Macroprudential Policy Interlinkages

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Abstract

Emerging markets are concerned about sudden stops in international financial flows, which may lead to severe recessions associated with vicious spirals of currency depreciations and tightening borrowing constraints. A common prescription is to actively manage international capital flows and limit external overborrowing. This paper analyzes the complementary role of domestic macroprudential policies: When domestic markets are shallow, a reallocation of domestic resources towards internationally constrained borrowers improves welfare because it shifts funds to households with a higher marginal propensity to consume. In contrast, if domestic markets are well established, borrowers could simply circumvent the international borrowing constraint with domestic borrowing, which would make any regulation obsolete.

Keywords: Macroprudential Policies; Capital Controls; Emerging Markets; Welfare

JEL: F34, F41, E44, D62

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1. INTRODUCTION

Emerging markets and developing economies (EMs) are exposed to large fluctuations in foreign financial flows. Particularly sudden stops in international capital have been identified as a threat for financial and macroeconomic stability ([Forbes and Warnock, 2012](#)). This sparked interest in so called macroprudential capital flow management measures (CFMs). A consensus emerged that EMs may restrict international capital flows preemptively to limit the build-up of systemic risk in the financial sector. However, should EMs regulate domestic flows in the presence of international financial cycles? Further, how do prudential domestic and international regulatory initiatives interact? This paper tackles both questions from a portfolio allocation perspective.

Figure 1, Panel (a) portrays the prevalence of domestic macroprudential policies and CFMs in EMs. Domestic macroprudential policies represent restrictions on, for example, bank leverage ratios or household debt-to-income ratios. Crucially, unlike CFMs, they do not particularly target international financial flows or exposure to foreign risk. CFMs in turn can be classified into capital controls that drive a wedge between domestic and foreign agents, and restrictions that reduce the external vulnerability, for example, via restrictions on foreign currency borrowings. As apparent from the figure, domestic macroprudential policies and policies geared towards foreign currency borrowings have become increasingly popular over the last two decades. The usage of capital controls in contrast has been relative stable at an elevated level. Panel (b) highlights that an increasing share of EMs implement two (red area) or all three (blue area) of the aforementioned policies at the same time, emphasizing the urgency to provide a coherent unified framework.

The first contribution of this paper is a normative justification to regulate the domestic financial market in addition to CFMs which directly address international markets. The intuition is as follows: Targeting domestic transactions ex-ante provides a margin to reallocate resources towards borrowers when they are limited in their ability to borrow internationally. This appreciates the exchange rate, since constrained borrowers have a higher marginal propensity to consume relative to domestic savers. Because available collateral increases with an appreciated exchange rate, sudden stops in international capital due to a binding collateral constraint are muted. This of course rests on the premise of shallow domestic markets, so that borrowers cannot circumvent the international borrowing constraint with additional domestic borrowing. Reassuringly, most EMs have a relatively small domestic financial sector.

The second contribution is a tractable formula that highlights the appropriate

macroprudential regulatory mix. Importantly, domestic regulation increases with international regulation (CFMs), but this comovement is not one-to-one: 1) Domestic and international prudential policies target different assets with unique payoffs. 2) The policies have a distinctive effect on the exchange rate and hence available international collateral during a crisis. 3) Domestic and international policies differ in their costs. Among other things, CFMs also manipulate the exchange rate when the international borrowing constraint does not bind ex-post.

Figure 1: Financial Regulation in Emerging Markets and Developing Economies

Notes: Panel (a): The graph displays the prevalence of regulatory policies in emerging markets and developing economies. Each index is normalized to range between [0,1]. CFMs are classified as capital controls (CC) or restrictions on foreign currency borrowings (FX). Domestic macroprudential policies represent rules that do not target international flows or foreign currency transactions. Panel (b): The chart presents the share of EMs that implement 0,1,2,3 of the aforementioned different regulatory policies at the same time. Restrictions for each category must be above the 25% percentile, else a policy is considered "not implemented". Data Sources: [Fernández et al. \(2016\)](#) and [Cerutti et al. \(2017\)](#). A list of included countries is available in Table A1 in the appendix.

I explore the interaction between domestic and international regulatory policies by means of a stylized three-period small open economy model. The model features three agents: Domestic savers, domestic borrowers and risk-neutral international investors. Domestic households issue (purchase) bonds denominated in local or foreign currency. International investors only borrow (lend) in foreign currency. They are hence unwilling to hold bonds denominated in the emerging market currency, mirroring the issue of liability dollarization. The model also includes an occasionally binding collateral constraint on foreign currency borrowings, which is a common feature in the literature. Access to domestic debt is subject to a capacity constraint, reflecting limited domestic financial market depth. This feature ensures that borrowers are unable to sidestep the international constraint via issuing more domestic debt.

The occasionally binding constraint on foreign currency debt is meant to capture

sudden stops in international financing. The collateral is tied to available income expressed in foreign currency and therefore improves in the exchange rate. A depreciation consequently reduces the value of the collateral, which triggers a feedback loop of tightening constraints, capital outflows and further exchange rate depreciations. Domestic agents however do not internalize the dependency between investment decisions, the exchange rate and hence the feedback loop, which introduces a pecuniary externality. This externality makes the competitive equilibrium inefficient and domestic agents overborrow/do not save enough, justifying domestic macroprudential policies in addition to CFMs, which have been extensively studied in the literature. This result rests on the premise that borrowers are not able to fully substitute international borrowing with domestic borrowing, but it does not depend on a domestic externality.

