\alpha_F}C_{F1}^H+\widehat{q}_1^H\right] & \text{for } s=L\\ \frac{1}{\mathcal{E}_1^L}\pi_1^H\left[\frac{G'\left(k_0^{Concave}\right)}{Y_{R1}}\frac{\alpha_R}{\alpha_F}C_{F1}^H+\widehat{q}_1^H\right] & \text{for } s=H\end{cases}$$

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial\eta_2^s}=-\frac{\mathcal{E}_1^s}{\mathcal{E}_1^L}\pi_1^s\frac{1}{\left(\chi_2^s\right)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial\eta_2^s}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial k_0^{Linear}}=\begin{bmatrix}\frac{\left[-G''\left(k_0^{Concave}\right)\right]}{Y_{R1}}\\ -\frac{G'\left(k_0^{Concave}\right)\left[1-G'\left(k_0^{Concave}\right)\right]}{\left(Y_{R1}\right)^2}\end{bmatrix}\frac{\alpha_R}{\alpha_F}\mathbb{E}_0\left[\frac{\mathcal{E}_1}{\mathcal{E}_1^L}C_{F1}\right]$$

$$\frac{\partial\left(\chi_1^L\widehat{q}_0\right)}{\partial k_1^{Linear,s}}=\frac{\mathcal{E}_1^s}{\mathcal{E}_1^L}\pi_1^s\frac{1}{\chi_2^s}\begin{bmatrix}\frac{\left[-G''\left(k_1^{Concave,s}\right)\right]}{Y_{R2}^s}\\ -\frac{G'\left(k_1^{Concave,s}\right)\left[1-G'\left(k_1^{Concave,s}\right)\right]}{\left(Y_{R2}^s\right)^2}\end{bmatrix}\frac{\alpha_R}{\alpha_F}C_{F2}^s\text{ for } s\in\{L,H\}$$

$$\frac{\partial\widehat{q}_1^s}{\partial C_{F1}^s}=-\frac{1}{\left(\chi_2^s\right)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial C_{F1}^s}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\widehat{q}_1^s}{\partial C_{F2}^s}=\begin{bmatrix}-\frac{1}{(\chi_2^s)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial C_{F2}^s}\\ +\frac{1}{\chi_2^s}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}\end{bmatrix}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\widehat{q}_1^s}{\partial\eta_2^s}=-\frac{1}{\left(\chi_2^s\right)^2}\frac{G'\left(k_1^{Concave,s}\right)}{Y_{R2}^s}\frac{\alpha_R}{\alpha_F}C_{F2}^s\frac{\partial\chi_2^s}{\partial\eta_2^s}\text{ for } s\in\{L,H\}$$

$$\frac{\partial\widehat{q}_1^s}{\partial k_1^{Linear,s}}=\frac{1}{\chi_2^s}\begin{bmatrix}\frac{\left[-G''\left(k_1^{Concave,s}\right)\right]}{Y_{R2}^s}\\ -\frac{G'\left(k_1^{Concave,s}\right)\left[1-G'\left(k_1^{Concave,s}\right)\right]}{\left(Y_{R2}^s\right)^2}\end{bmatrix}\frac{\alpha_R}{\alpha_F}C_{F2}^s\text{ for } s\in\{L,H\}$$

$$\frac{\partial\widehat{P}_{R0}}{\partial C_{F0}}=\frac{\alpha_R}{\alpha_F}\text{ and }\frac{\partial\widehat{P}_{R1}^s}{\partial C_{F1}^s}=\frac{\alpha_R}{\alpha_F}\frac{1}{Y_{R1}}\text{ for } s\in\{L,H\}$$

$$\frac{\partial \widehat{P}_{R1}^{s}}{\partial k_{0}^{Linear}}=-\frac{\alpha_{R}}{\alpha_{F}}\frac{\left[1-G'\left(k_{0}^{Concave}\right)\right]C_{F1}^{s}}{\left(Y_{R1}\right)^{2}}\text{ for }s\in\{L,H\}\,.$$

Finally, drawing on subsection A.2, we establish that the functional forms of $\left\{\chi_{t+1}^{s}\right\}_{t=0}^{1}$, and hence the partial derivatives in the above expressions, depend on whether capital inflow taxes or household debt taxes are used. For $\{\varphi_t \in \mathbb{R}, \theta_{HHt} \equiv 0\}$ and $\Psi_B^L = 0$:

$$\chi_{1}^{s}=\frac{1}{\beta\mathbb{E}_{0}\left[\frac{\mathcal{E}_{1}^{s}C_{F0}}{\mathcal{E}_{1}C_{F1}}\right]}\text{ and }\chi_{2}^{s}=\frac{C_{F2}^{s}}{\beta C_{F1}^{s}}\text{ for }s\in\{L,H\}$$

$$\Rightarrow\frac{\partial\chi_{1}^{s}}{\partial\eta_{1}^{s}}=\frac{\partial\chi_{2}^{s}}{\partial\eta_{2}^{s}}=\frac{\partial\left(\chi_{1}^{L}\widehat{q}_{0}\right)}{\partial\eta_{2}^{s}}=\frac{\partial\widehat{q}_{1}^{s}}{\partial\eta_{2}^{s}}=0\text{ for }s\in\{L,H\}\,,$$

while for $\{\varphi_t \equiv 0, \theta_{HHt} \in \mathbb{R}\}$ and $\Psi_B^L = 0$:

$$\chi_{t+1}^{s}=\eta_{t+1}^{s}\text{ for }t\in[0,1]\text{ and }s\in\{L,H\}$$

$$\Rightarrow\frac{\partial\chi_{1}^{s}}{\partial C_{F0}}=\frac{\partial\chi_{1}^{s}}{\partial C_{F1}^{s}}=\frac{\partial\chi_{1}^{s}}{\partial C_{F1}^{-s}}=\frac{\partial\chi_{1}^{s}}{\partial\mathcal{E}_{1}^{s}}=\frac{\partial\chi_{1}^{s}}{\partial\mathcal{E}_{1}^{-s}}=\frac{\partial\chi_{2}^{s}}{\partial C_{F1}^{s}}=\frac{\partial\chi_{2}^{s}}{\partial C_{F2}^{s}}=\frac{\partial\widehat{q}_{1}^{s}}{\partial C_{F1}^{s}}=0.$$

If $\Psi_B^L > 0$, in which case we set $\varphi_t^L = \theta_{HHt}^L = 0$, we obtain $\chi_2^L = \frac{C_{F2}^L}{\beta C_{F1}^L}$.

B Proofs of Results in the Main Text

Proof of Proposition 1

Regarding capital inflow taxes, conditions (19)-(20) are obtained by substituting zero capital controls into equations (13)-(14).

Regarding FX intervention, we follow two steps. From subsection A.3, allowing for capital inflow taxes ensures that $y_{\eta 1}^s = y_{\eta 2}^s = 0$ throughout the below.

Step 1. We obtain condition (21) by substituting equation (4) into equation (15).

Step 2. For ex post FX intervention, we establish that across three separate cases, condition (22) is sufficient to establish that $FXI_1 = 0$.

Case (a). $(1-\lambda)\,\Gamma > 0$. Substituting $FXI_1 = 0$ into equation (5) and then multiplying both sides by $\frac{\alpha_F}{C_{F2}}\,(1-\lambda)$ yields condition (22).

Case (b). $\lambda = 1$. Condition (22) trivially holds, and no additional condition needs to be checked because the FOC (16) indicates that FXI_1 is indeterminate (i.e., both the benefits and costs of the tool are zero) and can be set to zero.

Case (c). $\{\lambda < 1, \Gamma = 0\}$. Substituting equation (5) into equation (16) and then setting $\Gamma = 0$ establishes that FXI_1 is indeterminate and can be set to zero, so no additional condition needs to be checked.

Regarding housing debt taxes, subsection A.2 establishes that $\theta_{R1}^{Linear} = 0$ for both period-1 states. The subsection also establishes that for $\theta_{R0}^{Linear} = 0$ to be true, we require that $G'\left(k_0^{Concave}\right) = 1$, i.e., $k_0^{Linear} = 1$ and $\tau_{R1} = 0$. From equation (17), $\tau_{R1} = 0$ is obtained iff either one of two scenarios arise. The first scenario is that even if shocks destabilize allocations, the housing constraint does not bind, i.e., $\Psi_R^L = 0$. The second scenario is that $\chi_1^L \widehat{q}_0 - \widehat{P}_{R1}^L - \widehat{q}_1^L = 0$, but from the equations in subsection A.2, this condition requires that $\{\mathcal{E}_1, C_{F1}, \widehat{q}_1\}$ are identical across period-1 states; since we assume that the housing constraint does not bind in the period-1 H state, it follows from equation (6) that the constraint cannot bind in the L state either, which means that $\Psi_R^L = 0$. In summary, both scenarios require that $\Psi_R^L = 0$. Inserting this condition into equation (18), we obtain $\tau_{R2} = 0$. ■

Proof of Lemma 1

The proof proceeds in four steps.