In a numerical exercise the model is calibrated to match key characteristics of sudden stop episodes in smaller emerging markets. Two findings are noteworthy: First, optimal intervention in domestic financial markets is roughly half of the size of international intervention, as measured by wedges that account for each of these policies. Second, in a variant with just CFMs domestic households exploit the lack of domestic regulation, which, via general equilibrium effects, may increase the tightness of the international borrowing constraint relative to the unregulated equilibrium. A regulatory approach with policies geared towards the international *and* domestic market is hence crucial to limit adverse sudden stop dynamics.

From a technical point, the formulas for optimal macroprudential policy in this paper extend the well known expressions of a representative agent framework under uncertainty (see, for example, [Bianchi, 2011](#)). Similar to the literature, regulation is determined by its impact on a collateral constraint. However, two additional channels emerge when households are either net sellers or buyers of domestic goods. First, the exchange rate alters the net income (expense) from selling (purchasing) domestic goods, which introduces a desire to hedge. Second, international regulation, unlike domestic regulation, also affects the exchange rate when the constraint does not bind ex-post. This distortionary effect is mitigated if exchange rate movements increase the net worth of households who are not subject to the externality.

Related Literature: The paper belongs to the literature on pecuniary externalities that emerge from endogenous prices in collateral constraints and justify ex-ante regulation. I follow the small open economy tradition (see, for example, [Bianchi, 2011](#); [Benigno et al., 2013](#); [Korinek, 2018](#)) and introduce a constraint that depends on current income and hence the exchange rate. Relative to these papers, I specify a portfolio allocation problem in which heterogeneous households choose between domestic *and* foreign

assets, which generates a rationale for purely domestic regulation when borrowers have a higher marginal propensity to consume.

Only two other papers study the interaction between prudential policies. [Korinek and Sandri \(2016\)](#) focus on two instruments that can be classified as CFMs. This paper builds on their framework, but extends it in two ways: First, I introduce a domestic asset and hence a rationale for domestic regulation. Second, I fully characterize optimal macroprudential policies under uncertainty. In contrast to [Basu et al. \(2020\)](#), I focus on the consequences when agents have access to multiple assets and highlight a crucial role for the marginal propensity to consume as a justification for domestic regulation. By studying the implications of endogenous portfolio choices, the paper also relates to a recent literature on the determination of portfolios in an international context (see, for example, [Bocola and Lorenzoni, 2020](#); [Gopinath and Stein, 2020](#); [Salomao and Varela, 2021](#)).

2. FRAMEWORK

2.1. Environment

The small open economy features three periods $t = 0, 1, 2$ and three agents: domestic borrowers (B), domestic savers (S), each with measure one, and a large group of risk-neutral international investors. Both domestic households have identical preferences and derive utility from consuming tradable ($c_{i,t}^T$) and nontradable goods ($c_{i,t}^N$) with $i \in \{B, S\}$. The only distinctive feature relates to different exogenous endowment/initial bond positions, which ensures that savers find it optimal to save, and borrowers optimal to borrow.

To inter-temporally relocate funds, households have access to two non-state-contingent bonds: an international bond in units of tradable goods and a domestic bond in units of the nontradable good, which is meant to capture debt denominated in foreign and domestic currency respectively (see [Bocola and Lorenzoni, 2020](#) for an equivalent formulation). Each bond pays one unit of the respective underlying good. The international bond ($b_{i,t}^T$) is traded with inelastic international investors. Domestic bonds ($b_{i,t}^N$) are traded between borrowers and savers. Domestic and international financial markets are hence segmented. Both financial markets are subject to frictions: International borrowings is limited to a fraction of available income. The domestic bond market is shallow, which restricts the maximum issuance of domestic debt. I discuss these and other assumptions towards the end of

this section.

There is no production. The only source of uncertainty pertains to the collateralizable share of income in the international borrowing constraint during period 1. Thus all uncertainty is resolved at the start of the second period. I subsequently characterize the environment in more detail. All proofs are delegated to the appendix.

Household Maximization Problem

Each household maximizes expected utility by choosing a path for consumption $\{c_{i,t}^T, c_{i,t}^N\}$, and one-period international ($b_{i,t+1}^T$) or domestic bonds ($b_{i,t+1}^N$) where positive values indicate savings.

$$\max_{c_{i,t}^T, c_{i,t}^N, b_{i,t+1}^T, b_{i,t+1}^N} \left\{ u(c_{i,0}) + E[u(c_{i,1}) + u(c_{i,2}^T)] \right\}. \quad (P)$$

Preferences are characterized by log-utility, that is, $u(\cdot) = \ln(\cdot)$. Consumption in period 2 is limited to tradables. The composite consumption index $c_{i,t}$ at $t = 0, 1$ is defined as:

$$c_{i,t} = (c_{i,t}^T)^\omega (c_{i,t}^N)^{1-\omega}$$

The parameter ω determines the expenditure share of tradable consumption. Both agents receive exogenous endowments of $\{y_{i,t}^T, y_{i,t}^N\}$ at date 0 and 1 as well as tradable endowment $y_{i,2}^T$ in period 2. The relative price of nontradables in terms of tradables is denoted as p_t . As a standard feature of small open economy models, the relative price of nontradables can be equivalently characterized as a measure of the real exchange rate.

The price of international bonds is determined in world markets and normalized to one. The price of the domestic bond q_t will be determined in equilibrium. Because agents do not value nontradable consumption in $t = 2$, domestic bonds are accessed in $t = 0$ only. This feature eliminates a domestic financial market in $t = 1$, which can be interpreted as a rather extreme friction on the functioning of the domestic market as it implies zero domestic debt issuance.