Step 1. Allowing for capital inflow taxes, setting $S_1 = 0$, and rewriting equation (16):

$$(1-\lambda)\left[\eta_2 - (1+i_1^*)\right] = 0, \tag{B.1}$$

which implies that $I_1 = (1+i_1^*)$ irrespective of the value of λ. The reason is that for $\lambda < 1$, the above condition yields $\eta_2 = (1+i_1^*)$ and therefore $I_1 = (1+i_1^*)$; while for $\lambda = 1$, $I_1 = (1+i_1^*)$ by construction.

Step 2. We assume that constraint (7) is not binding in the Ramsey planner problem, and we characterize the relaxed planner problem without that constraint.[42] The FOCs for $\mathcal{E}_1$ and η_1 are modified, so in subsection 3.1, equations (9), (11), (13) and (15) are replaced respectively by the following conditions:

$$\tau_{H1} = 0 \tag{B.2}$$

$$\frac{\alpha_F}{C_{F0}} = \frac{\beta \mathbb{E}_0\left[I_0 z_1\right] + \beta(1-\lambda)\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H0}} \tag{B.3}$$

$$(1-\varphi_0)\frac{\beta \mathbb{E}_0\left[I_0 z_1\right] + \beta(1-\lambda)\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H0}} = \beta \mathbb{E}_0\left[\eta_1 \frac{z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}}\right] \tag{B.4}$$

$$(1-\lambda)\left[\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] z_1 + \mathbb{E}_0\left[z_1\left\{\eta_1 - (1+i_0^*)\right\}\right]\right] = 0, \tag{B.5}$$

where the first condition reflects the FOC for $\mathcal{E}_1$, the second combines the FOCs for C_{F0} and η_1, the third combines the second condition and the household Euler condition, and the fourth combines the FOCs for FXI_0 and η_1. In all the conditions, we have incorporated the assumption in the main text that the constraints (3) and (6) are slack. We can also define Ω_0, the multiplier on equation (4), as follows:

$$\Omega_0 = \beta(1-\lambda)(B_1 + FXI_0) z_1. \tag{B.6}$$

Given the above, we obtain from equations (5), (10), and (B.1) the following condition:

$$\frac{\alpha_F}{C_{Ft}} = z_t = \frac{\Phi}{\beta I_0} \text{ for } t \in \{1, 2\}. \tag{B.7}$$

We can then combine the FOCs for $\{C_{Ft}\}_{t=0}^2$ as follows:

$$\frac{\alpha_F}{C_{F0}} = \beta \mathbb{E}_0\left[I_0 \frac{\alpha_F}{C_{F1}}\right] + \beta(1-\lambda)\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right]\frac{\alpha_F}{C_{F1}} \tag{B.8}$$

$$C_{F1} = C_{F2}. \tag{B.9}$$

Substituting $I_1 = (1+i_1^*)$ and $C_{F1} = C_{F2}$ into the resource constraint (2), we obtain:

$$C_{F1} = C^* - \frac{1}{1+\beta}\left[\begin{array}{c}(1-\lambda)(B_1 + FXI_0)\eta_1 \\ +(1+i_0^*)\left[\lambda(B_1 + FXI_0) - FXI_0\right]\end{array}\right], \tag{B.10}$$

where $B_1 = C_{F0} - C^*$, since we have assumed that $B_0 = 0$.

Step 3. For all relevant cases of the relaxed planner problem, we establish that $(B_1 + FXI_0) = 0, \mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$, z_1 is equalized across period-1 states, and $\left\{\eta_1^L, \eta_1^H\right\}$ are not determined.

Case (a). $\lambda = 1$. Equation (B.10) establishes that C_{F1}, and hence z_1, are equalized across period-1 states, while $\left\{\eta_1^L, \eta_1^H\right\}$ are not determined. Equations (B.5) and (16) imply that $\{FXI_t\}_{t=0}^1$ are indeterminate and can be set to zero, and inserting $\lambda = 1$ into equations (B.8) and (B.10) produces $\{C_{Ft}\}_{t=0}^2 = C^*$ and $B_1 = B_2 = 0$.

[42] Specifically, if the constraint (7) is removed, the terms multiplying Λ are removed from the FOCs for $\mathcal{E}_1^s$ and η_1^s in subsection A.3.

Equation (4) then yields that $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$.

Case (b). $\{\lambda < 1, \Gamma = 0\}$. First, a proof by contradiction. If $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] \neq 0$, equation (B.5) implies that z_1 is equalized across period-1 states, and therefore that $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$, i.e., a contradiction. Accordingly, it must be that $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$. Second, another proof by contradiction. If $(B_1 + FXI_0) \neq 0$, equation (B.6) establishes that z_1, and hence C_{F1}, is equalized across period-1 states. Inserting this finding into equation (B.10) establishes that $\eta_1^L = \eta_1^H$, so both must be equal to $(1+i_0^*)$. Inserting these findings into equation (B.8) establishes that $C_{F0} = C_{F1}$. Then equation (B.10) establishes that $\{C_{Ft}\}_{t=0}^2 = C^*$, which in turn yields $B_1 = B_2 = 0$; and since $\Gamma = 0$, equation (B.5) indicates that FXI_0 is indeterminate and can be set to zero. So there is a contradiction, and it must be that $(B_1 + FXI_0) = 0$.

Given that $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$ and $(B_1 + FXI_0) = 0$, equation (B.10) establishes that C_{F1}, and hence z_1, are equalized across period-1 states, while $\left\{\eta_1^L, \eta_1^H\right\}$ are not determined. Equation (B.8) establishes that $C_{F0} = C_{F1}$. Substituting these findings into equation (B.10) establishes that $\{C_{Ft}\}_{t=0}^2 = C^*$, which in turn yields $B_1 = B_2 = 0$. Since $\Gamma = 0$, equation (B.5) indicates that FXI_0 is indeterminate and can be set to zero. Substituting equation (5) into equation (16) establishes that FXI_1 is indeterminate and can be set to zero.

Case (c). $\{\lambda < 1, \Gamma > 0\}$. As in case (b), $\mathbb{E}_0\left[\eta_1 - (1+i_0^*)\right] = 0$. Given $\Gamma > 0$, it must be that $(B_1 + FXI_0) = 0$. Equation (B.10) then establishes that C_{F1}, and hence z_1, are equalized across period-1 states, while $\left\{\eta_1^L, \eta_1^H\right\}$ are not determined. Equation (B.8) establishes that $C_{F0} = C_{F1}$. Substituting these findings into equation (B.10) establishes that $\{C_{Ft}\}_{t=0}^2 = C^*$, which in turn yields $B_1 = FXI_0 = 0$ and $B_2 = 0$. Substituting $\eta_2 = (1+i_1^*)$ into equation (5) yields $FXI_1 = 0$.

Step 4. The constrained efficient allocation is the solution of the relaxed planner problem which also solves the original Ramsey planner problem. The solutions for all the cases in step 3 do not determine $\left\{\eta_1^L, \eta_1^H\right\}$, so there are a continuum of solutions with various values of $\left\{\eta_1^L, \eta_1^H\right\}$. Out of those, the unique solution to the original problem is the one that sets $\left\{\eta_1^L, \eta_1^H\right\}$ such that constraint (7) holds, i.e., the expression for $\{\mathcal{E}_t\}_{t=0}^2$ provided in the lemma is derived from $\{\tau_{Ht}\}_{t=0}^2 = 0$, and the values of $\left\{\eta_1^L, \eta_1^H\right\}$ are set accordingly. For the productivity shock:

$$\eta_1^H = \frac{(1+i_0^*)\, A_1^L}{\left(\pi_1^H A_1^L + \pi_1^L A_1^H\right)} \text{ and } \eta_1^L = \frac{(1+i_0^*)\, A_1^H}{\left(\pi_1^H A_1^L + \pi_1^L A_1^H\right)},$$

which along with equation (B.1) establishes that $\{\tau_{\Gamma t}\}_{t=1}^2 = 0$. Substituting the above into equations (B.4) and (14) establishes that $\varphi_0 = \varphi_1 = 0$. Substituting them into the expressions for the policy rate and land price in subsection A.2, we obtain the expressions for $\{i_t\}_{t=0}^1$ provided in the lemma, as well as $\widehat{q}_1 = \beta \frac{\alpha_R}{\alpha_F} C^*$, which is equalized across period-1 states. Inserting the assumption that the constraints (3) and (6) are slack into equations (17)-(18), we obtain $\{\tau_{Rt}\}_{t=1}^2 = 0$ and $\left\{\theta_{R0}^{Linear}, \theta_{R1}^{Linear}\right\} = 0$. ■

Proof of Lemma 2

As described in the proof of Proposition 1, FX intervention is indeterminate and can be set to zero if $\lambda = 1$ and capital inflow taxes are allowed. Inserting $\lambda = 1$ and the assumption that the constraints (3) and (6) are slack into equations (8)-(9) and (17)-(18), we obtain $\left\{\{\tau_{Ht}\}_{t=0}^2, \{\tau_{\Gamma t}\}_{t=1}^2, \{\tau_{Rt}\}_{t=1}^2\right\} = 0$, $\left\{\theta_{R0}^{Linear}, \theta_{R1}^{Linear}\right\} = 0$, and the expression for $\{\mathcal{E}_t\}_{t=0}^2$ provided in the lemma. Inserting these findings into equation (10), we obtain $z_1 = \Phi$ and $z_2 = \frac{\Phi}{\beta(1+i_1^*)}$. Inserting these findings into equations (11)-(12) produces the path for $\{C_{Ft}\}_{t=0}^2$ provided in the lemma. Inserting the expressions alongside $\Gamma = 0$ into equation (5) and (14) produces $\eta_2 = (1+i_1^*)$ and $\varphi_1 = 0$, while inserting them into equation (13) produces the expression for φ_0 provided in the lemma. Inserting these findings and equation (7) into the expressions for the policy rate and land price in subsection A.2, we obtain the expressions for $\{i_0, i_1, \widehat{q}_1\}$ provided in the lemma. ■

Proof of Lemma 3

The proof proceeds in the same four steps as in the proof of Lemma 1, but with the following changes.