With the previous information, the budget constraints of savers and borrowers in $t = 0, 1, 2$ are

$$c_{i,0}^T + b_{i,1}^T + p_0(c_{i,0}^N + q_0 b_{i,1}^N) = y_{i,0}^T + b_{i,0}^T + p_0(y_{i,0}^N + b_{i,0}^N) \quad (1)$$

$$c_{i,1}^T + b_{i,2}^T + p_1 c_{i,1}^N = y_{i,1}^T + b_{i,1}^T + p_1(y_{i,1}^N + b_{i,1}^N) \quad (2)$$

$$c_{i,2}^T = y_{i,2}^T + b_{i,2}^T. \quad (3)$$

Borrowers are subject to an international financial constraint at date 1, which prevents them to borrow more than a fraction ϕ of their current income.

$$-b_{B,2}^T \leq \phi(y_{B,1}^T + p_1 y_{B,1}^N) \quad (4)$$

The specific functional form follows [Mendoza \(2002\)](#) and is common in the literature on financial crises and ex-ante regulation.¹ The collateralizable income share ϕ is uncertain and follows a two state process with realizations $\{\underline{\phi}, \bar{\phi}\}$. The constraint binds if $\phi = \underline{\phi}$, which occurs with probability p .

The presence of p_1 in the borrowing constraint is crucial for the subsequent analysis. The real exchange rate is an equilibrium object and depends, among others, on aggregate consumption and saving decisions in $t = 0$. Individual households however do not internalize this dependency, which generates a pecuniary externality, and provides a justification for macroprudential intervention. Intuitively, households do not realize that savings in $t = 0$ improve the exchange rate and therefore relax the borrowing constraint if it binds. I make the following assumption on $\underline{\phi}$:

Assumption 1 *The collateralizable fraction of current income satisfies $0 < \underline{\phi} < \frac{\omega}{1-\omega} \frac{\sum_i Y_{i,1}^N}{Y_{B,1}^N}$.*

This assumption is standard in the literature on financial amplification and ensures the existence of a unique constrained equilibrium ([Schmitt-Grohe and Uribe, 2021](#)). On the contrary if this condition was violated, an increase in $t = 1$ tradable borrowing would relax the borrowing constraint by more than one unit and the constraint would never bind.

Discussion of Assumptions

Three sets of assumptions deserve further attention: the constraints on domestic and international borrowing, financial market segmentation and the stochastic process determining the collateralizable share of income.

The focus in this paper is on the international borrowing constraint and its consequences for international and domestic regulation. As already explained, the international constraint entails an externality which will ultimately justify regulatory intervention, both in the international and, as the new feature of this model, the

¹The constraint can be endogenously derived based on limited commitment along the lines of [Kiyotaki and Moore \(1997\)](#). After borrowers received their loans in period 1, they have an opportunity to divert funds and default. In case of default lenders can at most claim a fraction ϕ of period 1 income. To avoid losses, lenders are hence only willing to provide loans up to ϕ times the current income.

domestic market. However, in the absence of a constraint on domestic borrowing, borrowers would be able to circumvent the international constraint. I therefore argue that domestic markets are shallow and restrict domestic debt issuance. This is consistent with the empirical observation that financial markets in EMs are small relative to international markets. The assumption of zero debt absorption in $t = 1$ is merely imposed to keep the framework simple. Domestic absorption in $t = 1$ could be positive as long as it is not large enough to accommodate the difference between desired and constrained international borrowing. At the expense of analytical tractability, I could therefore add nontradable utility and endowments in period 2, and impose a positive limit on domestic debt issuance in $t = 1$. Lastly, binding borrowing constraints in period 0 would lead to a degenerate equilibrium in which borrowing choices are dictated by constraints. This is not interesting to analyze. Hence, I do not impose borrowing constraints at date 0. Alternatively, I could introduce a borrowing constraint like equation (4) in period 0, restrict domestic $t = 0$ borrowing to $\chi > 0$ and focus on environments in which these constraints do not bind.

Regarding market segmentation, the framework would lead to equivalent results if borrowers and savers would be allowed to trade international bonds in the domestic market, so long as these international bonds exchanged at home would be subject to the same international borrowing constraint. However, the interpretation of regulation would change. Borrowers (savers) take on too much tradable debt (save too little). If tradable bonds were also traded at home, it would be challenging to interpret the associated regulatory intervention as CFMs. In contrast, domestic currency debt must be restricted to domestic markets. This is a consequence of the specific framework in which international investors are risk-neutral. International investors, unlike domestic savers, would not require a risk premium to compensate for exchange rate risk associated with domestic debt. Therefore, borrowers would never issue domestic bonds to savers in equilibrium.

The two state stochastic process provides a tractable characterization of the optimal policy intervention. However, because the international constraint binds in one state, but not the other, regulatory intervention does not decrease the likelihood of a binding constraint and hence recession. It is well known in the literature that macroprudential policies generally decrease *both* the likelihood and the severity of a recession. This drawback however has no implications on the characterization of the optimal policy.²

²The two states $\{\underline{\phi}, \overline{\phi}\}$ and two assets imply perfect risk sharing in the unregulated equilibrium even though both assets are non-state-contingent: The relevant payoff of the nontradable bond depends on the exchange rate, which varies by state.