Step 1. Equation (B.1) is obtained not by setting $S_1 = 0$, but instead by setting $(1-\lambda)\Gamma = 0$, in equation (16). Otherwise, no change.

Step 2. No change.

Step 3. The relevant cases are (a) and (b), and there is no change to them.

Step 4. The solutions for each of the cases in step 3 do not determine $\{\eta_1^L, \eta_1^H\}$, so there are a continuum of solutions with various values of $\{\eta_1^L, \eta_1^H\}$. Out of those, the unique solution to the original problem is the one that sets $\{\eta_1^L, \eta_1^H\}$ such that constraint (7) holds, i.e., the expression for $\{\mathcal{E}_t\}_{t=0}^2$ provided in the lemma is derived from $\{\tau_{Ht}\}_{t=0}^2 = 0$, and the values of $\{\eta_1^L, \eta_1^H\}$ are set accordingly: $\eta_1^L = \eta_1^H = (1+i_0^*)$. Substituting these findings into equations (B.4) and (14) establishes that $\varphi_0 = 0$ and $\varphi_1 = 1 - \beta\eta_2$, which from step 1 is equal to zero for $\lambda < 1$, and is equal to $\beta\Gamma S_1$ for $\lambda = 1$. Substituting these findings into the expression for the policy rate in subsection A.2, we obtain the expressions for $\{i_0, i_1\}$ provided in the lemma. From $\eta_1^L = \eta_1^H = (1+i_0^*)$ and equation (B.5), the UIP wedges are zero. ■

Proof of Proposition 2

The proof proceeds in the same four steps as in the proof of Lemma 1, but with the following changes.

Step 1. Combining equations (5) and (16) produces the following conditions, instead of equation (B.1):

$$FXI_1 = \frac{S_1}{2} - B_2,\ \eta_2 = \frac{1}{\beta} - \frac{\Gamma S_1}{2}, \text{ and } I_1 = \frac{1}{\beta} - \frac{(1-\lambda)\Gamma S_1}{2}. \tag{B.11}$$

Step 2. Equations (B.7) and (B.10) are replaced respectively by the following conditions:

$$\frac{\alpha_F}{C_{Ft}} = z_t = \frac{\Phi}{\beta^2 I_0 I_1} \text{ for } t \in \{1, 2\}. \tag{B.12}$$

$$C_{F1} = C^* + \frac{\beta}{1+\beta}\frac{(1-\lambda)\Gamma(S_1)^2}{4} - \frac{1}{1+\beta}\left[\begin{array}{c}(1-\lambda)(B_1 + FXI_0)\eta_1 \\ +(1+i_0^*)[\lambda(B_1+FXI_0) - FXI_0]\end{array}\right]. \tag{B.13}$$

Step 3. The relevant case is (c). The derivations of $\mathbb{E}_0[\eta_1 - (1+i_0^*)] = 0$ and $(B_1 + FXI_0) = 0$ remain valid. Since we have assumed that $S_1^H = -S_1^L$, we can obtain that $(S_1^H)^2 = (S_1^L)^2$. As a result, equation (B.13) establishes that C_{F1}, and hence z_1, are equalized across period-1 states, while $\{\eta_1^L, \eta_1^H\}$ are not determined. Equation (B.8) establishes that $C_{F0} = C_{F1}$. Substituting these findings into equation (B.13) establishes the expressions for $\{C_{Ft}\}_{t=0}^2$ and $\{B_t\}_{t=1}^2$ provided in the lemma.

Step 4. The solution in step 3 does not determine $\{\eta_1^L, \eta_1^H\}$, so there are a continuum of solutions with various values of $\{\eta_1^L, \eta_1^H\}$. Out of those, the unique solution to the original problem is the one that sets $\{\eta_1^L, \eta_1^H\}$ such that constraint (7) holds, i.e., the expression for $\{\mathcal{E}_t\}_{t=0}^2$ provided in the lemma is derived from $\{\tau_{Ht}\}_{t=0}^2 = 0$, and the values of $\{\eta_1^L, \eta_1^H\}$ are set accordingly: $\eta_1^L = \eta_1^H = (1+i_0^*)$. Substituting these findings into equations (B.4) and (14) and the expression for the policy rate in subsection A.2, we obtain the expressions for $\{\varphi_t, i_t\}_{t=0}^1$ provided in the lemma. From $\eta_1^L = \eta_1^H = (1+i_0^*)$ and equation (B.5), we obtain the UIP wedges. ■

Proof of Corollary 1

We consider two cases.

Case (a). FX intervention is not available ex post, i.e., FXI_1 is set to zero and its FOC is removed, which means that equation (16) no longer applies. From equations (2) and (5):

$$B_2 I_1 = [C^* - C_{F2}] \tag{B.14}$$

$$\text{where } B_2 = [C_{F0} - C^*] I_0 + [C_{F1} - C^*] + (1-\lambda) FXI_0 [\eta_1 - (1+i_0^*)]$$

$$\begin{aligned} I_0 &= \lambda\left(1+i_0^*\right)+(1-\lambda)\,\eta_1 \\ \eta_2 &= \left(1+i_1^*\right)+\Gamma\left(B_2-S_1\right) \\ \text{and } I_1 &= \left(1+i_1^*\right)+(1-\lambda)\,\Gamma\left(B_2-S_1\right). \end{aligned}$$

If we assume the perfect stabilization of imports and exchange rates—and hence premia η_1, via constraint (7)—across period-1 states, B_2 and C_{F2} should be equalized across those states. But because $(1-\lambda)\,\Gamma > 0$ and S_1 varies across period-1 states, it is then not possible for I_1 to be equalized across those states. As a result, equation (B.14) is violated, and there is a contradiction. Therefore, perfect stabilization is not constrained efficient if ex post FX intervention is not available.

Case (b). Capital inflow taxes and household debt taxes[43] are not available ex post, i.e., φ_1 is set to zero and an additional constraint is added to the Ramsey planner problem:

$$C_{F2} = \beta\eta_2 C_{F1} \qquad \forall s. \tag{B.15}$$

This additional constraint modifies the FOCs for C_{F1}, C_{F2}, and η_2 respectively as follows:

$$\frac{\alpha_F}{C_{F1}} = \frac{z_1+y_{F1}+\eta_2\Upsilon}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}} \tag{B.16}$$

$$\frac{\alpha_F}{C_{F2}} = \frac{z_2+y_{F2}-\frac{1}{\beta^2}\Upsilon}{1+\frac{\alpha_H}{\alpha_F}\tau_{H2}} \tag{B.17}$$

$$\Omega_1 = \Phi\,(1-\lambda)\,\frac{B_2+FXI_1}{I_0I_1}+y_{\eta 2}+\beta C_{F1}\Upsilon, \tag{B.18}$$

where Υ is the multiplier on constraint (B.15). Given the change in the FOC for η_2, equation (16) is replaced by the following condition:

$$(1-\lambda)\left[\left[\eta_2-\left(1+i_1^*\right)\right]+\frac{\Gamma S_1}{2}\right]+\Gamma y_{\eta 2}\frac{I_0I_1}{2\Phi}+\beta\Gamma C_{F1}\Upsilon\frac{I_0I_1}{2\Phi}=0. \tag{B.19}$$

Incorporating the assumption that the constraints (3) and (6) are slack ensures that$\{y_{F1}, y_{F2}, y_{\eta 2}\}=0$ in the above equations; while from the FOC for $\mathcal{E}_2$, $\tau_{H2}=0$. Combining equations (B.19) and (B.17) yields:

$$\left(B_2+FXI_1\right)=\frac{S_1}{2}-\frac{C_{F1}\Upsilon}{2\,(1-\lambda)\,\beta\left[\frac{\alpha_F}{C_{F2}}+\frac{1}{\beta^2}\Upsilon\right]}. \tag{B.20}$$

Substituting this condition into the resource constraint, we obtain:

$$B_2\left(1+i_1^*\right)=C^*+\frac{(1-\lambda)\,\Gamma}{4}\left[\left(S_1\right)^2-\left(\frac{C_{F1}\Upsilon}{(1-\lambda)\,\beta\left[\frac{\alpha_F}{C_{F2}}+\frac{1}{\beta^2}\Upsilon\right]}\right)^2\right]-C_{F2} \tag{B.21}$$

$$\begin{aligned} \text{where } B_2 &= \left[C_{F0}-C^*\right]I_0+\left[C_{F1}-C^*\right]+(1-\lambda)\,FXI_0\left[\eta_1-\left(1+i_0^*\right)\right] \\ I_0 &= \lambda\left(1+i_0^*\right)+(1-\lambda)\,\eta_1 \\ \eta_2 &= \left(1+i_1^*\right)+\Gamma\left(B_2+FXI_1-S_1\right) \\ \text{and } I_1 &= \left(1+i_1^*\right)+(1-\lambda)\,\Gamma\left(B_2+FXI_1-S_1\right). \end{aligned}$$

If we assume the perfect stabilization of imports and exchange rates—and hence premia η_1, via constraint (7)—across period-1 states, B_2 and C_{F2} should be equalized across those states. This assumption then requires that the second term in the square brackets in equation (B.21) is equalized across period-1 states. If that is so, equation

[43] In this setting, if household debt taxes were available, they could perfectly substitute for capital inflow taxes.

(B.20) establishes that $(B_2 + FXI_1 - S_1)$ varies across states. Rewriting the constraint (B.15), we can see that there is a contradiction:

$$C_{F2} = \beta \left[(1+i_1^*) + \Gamma (B_2 + FXI_1 - S_1)\right] C_{F1}.$$

If $(B_2 + FXI_1 - S_1)$ varies across period-1 states, C_{F1} and C_{F2} cannot both be equalized across those states. Therefore, perfect stabilization is not constrained efficient if ex post capital inflow taxes are not available. ■

Proof of Lemma 4

We assume that κ_q is sufficiently large that the housing constraint (6) is slack. From equation (9), we can derive:

$$\tau_{H1}^L \pi_1^L = \frac{\Psi_B^L \kappa_H^L}{\beta I_0^L \alpha_H \mathcal{E}_1^L} \pi_1^L - \frac{(1-\lambda) B_1}{\alpha_H} Y \text{ and } \tau_{H1}^H \pi_1^H = \frac{(1-\lambda) B_1}{\alpha_H} Y \tag{B.22}$$

$$\text{where } Y = \pi_1^L \eta_1^L \left[z_1^L - \frac{\mathbb{E}_0 [z_1 \eta_1]}{\mathbb{E}_0 \eta_1}\right] = \pi_1^H \eta_1^H \left[\frac{\mathbb{E}_0 [z_1 \eta_1]}{\mathbb{E}_0 \eta_1} - z_1^H\right]. \tag{B.23}$$

Equation (B.23) establishes the following feasible configurations: (i) $z_1^L > \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1} > z_1^H$; (ii) $z_1^L = \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1} = z_1^H$; and (iii) $z_1^L < \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1} < z_1^H$. Equation (12) can be rewritten as follows for $t = 1$:

$$\tau_{H1} = \frac{1}{\alpha_H} \left[z_1 C_{F1} - \alpha_F\right]. \tag{B.24}$$

Next, a proof by contradiction. Suppose that (i) is false, and one of (ii) or (iii) is true, i.e., $Y \leq 0$. Since the binding external constraint in the period-1 L state causes $C_{F1}^L < C_{F1}^H$, equation (B.24) implies that $\tau_{H1}^L < \tau_{H1}^H$. Inserting this inequality into equation (B.22), we obtain:

$$\frac{\Psi_B^L \kappa_H^L}{\beta I_0^L \alpha_H \mathcal{E}_1^L} < \frac{(1-\lambda) B_1}{\alpha_H \pi_1^H \pi_1^L} Y.$$

$(1-\lambda) Y \leq 0$ irrespective of the value of λ. As a result, there is a contradiction: the left hand side cannot be lower than zero if the external constraint binds. Accordingly, it must be that (i) is true. ■

Proof of Proposition 3

Substituting $\{\lambda = 1, \Gamma = 0\}$ and Assumption 1 into equations (4), (B.22), (12), and (13), we obtain:

$$\left[\eta_1^H - (1+i_0^*)\right] = \frac{\pi_1^L}{\pi_1^H} \left[(1+i_0^*) - \eta_1^L\right] > 0$$

$$\tau_{H1}^L = \frac{\Psi_B^L \kappa_H^L}{\beta I_0^L \alpha_H \mathcal{E}_1^L} > 0 \text{ and } \tau_{H1}^H = 0 \tag{B.25}$$

$$\varphi_0 = 1 - \frac{1}{\mathbb{E}_0 z_1} \mathbb{E}_0 \left[\frac{\eta_1}{(1+i_0^*)} \frac{z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}}\right], \text{ where } \frac{z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}} = \frac{\alpha_F}{C_{F1}}.$$

Next, we define a separate variable:

$$\widetilde{\varphi}_0 = 1 - \frac{1}{\mathbb{E}_0 z_1} \mathbb{E}_0 \left[\frac{z_1}{1 + \frac{\alpha_H}{\alpha_F}\tau_{H1}}\right],$$

where relative to the previous equation, the values of $\{\eta_1^L, \eta_1^H\}$ are replaced with $(1+i_0^*)$, while all other variables continue to be evaluated at their constrained efficient levels. Condition (B.25) establishes that $\widetilde{\varphi}_0 > 0$.

Moving from $\widetilde{\varphi}_0$ to φ_0, we observe that less weight is placed on $\pi_1^L \frac{z_1^L}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^L} = \pi_1^L \frac{\alpha_F}{C_{F1}^L}$ while more weight is placed on $\pi_1^H \frac{z_1^H}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^H} = \pi_1^H \frac{\alpha_F}{C_{F1}^H}$, and the weights sum in expected terms to one: $\mathbb{E}_0\left[\frac{\eta_1}{(1+i_0^*)}\right] = 1$. Since $C_{F1}^L < C_{F1}^H$, we conclude that $\varphi_0 > \widetilde{\varphi}_0 > 0$.

In the period-1 L state, $\varphi_1^L = 0$ from the argument in subsection 5.1. In the H state, we can substitute $\tau_{H1}^H = 0$ and equations (5) and (10) into equation (16) to establish that $\varphi_1^H = 0$. Finally, $\lambda = 1$ means that the UIP wedges are zero. ■

Proof of Lemma 5

We take the derivative of the Ramsey planner problem with respect to λ:

$$\frac{dV^{Planner}}{d\lambda} = \mathbb{E}_0\left[\Phi\left\{\begin{array}{c} -\frac{[C^*-C_{F1}]}{(I_0)^2}\left((1+i_0^*)-\eta_1\right) \\ -\frac{[C^*-C_{F2}]}{(I_0 I_1)^2}\left[\left((1+i_0^*)-\eta_1\right)I_1 + \left((1+i_1^*)-\eta_2\right)I_0\right]\end{array}\right\}\right]$$
$$-\Psi_B^L \pi_1^L \frac{[C^*-C_{F1}] + \frac{\kappa_H}{E_1}}{(I_0)^2}\left((1+i_0^*)-\eta_1\right) - \mathbb{E}_0\left[\Gamma\Omega_1 B_1\left((1+i_0^*)-\eta_1\right)\right],$$

where consistent with our statement of the constrained efficient allocation, the planner ignores the impact of its policy decisions on the pre-set export price, P_X. Into this equation, we substitute in the resource constraint (2), the external borrowing constraint (3), the Gamma equations (4)-(5), equation (10), and the definition of covariance, to prove the lemma. ■