Solution Strategy

In what follows, I solve this model via backward induction. Hence, I will first derive the continuation equilibrium for periods $t = 1, 2$ conditional on $t = 0$ borrowing and saving decisions (Section 2.2). The continuation equilibrium is characterized by two regimes depending on whether borrowers are constrained in international markets or not. I then proceed backward and solve for period 0 choices in the laissez-faire competitive equilibrium (Section 2.3). I contrast this solution with a social planner (Section 3.1), who internalizes the externality in this model. Subsequently I describe the implementation of the social planner allocation via CFMs and domestic macroprudential policies (Section 3.2).

2.2. Period 1 Continuation Equilibrium

In period 1, savers and borrowers maximize period 1 and 2 utility. The state vector in $t = 1$ is fully described by date 0 international and domestic borrowing/saving decisions, exogenous endowments and the realization of the stochastic process. I follow the convention in the literature and use capital letters to denote aggregate variables. The aggregate endogenous state vector is therefore described by $B = \{B_{B,1}^T, B_{B,1}^N, B_{S,1}^T, B_{S,1}^N\}$ with $b_{i,1}^T = B_{i,1}^T$ and $b_{i,1}^N = B_{i,1}^N$ in equilibrium as households are of measure one.

Each agent in period 1 solves

$$V_i(b_{i,1}^T, b_{i,1}^N; B) = \max_{c_{i,1}^T, c_{i,1}^N, b_{i,2}^T, c_{i,2}^T} \left\{ u \left((c_{i,1}^T)^\omega (c_{i,1}^N)^{1-\omega} \right) + u \left(c_{i,2}^T \right) \right\} \quad (\text{P1})$$

subject to

$$c_{i,1}^T + b_{i,2}^T + p_1 c_{i,1}^N = y_{i,1}^T + b_{i,1}^T + p_1 (y_{i,1}^N + b_{i,1}^N) \quad (5)$$

$$c_{i,2}^T = y_{i,2}^T + b_{i,2}^T \quad (6)$$

$$-b_{B,2}^T \leq \phi(y_{B,1}^T + p_1 y_{B,1}^N). \quad (7)$$

Definition 1: (Continuation Equilibrium) *The continuation equilibrium is characterized by the real exchange rate p_1 and endogenous quantities $\{c_{i,1}^T, c_{i,1}^N, b_{i,2}^T, c_{i,2}^T\}$ with $i \in \{B, S\}$ such that*

1. households maximize utility (P1) subject to the period 1 and 2 budget constraints (5), (6) and the borrowing constraint (7) (only borrowers) taking the real exchange rate as given;

2. the period 1 market for nontradables clears, $\sum_i C_{i,1}^N = \sum_i Y_{i,1}^N$.

I define $u_{i,t}^T = \frac{\partial u(c_{i,t})}{\partial c_{i,t}^T}$ as the marginal utility from tradable consumption for household i in period t . The same convention applies to $u_{i,t}^N$. The first order conditions are

$$\begin{aligned} u_{i,1}^T &= u_{i,2}^T + \lambda_i \\ u_{i,1}^N &= p_1 u_{i,1}^T. \end{aligned}$$

The first equation is a standard Euler equation augmented for a potentially binding borrowing constraint with Lagrange multiplier λ_i . The multiplier is positive whenever the constraint binds and prevents borrowers from smoothing their tradable consumption between $t = 1$ and $t = 2$. Savers are by construction never constrained, hence $\lambda_S = 0$.

The second equation weights tradable and nontradable consumption. It can be aggregated over all agents and combined with the market clearing condition for nontradables. Because domestic bond holdings sum to zero on aggregate, the real exchange rate satisfies

$$p_1 = \frac{1 - \omega \sum_i C_{i,1}^T}{\omega \sum_i Y_{i,1}^N}.$$

The exchange rate improves with economy-wide tradable consumption due to the complementarity between tradable and nontradable consumption. In what follows, I focus on the period 1 exchange rate in the unconstrained and constrained regime. Specifically, I will show that the exchange rate is a function of economy-wide period 0 borrowing/saving decisions related to domestic and international bonds.

Unconstrained Period 1 Equilibrium

The unconstrained equilibrium emerges when $\phi = \bar{\phi}$ in which case the borrowing constraint does not bind. Both households perfectly smooth tradable consumption, that is, $u_{i,1}^T = u_{i,2}^T$. As a result, period 1 tradable consumption is

$$c_{i,1}^{T,un} = \frac{\omega}{2} \left(y_{i,1}^T + b_{i,1}^T + p_1 (y_{i,1}^N + b_{i,1}^N) + y_{i,2}^T \right).$$

Agents spend half of their income in period 1 and a fraction ω thereof on tradable goods. The real exchange rate corresponds to

$$p_1^{un}(B_{B,1}^T, B_{S,1}^T) = \frac{(1 - \omega) \left[\sum_i (Y_{i,1}^T + B_{i,1}^T + Y_{i,2}^T) \right]}{(1 + \omega) \left[\sum_i Y_{i,1}^N \right]}.$$

The real exchange rate is increasing in international savings. More external wealth increases tradable consumption and the desire for nontradable consumption which must be offset by a higher real exchange rate. On the other hand, the equilibrium exchange rate is independent of the specific allocation of domestic bonds. Any ex-ante intervention that alters incentives to hold domestic bonds has hence no impact on the period 1 exchange rate if borrowers are unconstrained. This result emerges as borrowers and savers have the same marginal propensity to consume. Domestic savings and borrowings therefore cancel out. However, this is about to change once the international borrowing constraint binds.