Proof of Proposition 4

We analyze Perturbation 1 given Assumption 1 and $\Gamma = 0$. Since $\left\{\mathcal{E}_1^L, \mathcal{E}_1^H\right\} = \left\{\overline{\mathcal{E}}_1^L, \overline{\mathcal{E}}_1^H\right\}$ are held fixed and $\Gamma = 0$, the contingency condition (7) and the period-0 Gamma equation (4) indicate that $\left\{\eta_1^L, \eta_1^H\right\}$ are held fixed as well:

$$\overline{\mathcal{E}}_1^H < \overline{\mathcal{E}}_1^L \text{ and } \eta_1^L = \frac{(1+i_0^*)\,\overline{\mathcal{E}}_1^H}{\overline{\mathcal{E}}_1^H \pi_1^L + \overline{\mathcal{E}}_1^L \pi_1^H} < \eta_1^H = \frac{(1+i_0^*)\,\overline{\mathcal{E}}_1^L}{\overline{\mathcal{E}}_1^H \pi_1^L + \overline{\mathcal{E}}_1^L \pi_1^H},$$

and the FOCs for $\mathcal{E}_1$ and η_1 should be removed from the system. Combining the remaining equations in (2)-(7) and (8)-(14), the system of equations for us to analyze is as follows:

$$C_{F1}^L = C^* + \frac{\kappa_H}{\overline{\mathcal{E}}_1^L} - B_1 I_0^L \text{ and } C_{F2}^L = C^* - (1+i_1^*)\frac{\kappa_H}{\overline{\mathcal{E}}_1^L}$$

$$C_{F2}^H + (1+i_1^*)\,C_{F1}^H = C^* + (1+i_1^*)\,C^* - B_1 I_0^H\,(1+i_1^*)$$
$$B_1 = \left(1+i_{-1}^*\right)B_0 + C_{F0} - C^*$$

$$\mathbb{E}_0\eta_1 = (1+i_0^*) \Leftrightarrow \left[\eta_1^H - (1+i_0^*)\right] = \frac{\pi_1^L}{\pi_1^H}\left[(1+i_0^*) - \eta_1^L\right]$$

$$I_0^L = \lambda\,(1+i_0^*) + (1-\lambda)\,\eta_1^L \text{ and } I_0^H = \lambda\,(1+i_0^*) + (1-\lambda)\,\eta_1^H$$
$$\eta_2^s = (1+i_1^*) \text{ and } I_1^s = (1+i_1^*) \text{ for } s \in \{L, H\}$$
$$\tau_{H0} = \tau_{H2}^s = 0 \text{ for } s \in \{L, H\}$$
$$\frac{\alpha_F}{C_{F0}} = \beta\pi_1^L I_0^L z_1^L + \beta\pi_1^H I_0^H z_1^H$$

$$\frac{\alpha_F}{C_{F1}^L} = \frac{z_1^L}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^L} \text{ and } \frac{\alpha_F}{C_{F1}^H} = \frac{z_1^H}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^H}, \text{ where } \tau_{H1}^s = 1 - \frac{1}{\alpha_F}\overline{\mathcal{E}}_1^s C_{F1}^s \text{ for } s \in \{L, H\}$$

$$\frac{\alpha_F}{C_{F2}^L} = z_2^L \text{ and } \frac{\alpha_F}{C_{F2}^H} = z_1^H = z_2^H$$

$$\varphi_0 = 1 - \frac{1}{\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H}\left[\frac{\pi_1^L \eta_1^L z_1^L}{1+\frac{\alpha_H}{\alpha_F}\tau_H^L} + \frac{\pi_1^H \eta_1^H z_1^H}{1+\frac{\alpha_H}{\alpha_F}\tau_H^H}\right]$$

$$\varphi_1^L = 0 \text{ and } \varphi_1^H = 1 - \frac{C_{F1}^H}{C_{F2}^H}$$

$$V^{Planner} = \mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t V\left(C_{Ft}, \mathcal{E}_t, k_{t-1}^{Linear} = 1, A_t = A\right)\right].$$

Taking derivatives of this system, we obtain:

$$dC_{F0} = \frac{\pi_1^L\left[(1+i_0^*) - \eta_1^L\right]\left[\begin{array}{c} B_1\left[-\beta I_0^L \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_1 + \beta I_0^H \frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_1^*)\right] \\ -\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2 \Delta X \end{array}\right]}{\left[\left[1+\pi_1^L\beta\left(I_0^L\right)^2 \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X + \pi_1^H\beta\left(I_0^H\right)^2\frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_1^*)\right]}d\lambda$$

$$dC_{F1}^L = \frac{\left[(1+i_0^*) - \eta_1^L\right]\left[\begin{array}{c} -B_1\left[X_1 + \beta I_0^H \frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_0^*)(1+i_1^*)\right] \\ +\pi_1^L\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2 I_0^L \Delta X \end{array}\right]}{\left[\left[1+\pi_1^L\beta\left(I_0^L\right)^2 \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_1 + \pi_1^H\beta\left(I_0^H\right)^2\frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_1^*)\right]}d\lambda$$

$$dC_{F1}^H = \frac{\frac{\pi_1^L}{\pi_1^H}\left[(1+i_0^*) - \eta_1^L\right]\left[\begin{array}{c} B_1\left[1 + \beta I_0^L \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_0^*)(1+i_1^*)\right] \\ +\pi_1^H\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2 I_0^H \Delta(1+i_1^*) \end{array}\right]}{\left[\left[1+\pi_1^L\beta\left(I_0^L\right)^2 \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X + \pi_1^H\beta\left(I_0^H\right)^2\frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_1^*)\right]}d\lambda$$

$$d\varphi_0 = \frac{\left[(1+i_0^*) - \eta_1^L\right]}{\left[\begin{array}{c} \left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H\right]^2 \\ \times\left[\left[1+\pi_1^L\beta\left(I_0^L\right)^2 \frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X + \pi_1^H\beta\left(I_0^H\right)^2\frac{(C_{F0})^2}{(C_{F1}^H)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_1^*)\right] \end{array}\right]}d\lambda$$
$$\times\left\{\begin{array}{c} B_1\left\{\begin{array}{c} \frac{1}{\beta}\pi_1^L\left[\widehat{z} - \widetilde{z}\right]\alpha_F\left(\frac{I_0^L}{(C_{F1}^L)^2}\beta X - \frac{I_0^H}{(C_{F1}^H)^2}\right)\mathbb{E}_0\eta_1 \\ +\pi_1^L\pi_1^H\left(I_0^L\eta_1^H - I_0^H\eta_1^L\right)\left[\begin{array}{c} z_1^H\frac{\alpha_F}{(C_{F1}^L)^2}X + z_1^L\frac{\alpha_F}{(C_{F1}^H)^2}(1+i_1^*) \\ +\left[I_0^L z_1^L + I_0^H z_1^H\right]\frac{\alpha_F}{(C_{F1}^H)^2}\frac{(C_{F0})^2}{(C_{F1}^L)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)(1+i_0^*) \end{array}\right] \end{array}\right\} \\ +\Delta\left\{\begin{array}{c} \pi_1^L\left[\pi_1^L\eta_1^L\beta I_0^L\frac{(C_{F0})^2}{(C_{F1}^L)^2}\left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H\right] + \widehat{z}\frac{\mathbb{E}_0\eta_1}{1+\frac{\alpha_H}{\alpha_F}}\right]X \\ +\pi_1^L\pi_1^H\beta I_0^H\eta_1^H\left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H\right]\frac{(C_{F0})^2}{(C_{F1}^H)^2}(1+i_1^*) \end{array}\right\} \end{array}\right\}$$

$$\text{where } X = \frac{\left(C_{F2}^H\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right) + (1+i_1^*)$$

$$
\begin{aligned}
\Delta &= \left[z_1^L - z_1^H\right] > 0 \\
\widetilde{z} &= \frac{\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1} \text{ and } \widehat{z} = \frac{\left(1+\frac{\alpha_H}{\alpha_F}\right)}{\mathbb{E}_0\eta_1}\mathbb{E}_0\left[\frac{z_1\eta_1}{1+\frac{\alpha_H}{\alpha_F}\tau_H}\right] \Rightarrow \left[\widehat{z}-\widetilde{z}\right] > 0 \\
\left(I_0^L\eta_1^H - I_0^H\eta_1^L\right) &= \lambda\left(1+i_0^*\right)\left(\eta_1^H - \eta_1^L\right) > 0.
\end{aligned}
$$

This expression for $d\varphi_0$ establishes the sufficient condition provided in the proposition. The planner values the welfare change as follows:

$$
\begin{aligned}
dV^{Planner} &= \frac{\alpha_F}{C_{F0}}dC_{F0} + \beta\mathbb{E}_0\left[\frac{\alpha_F}{C_{F1}}\left[1+\frac{\alpha_H}{\alpha_F}\left(1-\frac{1}{\alpha_F}\overline{\mathcal{E}}_1 C_{F1}\right)\right]dC_{F1}\right] + \beta^2\mathbb{E}_0\left[\frac{\alpha_F}{C_{F2}^L}dC_{F2}^L\right] \\
&= -\pi_1^L B_1\left[\left(1+i_0^*\right)-\eta_1^L\right]\beta\Delta d\lambda.
\end{aligned}
$$

Therefore, for $d\lambda < 0$, the planner achieves a preferred allocation. ■

Proof of Proposition 5

Relative to the proof of Proposition 4, we now allow $\Gamma > 0$. Since $\left\{\mathcal{E}_1^L, \mathcal{E}_1^H\right\} = \left\{\overline{\mathcal{E}}_1^L, \overline{\mathcal{E}}_1^H\right\}$ are held fixed, the FOCs for $\mathcal{E}_1$ should be removed from the system, but the FOCs for η_1 are no longer removed:.the contingency condition (7) and the period-0 Gamma equation (4) indicate that $\left\{\eta_1^L, \eta_1^H\right\}$ may vary and are determined as follows:

$$
\overline{\mathcal{E}}_1^H < \overline{\mathcal{E}}_1^L \text{ and } \eta_1^L = \frac{\left[\left(1+i_0^*\right)+\Gamma B_1\right]\overline{\mathcal{E}}_1^H}{\overline{\mathcal{E}}_1^H\pi_1^L + \overline{\mathcal{E}}_1^L\pi_1^H} < \eta_1^H = \frac{\left[\left(1+i_0^*\right)+\Gamma B_1\right]\overline{\mathcal{E}}_1^L}{\overline{\mathcal{E}}_1^H\pi_1^L + \overline{\mathcal{E}}_1^L\pi_1^H}.
$$

Combining the remaining equations in (2)-(7) and (8)-(14), the system of equations for us to analyze is as follows:

$$
C_{F1}^L = C^* + \frac{\kappa_H}{\overline{\mathcal{E}}_1^L} - B_1 I_0^L \text{ and } C_{F2}^L = C^* - \left[\left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma\frac{\kappa_H}{\overline{\mathcal{E}}_1^L}\right]\frac{\kappa_H}{\overline{\mathcal{E}}_1^L}
$$

$$
\begin{aligned}
& C_{F2}^H + \left[\left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma B_2^H\right]C_{F1}^H \\
= \; & C^* + \left[\left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma B_2^H\right]C^* - B_1 I_0^H\left[\left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma B_2^H\right]
\end{aligned}
$$

$$
B_1 = \left(1+i_{-1}^*\right)B_0 + C_{F0} - C^*
$$

$$
B_2^L = \frac{\kappa_{BH}}{\overline{\mathcal{E}}_1^L} \text{ and } B_2^H = B_1 I_0^H + C_{F1}^H - C^*
$$

$$
\mathbb{E}_0\eta_1 = \left[\left(1+i_0^*\right)+\Gamma B_1\right] \Leftrightarrow \left[\eta_1^H - \left(1+i_0^*\right)\right] = \frac{\pi_1^L}{\pi_1^H}\left[\left(1+i_0^*\right)-\eta_1^L\right] + \frac{1}{\pi_1^H}\Gamma B_1
$$

$$
I_0^L = \lambda\left(1+i_0^*\right)+\left(1-\lambda\right)\eta_1^L \text{ and } I_0^H = \lambda\left(1+i_0^*\right)+\left(1-\lambda\right)\eta_1^H
$$

$$
\eta_2^L = \left(1+i_1^*\right)+\Gamma\frac{\kappa_H}{\overline{\mathcal{E}}_1^L} \text{ and } \eta_2^H = \left(1+i_1^*\right)+\Gamma B_2^H
$$

$$
I_1^L = \left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma\frac{\kappa_H}{\overline{\mathcal{E}}_1^L} \text{ and } I_1^H = \left(1+i_1^*\right)+\left(1-\lambda\right)\Gamma B_2^H
$$

$$
\tau_{H0} = \tau_{H2}^s = 0 \text{ for } s \in \{L, H\}
$$

$$
\frac{\alpha_F}{C_{F0}} = \beta\pi_1^L I_0^L z_1^L + \beta\pi_1^H I_0^H z_1^H + \beta\left(1-\lambda\right)\Gamma B_1\frac{\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1}
$$

$$\frac{\alpha_F}{C_{F1}^L} = \frac{z_1^L}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^L} \text{ and } \frac{\alpha_F}{C_{F1}^H} = \frac{z_1^H}{1+\frac{\alpha_H}{\alpha_F}\tau_{H1}^H}, \text{ where } \tau_{H1}^s = 1 - \frac{1}{\alpha_F}\overline{\mathcal{E}}_1^s C_{F1}^s \text{ for } s \in \{L, H\}$$

$$\frac{\alpha_F}{C_{F2}^L} = z_2^L \text{ and } \frac{\alpha_F}{C_{F2}^H} = \frac{z_1^H}{\beta\left[I_1^H + (1-\lambda)\,\Gamma B_2^H\right]} = z_2^H$$

$$\varphi_0 = 1 - \frac{1}{\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H + (1-\lambda)\,\Gamma B_1 \frac{\mathbb{E}_0[z_1\eta_1]}{\mathbb{E}_0\eta_1}}\left[\frac{\pi_1^L\eta_1^L z_1^L}{1+\frac{\alpha_H}{\alpha_F}\tau_H^L} + \frac{\pi_1^H\eta_1^H z_1^H}{1+\frac{\alpha_H}{\alpha_F}\tau_H^H}\right]$$

$$\varphi_1^L = 0 \text{ and } \varphi_1^H = 1 - \beta\eta_2^H\frac{C_{F1}^H}{C_{F2}^H}$$

$$V^{Planner} = \mathbb{E}_0\left[\sum_{t=0}^{2}\beta^t V\left(C_{Ft}, \mathcal{E}_t, k_{t-1}^{Linear} = 1, A_t = A\right)\right].$$

Taking derivatives of this system, we obtain:

$$dC_{F0} = \frac{\left[\begin{array}{c}\left[\begin{array}{c} -B_1\left[(1+i_0^*) - \eta_1^L\right]\pi_1^L\beta\widetilde{I}_0^L\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_1 \\ +B_1\left[\eta_1^H - (1+i_0^*)\right]\pi_1^H\beta\widetilde{I}_0^H\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2 \end{array}\right] \\ -\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2\widetilde{\Delta}X_1 + \pi_1^H\beta\widetilde{I}_0^H\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_3\end{array}\right]}{\left[\left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_1 + \pi_1^H\beta\left[\widetilde{I}_0^H\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\right]}d\lambda$$

$$dC_{F1}^L = \frac{\left[\begin{array}{c}\left[\begin{array}{c} -B_1\left[(1+i_0^*) - \eta_1^L\right] \\ \times\left[X_0X_1 + \pi_1^H\beta\left[\widetilde{I}_0^H\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\right] \\ -B_1\left[\eta_1^H - (1+i_0^*)\right]\pi_1^H\beta\widetilde{I}_0^L\widetilde{I}_0^H\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2 \end{array}\right] \\ +\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2\widetilde{I}_0^L\widetilde{\Delta}X_1 - \pi_1^H\beta\widetilde{I}_0^L\widetilde{I}_0^H\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_3\end{array}\right]}{\left[\left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_1 + \pi_1^H\beta\left[\widetilde{I}_0^H\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\right]}d\lambda$$

$$dC_{F1}^H = \frac{\left[\begin{array}{c}\left[\begin{array}{c} B_1\left[(1+i_0^*) - \eta_1^L\right]\pi_1^L\beta\widetilde{I}_0^L\widetilde{I}_0^H\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2 \\ +B_1\left[\eta_1^H - (1+i_0^*)\right] \\ \times\left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_2 \end{array}\right] \\ +\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2\widetilde{I}_0^H\widetilde{\Delta}X_2 + \left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_3\end{array}\right]}{\left[\left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_1 + \pi_1^H\beta\left[\widetilde{I}_0^H\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\right]}d\lambda$$

$$d\varphi_0 = \frac{Z_1 + Z_2 + Z_3}{\left[\begin{array}{c}\left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H + (1-\lambda)\,\Gamma B_1\widetilde{z}\right]^2 \\ \times\left[\left[X_0 + \pi_1^L\beta\left[\widetilde{I}_0^L\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^L\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)\right]X_1 + \pi_1^H\beta\left[\widetilde{I}_0^H\right]^2\frac{(C_{F0})^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\right]\end{array}\right]}d\lambda$$

$$\text{where } Z_1 = \left[\widehat{z}-\widetilde{z}\right]\left(\pi_1^L\eta_1^L+\pi_1^H\eta_1^H\right)X_0 \begin{bmatrix} \pi_1^L B_1\left[(1+i_0^*)-\eta_1^L\right]\frac{\alpha_F}{\left(C_{F1}^L\right)^2}\widetilde{I}_0^L X_1 \\ -\pi_1^H B_1\left[\eta_1^H-(1+i_0^*)\right]\frac{\alpha_F}{\left(C_{F1}^H\right)^2}\widetilde{I}_0^H X_2 \end{bmatrix}$$

$$+\left[I_0^L\eta_1^H - I_0^H\eta_1^L\right]\pi_1^L\pi_1^H \begin{bmatrix} X_0\begin{bmatrix} B_1\left[(1+i_0^*)-\eta_1^L\right]z_1^H\frac{\alpha_F}{\left(C_{F1}^L\right)^2}X_1 \\ +B_1\left[\eta_1^H-(1+i_0^*)\right]z_1^L\frac{\alpha_F}{\left(C_{F1}^H\right)^2}X_2 \end{bmatrix} \\ +\left[\pi_1^L z_1^L I_0^L + \pi_1^H z_1^H I_0^H + (1-\lambda)\Gamma B_1\widetilde{z}\right] \\ \times\beta\frac{\alpha_F}{\left(C_{F1}^L\right)^2}\frac{\left(C_{F0}\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)X_2\begin{bmatrix} B_1\left[(1+i_0^*)-\eta_1^L\right]\widetilde{I}_0^H \\ +B_1\left[\eta_1^H-(1+i_0^*)\right]\widetilde{I}_0^L \end{bmatrix} \end{bmatrix}$$