Constrained Period 1 Equilibrium

The constrained or crisis equilibrium emerges when $\underline{\phi}$ is realized and borrowers are constrained in international markets. It follows that $\lambda^B > 0$, and via the Euler equation, $u_{B,1}^T > u_{B,2}^T$. Borrowers are no longer able to smooth tradable consumption. Period 1 tradable consumption for borrowers is pinned down via the budget constraint:

$$c_{B,1}^{T,con} = \omega \left(y_{i,1}^T + b_{i,1}^T + p_1(y_{i,1}^N + b_{i,1}^N) + \phi(y_{B,1}^T + p_1 y_{B,1}^N) \right).$$

Borrowers use all of their available resources and spend a fraction ω on tradable consumption. Savers are not constrained, hence their period 1 tradable consumption is still given by the consumption formula in the unconstrained equilibrium. The real exchange rate is consequently characterized by

$$p_1^{con}(B_{B,1}^T, B_{S,1}^T, B_{B,1}^N) = \frac{(1 - \omega) \left[(1 + \underline{\phi}) Y_{B,1}^T + B_{B,1}^T + \frac{Y_{S,1}^T + B_{S,1}^T + Y_{S,2}^T}{2} \right]}{\sum_i Y_{i,1}^N - (1 - \omega) \left[Y_{B,1}^N (1 + \underline{\phi}) + \frac{Y_{S,1}^N}{2} + \frac{B_{B,1}^N}{2} \right]}.$$

Both, numerator and denominator are positive. A sufficient condition is $B_{B,1}^N < 0$, that is, borrowers borrow in the domestic market. I summarize the impact of the date 0 borrowing/saving decisions on the exchange rate in the first Lemma.

Lemma 1

1. *The real exchange rate appreciates with the international net worth position. If borrowers are constrained then $\frac{\partial p_1}{\partial B_{B,1}^T} > \frac{\partial p_1}{\partial B_{S,1}^T} > 0$, otherwise $\frac{\partial p_1}{\partial B_{B,1}^T} = \frac{\partial p_1}{\partial B_{S,1}^T} > 0$.*
2. *The exchange rate improves if borrowers (savers) hold less domestic debt (save less) in a constrained equilibrium, that is, $\frac{\partial p_1}{\partial B_{B,1}^N} = -\frac{\partial p_1}{\partial B_{S,1}^N} > 0$. Otherwise the exchange rate does not depend on the allocation of domestic savings/borrowings.*

When borrowers are constrained, a reduction in international debt stabilizes the exchange rate by more than an increase in savings, that is, $\frac{\partial p_1}{\partial B_{B,1}^T} > \frac{\partial p_1}{\partial B_{S,1}^T}$. This can be traced back to distinct marginal propensities to consume. A marginal increase in external net worth increases the consumption expenditure for constrained borrowers by more than one unit due to feedback effects via the exchange rate in the collateral constraint. Contrary, savers prefer to smooth consumption between date 1 and 2 and hence save parts of the additional net worth. Borrowers therefore increase consumption by more than savers, which induces a comparably larger effect on the real exchange rate. Figure 2, Panel (a) plots the exchange rate as a function of international debt ($-B_{B,1}^T$) in the constrained and the unconstrained regime. Two additional results emerge: the exchange rate is lower and more sensitive to foreign debt in the constrained regime. The latter result is tied to the different marginal propensities to consume, while the former is a consequence of subdued tradable consumption when the constraint binds.

In addition, and this will be vital to justify domestic regulation, the exchange rate is a function of the domestic bond allocation. As illustrated in Figure 2, Panel (b), the exchange rate deteriorates with domestic debt (higher $-B_{B,1}^N$) when borrowers are constrained. This effect stems from distributional considerations of nontradable net worth at the beginning of date 1. Borrowers have a higher marginal propensity to consume, so one unit of additional wealth in the hands of borrowers overcompensates the equivalent wealth loss of savers in terms of consumption demand. The domestic borrowings/savings decision hence materially affects aggregate tradable consumption, which in turn affects the real exchange rate and the tightness of the international borrowing constraint/severity of the recession.

Figure 2: Exchange Rate: Comparative Statics

Notes: The horizontal axis displays international debt (Panel (a)) or domestic debt (Panel (b)). The vertical axis represents the real exchange rate. The solid line characterizes the unconstrained regime and the dotted line the constrained regime.

2.3. Period 0 Laissez-faire Equilibrium

In period 0, savers and borrowers maximize date 0 utility and the value function from the continuation equilibrium $V_i(b_{i,1}^T, b_{i,1}^N; B)$ which depends on date 0 borrowing and saving decisions. Further, borrowers are not constrained in terms of their access to international financial markets and households participate in a domestic bond market. Each household solves

$$\max_{c_{i,0}^T, c_{i,0}^N, b_{i,1}^T, b_{i,1}^N} \left\{ u \left((c_{i,0}^T)^\omega (c_{i,0}^N)^{1-\omega} \right) + E[V_i(b_{i,1}^T, b_{i,1}^N; B)] \right\} \quad (\text{Po:CE})$$

subject to

$$c_{i,0}^T + b_{i,1}^T + p_0(c_{i,0}^N + q_0 b_{i,1}^N) = y_{i,0}^T + b_{i,0}^T + p_0(y_{i,0}^N + b_{i,0}^N). \quad (8)$$