$$+\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2\Gamma\widehat{z}\begin{bmatrix} \pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H \\ -(1-\lambda)\left[2\left(1+i_0^*\right)+\Gamma B_1\right]\widetilde{z} \end{bmatrix}\begin{bmatrix} \pi_1^L B_1\left[(1+i_0^*)-\eta_1^L\right]\frac{\alpha_F}{\left(C_{F1}^L\right)^2}\widetilde{I}_0^L X_1 \\ -\pi_1^H B_1\left[\eta_1^H-(1+i_0^*)\right]\frac{\alpha_F}{\left(C_{F1}^H\right)^2}\widetilde{I}_0^H X_2 \end{bmatrix}$$

$$Z_2 = \widetilde{\Delta}\begin{bmatrix} \left[\pi_1^L z_1^L I_0^L + \pi_1^H z_1^H I_0^H + (1-\lambda)\Gamma B_1\widetilde{z}\right] \\ \times\left[\pi_1^L\eta_1^L\beta\frac{\left(C_{F0}\right)^2}{\left(C_{F1}^L\right)^2}\widetilde{I}_0^L X_1 + \pi_1^H\eta_1^H\beta\frac{\left(C_{F0}\right)^2}{\left(C_{F1}^H\right)^2}\widetilde{I}_0^H X_2\right] \\ +\widehat{z}\frac{\mathbb{E}_0\eta_1}{1+\frac{\alpha_H}{\alpha_F}}X_0X_1 \\ +\Gamma\widehat{z}\frac{1}{1+\frac{\alpha_H}{\alpha_F}}\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2X_1\begin{bmatrix} \pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H \\ -(1-\lambda)\left[2\left(1+i_0^*\right)+\Gamma B_1\right]\widetilde{z} \end{bmatrix} \end{bmatrix}$$

$$Z_3 = X_3\begin{bmatrix} -\pi_1^H\left[\widehat{z}-\widetilde{z}\right]\widetilde{I}_0^H\frac{\alpha_F}{\left(C_{F1}^H\right)^2}X_0\mathbb{E}_0\eta_1 \\ +\pi_1^L\pi_1^H\left[I_0^L\eta_1^H - I_0^H\eta_1^L\right]\begin{bmatrix} \left[\pi_1^L z_1^L I_0^L + \pi_1^H z_1^H I_0^H + (1-\lambda)\Gamma B_1\widetilde{z}\right] \\ \times\beta\widetilde{I}_0^L\frac{\alpha_F}{\left(C_{F1}^L\right)^2}\frac{\left(C_{F0}\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)+z_1^L\frac{\alpha_F}{\left(C_{F1}^H\right)^2}X_0 \end{bmatrix} \\ -\Gamma\widehat{z}\begin{bmatrix} \pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H \\ -(1-\lambda)\left[2\left(1+i_0^*\right)+\Gamma B_1\right]\widetilde{z} \end{bmatrix}\pi_1^H\beta\widetilde{I}_0^H\frac{\left(C_{F0}\right)^2}{\left(C_{F1}^H\right)^2} \end{bmatrix}$$

$$\Gamma\beta B_2^H\left[R_1^H B_2^H + 2C_{F2}^H\right]\omega_2 \geq 0$$

$$\begin{aligned}
\widetilde{I}_0^L &= \left[I_0^L + (1-\lambda)\Gamma B_1\frac{\eta_1^L}{\mathbb{E}_0\eta_1}\right] \text{ and } \widetilde{I}_0^H = \left[I_0^H + (1-\lambda)\Gamma B_1\frac{\eta_1^H}{\mathbb{E}_0\eta_1}\right] \\
\widetilde{\Delta} &= \left[\pi_1^L z_1^L\left[(1+i_0^*)-\eta_1^L\right] - \pi_1^H z_1^H\left[\eta_1^H-(1+i_0^*)\right] - \Gamma B_1\widetilde{z}\right] \\
X_0 &= \left[1+\frac{1}{\alpha_F}\beta\left(C_{F0}\right)^2 2(1-\lambda)\Gamma\widetilde{z}\right] \\
X_1 &= \left[\frac{\left(C_{F2}^H\right)^2}{\left(C_{F1}^H\right)^2}\left(1+\frac{\alpha_H}{\alpha_F}\right)+\left[\beta\left(R_1^H\right)^2+2\beta(1-\lambda)\Gamma C_{F2}^H\right]\right] \\
X_2 &= \left[\beta\left(R_1^H\right)^2+2\beta(1-\lambda)\Gamma C_{F2}^H\right] \\
X_3 &= \beta\Gamma B_2^H\left[R_1^H B_2^H + 2C_{F2}^H\right] \\
X_4 &= \left[\pi_1^L I_0^L z_1^L + \pi_1^H I_0^H z_1^H + (1-\lambda)\Gamma B_1\widetilde{z}\right] \\
R_1^H &= I_1^H + (1-\lambda)\Gamma B_2^H = \frac{1}{\beta}+2(1-\lambda)\Gamma B_2^H \\
\widetilde{z} &= \frac{\mathbb{E}_0\left[z_1\eta_1\right]}{\mathbb{E}_0\eta_1} \text{ and } \widehat{z} = \frac{\left(1+\frac{\alpha_H}{\alpha_F}\right)}{\mathbb{E}_0\eta_1}\mathbb{E}_0\left[\frac{z_1\eta_1}{1+\frac{\alpha_H}{\alpha_F}\tau_H}\right] \Rightarrow \left[\widehat{z}-\widetilde{z}\right] > 0 \\
\left(I_0^L\eta_1^H - I_0^H\eta_1^L\right) &= \lambda\left(1+i_0^*\right)\left(\eta_1^H-\eta_1^L\right) > 0.
\end{aligned}$$

Conditions (28) and (30) provided in the lemma are together sufficient to ensure that $Z_1 > 0$, where we define $\omega_1 = \frac{X_1}{X_2}$. Conditions (29) and (30) are together sufficient to ensure that $Z_2 > 0$. Condition (31) amounts to $C > 0$, where we define ω_2 to be the square bracket to the right of X_3 in the expression for Z_3. Therefore, the conditions (28)-(31) are a sufficient condition for $d\varphi_0 < 0$ when $d\lambda < 0$.

The planner values the welfare change as follows:

$$dV^{Planner} = -\beta \left[\begin{array}{c} B_1 \left[\begin{array}{c} z_1^L \pi_1^L \left[(1+i_0^*) - \eta_1^L \right] \\ -z_1^H \left[\pi_1^L \left[(1+i_0^*) - \eta_1^L \right] + \Gamma B_1 \right] \end{array} \right] \\ -\beta \left[\pi_1^L \frac{\alpha_F}{C_{F2}^L} \Gamma \left(\frac{\kappa_H}{E_1^L} \right)^2 + \pi_1^H \frac{\alpha_F}{C_{F2}^H} \Gamma \left(B_2^H \right)^2 \right] \end{array} \right] d\lambda$$

Condition (27) provided in the lemma is sufficient to ensure that for $d\lambda < 0$, the planner achieves a preferred allocation. ■

Proof of Lemma 6

We follow the assumptions in section 5 that: the only shock is a reduction of κ_H in the period-1 L state which makes the external borrowing constraint (3) bind in that state; κ_q is sufficiently large that the housing constraint (6) is slack; and $\{FXI_t\}_{t=0}^1 = 0$ and $\varphi_1^L = 0$.

Domestic households own a fraction λ of the global financiers, and we assume the planner has the jurisdiction to shut down a fraction $\xi \in [0,1]$ of these financiers, while allowing the rest of them to operate. The local currency bond market clearing condition is amended, and as a result, each remaining intermediary must absorb more of any bonds:

$$[(1-\xi)\lambda + (1-\lambda)] Q_{t+1} = D_{t+1} \Rightarrow Q_{t+1} = \frac{D_{t+1}}{[(1-\xi)\lambda + (1-\lambda)]}.$$

Substituting this expression into the system in section 2, we obtain that the constraints of the competitive equilibrium and constrained efficient allocations are amended according to the conditions (i)-(ii) provided in the lemma. In particular:

$$\widehat{\lambda} \equiv \frac{(1-\xi)\lambda}{(1-\xi)\lambda + (1-\lambda)} \in [0,\lambda] \Rightarrow \frac{d\widehat{\lambda}}{d\xi} = -\frac{(1-\lambda)\lambda}{[(1-\xi)\lambda + (1-\lambda)]^2} < 0$$

$$\begin{aligned} \widehat{\Gamma} \quad &\equiv \quad \frac{\Gamma}{(1-\xi)\lambda + (1-\lambda)} \in \left[\Gamma, \frac{\Gamma}{(1-\lambda)} \right] \Rightarrow \frac{d\widehat{\Gamma}}{d\xi} = \frac{\Gamma\lambda}{[(1-\xi)\lambda + (1-\lambda)]^2} > 0 \\ \Rightarrow \quad & \frac{d\widehat{\Gamma}}{d\widehat{\lambda}} = \frac{d\widehat{\Gamma}/d\xi}{d\widehat{\lambda}/d\xi} = -\frac{\Gamma}{1-\lambda} < 0 \end{aligned}$$