Definition 2: (Unregulated Equilibrium) *The unregulated equilibrium is characterized by the real exchange rate p_0 , the price of domestic bonds q_0 and endogenous quantities $\{c_{i,0}^T, c_{i,0}^N, b_{i,1}^T, b_{i,1}^N\}$ with $i \in \{B, S\}$ such that*

1. *households maximize utility (Po:CE) subject to the period 0 budget constraint (8) taking the real exchange rates in $t = 0, 1$ and the bond price as given;*
2. *the domestic bond market clears, $\sum_i B_{i,1}^N = 0$;*
3. *the period 0 market for nontradables clears, $\sum_i \{C_{i,0}^N + B_{i,1}^N\} = \sum_i \{Y_{i,0}^N + B_{i,0}^N\}$.*

The derivatives of the date 1 value function correspond to $\frac{\partial V_i(\cdot)}{\partial b_{i,1}^T} = u_{i,1}^T$ and $\frac{\partial V_i(\cdot)}{\partial b_{i,1}^N} = p_1 u_{i,1}^T = u_{i,1}^N$. Hence,

$$\begin{aligned} u_{i,0}^T &= E[u_{i,1}^T] \\ q_0 u_{i,0}^N &= E[u_{i,1}^N] \\ u_{i,0}^N &= p_0 u_{i,0}^T. \end{aligned}$$

Both households smooth tradable and nontradable consumption. The third condition relates tradable and nontradable consumption. The domestic bond entails a risk premium due to the uncertain $t = 1$ exchange rate. Combining both Euler equations with the intratemporal first order conditions yields

$$q_0 = \frac{E[p_1]}{p_0} + \underbrace{\frac{\text{Cov}(\frac{p_1}{p_0}, u_{i,1}^T)}{E[u_{i,1}^T]}}_{<0}.$$

The covariance term is negative. As portrayed in Figure 2, the exchange rate depreciates when the borrowing constraint binds. A binding borrowing constraint in turn implies a higher marginal utility for both households, either directly for borrowers, or indirectly via general equilibrium price effects for savers. Intuitively, domestic bonds have a low payoff during a recession and hence trade at a discount.

3. CAPITAL FLOW MEASURES AND DOMESTIC MACROPRUDENTIAL REGULATION

Can a benevolent regulator increase domestic welfare relative to the competitive equilibrium? The answer to this question is affirmative. The pecuniary externality embedded in this model justifies prudential interventions in period 0. In order to characterize the optimal policy, I follow the common approach of a constrained social planner who achieves a second best solution by allocating date 0 resources efficiently given the set of markets operating (Stiglitz, 1982, Geanakoplos and Polemarchakis, 1986). The allocations in $t = 1, 2$ are determined by decentralized agents in competitive markets.³ The solution is second best in the sense that the social planner is subject to the same financial constraint (4) at date 1. By choosing period 0 allocations on behalf of all domestic agents, the planner however internalizes the dependency between aggregate period 0 bond holdings, the real exchange rate at date 1 and the tightness of the borrowing constraint.

I adhere to the dynamic public finance literature and use the primal approach (Lucas and Stokey, 1983). That is, the social planner directly chooses the consumption path of domestic households as well as the allocation of domestic and international bonds (Section 3.1). Subsequently, I decentralize the allocation based on three distinctive policy instruments that are akin to CFMs and domestic macroprudential policies (Section 3.2).

3.1. Period 0 Social Planner Equilibrium

The social planner maximizes the weighted utility (Pareto weights γ_i) of all borrowers and savers,

³For complementary work on the interplay between ex-ante and ex-post policies, see, for example, Benigno et al. (2016), and Jeanne and Korinek (2020). The consensus view is that both policies are necessary since ex-post policies are likely to create moral hazard or entail efficiency losses due to distortionary financing.

$$\max_{C_{i,0}^T, C_{i,0}^N, B_{i,1}^T, B_{i,1}^N} \left\{ \sum_i \gamma_i \left\{ u \left((C_{i,0}^T)^\omega (C_{i,0}^N)^{1-\omega} \right) + E[V_i(B)] \right\} \right\} \quad (\text{Po:SP})$$

subject to

$$\sum_i \{C_{i,0}^T + B_{i,1}^T\} = \sum_i \{Y_{i,0}^T + B_{i,0}^T\} \quad (9)$$

$$\sum_i \{C_{i,0}^N + B_{i,1}^N\} = \sum_i \{Y_{i,0}^N + B_{i,0}^N\} \quad (10)$$

$$\sum_i B_{i,1}^N = 0. \quad (11)$$

The first (second) equation is the period 0 resource constraint for tradable (nontradable) goods. The third constraint captures the market clearing condition for domestic bonds. The planner is hence able to freely allocate tradable and nontradable consumption goods across agents. However, domestic bonds must sum to zero, consistent with the functioning of the domestic financial market. Further, the planner directly chooses the endogenous period 1 aggregate state variables and hence internalizes that date 0 saving and borrowing decisions affect the real exchange rate at date 1.