For the resulting Ramsey planner problem, taking the FOC with respect to $\widehat{\lambda}$ yields:

$$\begin{aligned} \frac{dV^{Planner}}{d\widehat{\lambda}} &= \mathbb{E}_0 \left[\Phi \left\{ \begin{array}{c} -\frac{[C^* - C_{F1}]}{(I_0)^2} ((1+i_0^*) - \eta_1) \\ -\frac{[C^* - C_{F2}]}{(I_0 I_1)^2} [((1+i_0^*) - \eta_1) I_1 + ((1+i_1^*) - \eta_2) I_0] \end{array} \right\} \right] \\ &\quad - \Psi_B^L \pi_1^L \frac{[C^* - C_{F1}] + \frac{\kappa_H}{E_1}}{(I_0)^2} ((1+i_0^*) - \eta_1) \\ &\quad + \frac{\Gamma}{1-\lambda} \Omega_0 B_1 + \mathbb{E}_0 \left[-\Gamma \Omega_1 B_1 ((1+i_0^*) - \eta_1) + \frac{\Gamma}{1-\lambda} \Omega_1 B_2 \right]. \end{aligned}$$

Into this equation, we substitute in the resource constraint (2), the external borrowing constraint (3), the Gamma equations (4)-(5), equation (10), and the definition of covariance, to prove condition (iii) in the lemma. ■

Proof of Proposition 6

The proof follows from Lemma 6 and the argument presented in the main text of subsection 5.4 after that lemma. For $\Gamma > 0$, the planner selects $\widehat{\lambda} \in \left(\widehat{\lambda}_{\Gamma=0}, \lambda\right]$ iff starting from $\widehat{\lambda} = \lambda$, a gradual marginal reduction of $\widehat{\lambda}$ eventually ceases to produce a marginally preferred allocation before the planner reaches $\widehat{\lambda} = \widehat{\lambda}_{\Gamma=0}$. This outcome requires that for $\widehat{\lambda} \in \left(\widehat{\lambda}_{\Gamma=0}, \lambda\right]$:

$$\Gamma \geq \frac{-\beta B_1 Cov\left(z_1, \eta_1\right)}{\left[\begin{array}{c} \left\{\beta\left(B_1\right)^2 \mathbb{E}_0 z_1 + \beta^2 \mathbb{E}_0\left[z_2\left(B_2\right)^2\right]\right\} \\ +\frac{1-\widehat{\lambda}}{1-\lambda}\left\{\beta\left(B_1\right)^2\left[\frac{Cov(z_1,\eta_1)}{(1+i_0^*)+\Gamma B_1} + \mathbb{E}_0 z_1\right] + \beta^2 \mathbb{E}_0\left[z_2\left(B_2\right)^2\right]\right\} \end{array}\right]}.$$

For given $Cov\left(z_1, \eta_1\right)$, this condition holds for sufficiently high Γ (which means that the left hand side is large) and B_0 (which means that in the denominator of the right hand side, the terms B_1 and B_2 are large and the negative term $\frac{Cov(z_1,\eta_1)}{(1+i_0^*)+\Gamma B_1}$ is small). ■

Proof of Proposition 7

In section 6, we assume that the housing constraint (6) is slack in the period-1 H state, and we check whether it may bind in the L state. The proof proceeds in two steps.

Step 1. Solve for the different relevant configurations of tools available to the planner.

Case (a). Capital inflow taxes and FX intervention are available, while household debt taxes are not available and are set to zero, i.e., $\{\varphi_t \in \mathbb{R}, FXI_t \in \mathbb{R}, \theta_{HHt} \equiv 0\}$. Let us suppose that the housing constraint is slack in the L state, and then see whether the supposition is validated or contradicted. Inserting the solution from Proposition 2 into the expressions related to the housing sector in subsection A.2, we obtain:

$$\chi_1 = \chi_2 = \frac{1}{\beta},\ \widehat{P}_{R1} = \frac{\alpha_R}{\alpha_F} C_F,\ \widehat{q}_1 = \beta\frac{\alpha_R}{\alpha_F} C_F, \text{ and } k_0^{Linear} = k_1^{Linear} = 1.$$

As a result, every term in the housing constraint can be equalized between period-1 states. The result validates our supposition: if the value of κ_q is such that the constraint is slack in the H state, the constraint must also be slack in the L state. The use of capital inflow taxes and FX intervention achieves zero housing wedges and housing debt taxes, i.e., $\left\{\{\tau_{Rt}\}_{t=1}^2, \{\theta_{Rt}^{Linear}\}_{t=0}^1\right\} = 0$.

Case (b). Household debt taxes and FX intervention are available, while capital inflow taxes are not available and are set to zero, i.e., $\{\varphi_t \equiv 0, FXI_t \in \mathbb{R}, \theta_{HHt} \in \mathbb{R}\}$. Let us suppose that the housing constraint is slack in the L state, and then see whether the supposition is validated or contradicted. Under this supposition, the perfect substitutability result in equation (33) remains valid. Combining it with Proposition 2, we can establish that if we set $\varphi_0 = \varphi_1 = 0$, we would need the following household debt taxes:

$$\theta_{HH0} = 0 \text{ and } \theta_{HH1} = \frac{\beta\Gamma S_1}{2 - \beta\Gamma S_1}.$$

Inserting these taxes into the expressions related to the housing sector in subsection A.2, we obtain:

$$\chi_1 = \frac{1}{\beta},\ \chi_2 = \frac{1}{\beta} - \frac{\Gamma S_1}{2},\ \widehat{P}_{R1} = \frac{\alpha_R}{\alpha_F} C_F,\ \widehat{q}_1 = \frac{2\beta\frac{\alpha_R}{\alpha_F} C_F}{2 - \beta\Gamma S_1}, \text{ and } k_0^{Linear} = k_1^{Linear} = 1.$$

As a result, the price $\widehat{q}_1$ is not equalized between period-1 states: it is lower in the L state, when $S_1 < 0$. Given Assumption 2 and the above findings, the left hand side of constraint (6) is positive and identical across period-1 states. However, the right hand side is lower in the L state than in the H state, which means that the constraint may bind in the L state even when it does not bind in the H state. There exists $\overline{\kappa}_q$ such that: for $\kappa_q \in [\overline{\kappa}_q, \infty)$, the constraint is slack in both period-1 states, so the supposition that the housing constraint is slack in the L

state is validated; while for $\kappa_q \in [0, \overline{\kappa}_q)$, the constraint is binding in the L state even if it is slack in the H state, and the supposition is contradicted. When the supposition is contradicted, the equivalence condition (33) is no longer valid, and the system of equations needs to be solved with $\Psi_R^L > 0$.

For $\Psi_R^L > 0$, y_{E1} is non-zero (except in a knife-edge case), which means that according to (9), the period-1 AD wedges τ_{H1} become non-zero. In addition, the $\{y_{Ft}\}_{t=0}^1$ are non-zero, which means that condition (19) is violated (except in a knife-edge case when the $\{y_{Ft}\}_{t=0}^1$ terms balance in that condition), and θ_{HH0} also becomes non-zero. Finally, since $k_1^{Linear,L} < k_1^{Linear,H} = 1$, we obtain $\left\{\tau_{R2}^L > 0, \tau_{R2}^H = 0\right\}$, which means that condition (23) is also violated, and it may be optimal to use an ex ante housing debt tax.

Step 2. Finally, we combine the findings from step 1. For $\kappa_q \in [\overline{\kappa}_q, \infty)$, the constrained efficient allocation and welfare are identical irrespective of which of capital inflow taxes and household debt taxes are available. For $\kappa_q \in [0, \overline{\kappa}_q)$, the constrained efficient allocation and welfare are different depending on which of these policy tools are available. ■

C Parameterization of Simulations

Table 1: Parameter Values

Parameter	Description	Value	
		Section 3	Section 4
α_H	Expenditure share of tradable goods	1/3	1/3
α_F	Expenditure share of imports	1/3	1/3
α_R	Expenditure share of housing services	1/3	1/3
β	Discount factor	0.8	0.8
C^*	World demand level	1	1
i_0^*	Initial world interest rate	$1/\beta$-1	$1/\beta$-1
A_0	Initial level of productivity	1	1
B_0	Initial debt level	0	0.6
B_{R0}	Initial housing sector debt level	NA	NA
λ	Domestic share of intermediaries	0.8	[0, 1]
Γ	Balance sheet friction	0.9	{0, 0.0025}
Shocks	Description	Value	
π	Probability of good/bad shock	0.5	0.5
κ_H	Bank Debt limit	NA	{0.025, 1}
S_1	Foreign risk appetite	$S_1^L = -1$, $S_1^H \in [0.1, 3]$	NA

PUBLICATIONS

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