Definition 3: (Social Planner Equilibrium) *The social planner equilibrium is characterized by aggregate endogenous quantities $\{C_{i,0}^T, C_{i,0}^N, B_{i,1}^T, B_{i,1}^N\}$ with $i \in \{B, S\}$ such that*

1. *the social planner maximizes the weighed utility (Po:SP) subject to the tradable resource constraint (9), the nontradable resource constraint (10) and the constraint imposed by the domestic bond market (11);*
2. *the planner internalizes the impact of aggregate borrowing and saving decisions on the real exchange rate at date 1.*

The first order conditions of the social planner with respect to consumption provide two equations that balance the weighted marginal utility from tradables and nontradables across agents: $\gamma_i u_{i,0}^T = \gamma_j u_{j,0}^T$ and $\gamma_i u_{i,0}^N = \gamma_j u_{j,0}^N$ for $i \neq j$. Further, combining the first order conditions for tradable and nontradable consumption implies $u_{i,0}^N = \beta_2 u_{i,0}^T$. Households hence consume tradable and nontradables proportionally, determined by the Lagrange multiplier β_2 .⁴ The optimality conditions regarding the accumulation of foreign and domestic debt are summarized as

⁴The Lagrange multipliers of equations (9), (10) and (11) are β_1 , $\beta_1\beta_2$ and $\beta_1\beta_2\beta_3$ respectively. With this definition, β_2 reflects the value of nontradables in terms of tradables, just as p_0 in the decentralized equilibrium. β_3 represents the tightness of the domestic bond resource constraint in units of nontradables. It can be shown that $1 - \beta_3 = q_0$ (Lemma 2).

$$\begin{aligned}
& \underbrace{\gamma_i u_{i,0}^T = E[\gamma_i u_{i,1}^T]}_{\text{Consumption Smoothing}} + E \left[\underbrace{\frac{\partial p_1}{\partial B_{i,1}^T} (\gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N)}_{\text{Redistribution}} \right] + E \left[\underbrace{\frac{\partial p_1}{\partial B_{i,1}^T} \gamma_B \lambda_B \phi Y_{B,1}^N}_{\text{Externality}} \right] \\
& \hspace{15em} (\text{FOC: } B_{i,1}^T) \\
& \underbrace{\gamma_i u_{i,0}^N (1 - \beta_3) = E[\gamma_i u_{i,1}^N]}_{\text{Consumption Smoothing}} + E \left[\underbrace{\frac{\partial p_1}{\partial B_{i,1}^N} (\gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N)}_{\text{Redistribution}} \right] + E \left[\underbrace{\frac{\partial p_1}{\partial B_{i,1}^N} \gamma_B \lambda_B \phi Y_{B,1}^N}_{\text{Externality}} \right] \\
& \hspace{15em} (\text{FOC: } B_{i,1}^N)
\end{aligned}$$

The variable β_3 relates to the Lagrange multiplier of the domestic bond resource constraint (11). Both Euler equations can be split into three parts. The first component is motivated by consumption smoothing and coincides with the Euler equations in the decentralized equilibrium. The second term captures distributional effects associated with movements in the real exchange rate. An appreciated exchange rate benefits sellers of nontraded goods. The sales are multiplied by the difference between the households' marginal utility to balance the gains and cost from redistribution. The third term refers to the pecuniary externality of the model. Aggregate saving and borrowing decisions affect the real exchange rate and hence the tightness of the borrowing constraint.

Based on the above first order conditions it is possible to derive four wedges that account for the distinctive valuation of savings/borrowings relative to the competitive equilibrium. However, I have to make one additional assumption which ensures that transfers of tradables from savers to borrowers do not lead to a decline in borrowers' expected wealth:

Assumption 2 *A $t = 1$ transfer in tradables from savers to borrowers increases the expected wealth of borrowers, that is, $1 + E \left[\left(\frac{\partial p_1}{\partial B_{B,1}^T} - \frac{\partial p_1}{\partial B_{S,1}^T} \right) (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N) \right] \equiv D > 0$.*

A one unit transfer leads to an equivalent increase in borrowers' period 1 tradable wealth, however it also leads to a change in the exchange rate which affects the net income from nontradable sales/purchases.

Proposition 1 *A constrained efficient solution satisfies:*

$$\frac{E[u_{B,1}^T]}{u_{B,0}^T} = 1 - \underbrace{\left(\underbrace{E \left[\frac{\partial p_1}{\partial B_{B,1}^T} \lambda_B \phi Y_{B,1}^N \right]}_{\text{Externality}} \underbrace{\left(1 - \frac{1}{2}(1-p) \frac{\partial p_1^{un}}{\partial B_{B,1}^T} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^{N,un}) \right)}_{\text{Ex-Post Adjustment}} + \underbrace{\frac{\text{Cov} \left(\frac{\partial p_1}{\partial B_{B,1}^T} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), u_{B,1}^T - \frac{\gamma_S}{\gamma_B} u_{S,1}^T \right)}_{\text{Hedging}} \frac{1}{u_{B,0}^T} \right)}_{\tau_B^T} - \Xi_B^T$$

$$\begin{aligned}
\frac{E[u_{S,1}^T]}{u_{S,0}^T} &= 1 - \underbrace{\left(\frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^T} \lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^T D} \left(1 + \frac{1}{2}(1-p) \frac{\partial p_1^{un}}{\partial B_{S,1}^T} (Y_{S,1}^N + B_{S,1}^N - C_{S,1}^{N,un})\right) + \frac{Cov\left(\frac{\partial p_1}{\partial B_{S,1}^T} (Y_{S,1}^N + B_{S,1}^N - C_{S,1}^N), \frac{\gamma_S}{\gamma_B} u_{S,1}^T - u_{B,1}^T\right)}{u_{B,0}^T} - \Xi_S^T \right)}_{\tau_S^T} \\
\frac{E[u_{B,1}^N]}{u_{B,0}^N} \frac{1}{1-\beta_3} &= 1 - \frac{1}{1-\beta_3} \underbrace{\left(\frac{E\left[\frac{\partial p_1}{\partial B_{B,1}^N} \lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^N D} + \frac{Cov\left(\frac{\partial p_1}{\partial B_{B,1}^N} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), u_{B,1}^T - \frac{\gamma_S}{\gamma_B} u_{S,1}^T\right)}{u_{B,0}^N} - \Xi_B^N \right)}_{\tau_B^N} \\
\frac{E[u_{S,1}^N]}{u_{S,0}^N} \frac{1}{1-\beta_3} &= 1 - \frac{1}{1-\beta_3} \underbrace{\left(\frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^N} \lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^N D} + \frac{Cov\left(\frac{\partial p_1}{\partial B_{S,1}^N} (Y_{S,1}^N + B_{S,1}^N - C_{S,1}^N), \frac{\gamma_S}{\gamma_B} u_{S,1}^T - u_{B,1}^T\right)}{u_{B,0}^N} - \Xi_S^N \right)}_{\tau_S^N}
\end{aligned}$$

All Ξ s are close to zero. The terms $\{\tau_B^T, \tau_S^T, \tau_B^N, \tau_S^N\}$ represent wedges that characterize the difference between the social planner and decentralized equilibrium.

1. If the borrowing constraint never binds, the planner has the same incentive to save/borrow as households in the decentralized equilibrium. In this case, $\tau_B^T = \tau_S^T = \tau_B^N = \tau_S^N = 0$;
2. If the borrowing constraint binds with positive probability, the planner introduces wedges in the intertemporal marginal rate of substitution. The specific intervention is a function of three factors: the extent of the externality, the effect on wealth if the constraint does not bind ex-post and the desire to hedge against adverse outcomes. The first factor is precautionary and larger for borrowers than for savers. The other two factors may or may not induce incentives to save, but never offset the prudential externality motive. Thus, $\tau_B^T > 0$ and $\tau_S^T > 0$;
3. The planner also introduces wedges for domestic bonds. The borrowing constraint discourages domestic borrowing for borrowers and discourages domestic savings for savers. Further, the externality always dominates the desire to hedge. Hence, $\tau_B^N > 0$ and $\tau_S^N < 0$. The domestic wedges are equivalent in absolute terms, $\tau_B^N = |\tau_S^N|$.

The first Proposition characterizes the constrained efficient marginal rates of intertemporal substitution, for both households and bonds. The rates differ from the competitive equilibrium as highlighted by four wedges. These wedges are however zero if borrowers are always unconstrained ($\lambda_B = 0$). Intuitively, the only justification for prudential intervention in this model relates to the pecuniary externality associated with the international borrowing constraint.

If the borrowing constraint binds with positive probability, all four wedges are nonzero. The wedges can be grouped into two sets. The first set pertains to the tradable Euler equations and hence the willingness to borrow (save) internationally in foreign currency. The planner introduces wedges (τ_B^T, τ_S^T) that distort the competitive tradable intertemporal marginal rate of substitution. The wedge for borrowers may be intuitive, since borrowers (and not savers) are exposed to the pecuniary externality. However, a regulator also finds it optimal to introduce a wedge for savers, even though they are not constrained in their ability to borrow international funds. This is because the planner maximizes the joint welfare of both agents and therefore internalizes the dependency between savers and the tightness of the borrowing constraint.

The main insight of this paper pertains to the remaining two wedges related to domestic currency bonds traded at home. Based on Lemma 1, the exchange rate appreciates with less domestic debt, precisely because borrowers have a higher marginal propensity to consume. The constrained efficient nontradable Euler equations reflect this observation. A planner finds it optimal to shift nontradable resources towards borrowers when they are constrained in international markets. This is mirrored by two wedges (τ_B^N, τ_S^N) with $\tau_B^N > 0$ and $\tau_S^N < 0$. Because a reduction in domestic borrowings has the same effect as a decrease in savings, both wedges have the same size in absolute value. The crucial point here is that a planner finds it optimal to distort the allocation of domestic bonds, even when there is no domestic externality. The allocation of domestic wealth provides an additional margin to shift resources towards constrained households, which ultimately alleviates the international borrowing constraint due to general equilibrium exchange rate effects associated with distinct marginal propensities to consume.

The wedges can be decomposed into three factors: The first component, "Externality", directly addresses the externality embedded in the international borrowing constraint. The size of this effect depends on the sensitivity of the exchange rate with respect to borrowing/saving decisions. Because borrowers have a higher marginal propensity to consume, the externality is larger for international borrowings than savings and nonzero for domestic borrowings. The second component, "Ex-Post Adjustment", emerges as international saving/borrowing decisions also affect the exchange rate if the economy is unconstrained ex-post. Intervention generally favors borrowers, since they are subject to the externality, and is generally detrimental if the constraint does not bind. This drawback is however muted, if exchange rate movements improve the domestic net worth position of savers when the constraint does not bind ex-post. This adjustment may therefore amplify or mitigate the intervention related to the externality. The third component represents a "Hedging" motive. This term is

positive whenever households are net sellers of nontradable goods during a recession and at the same time experience a high marginal utility relative to the other household sector. This covariance term is zero in the unregulated equilibrium due to perfect risk sharing with two assets and two realizations of uncertainty.⁵ Intervention at the margin is therefore due to the pecuniary externality and not hedging or ex-post adjustments.

3.2. Implementation

The constrained efficient social planner solution can be decentralized by date 0 taxes/subsidies on domestic and international bonds. The period 0 budget constraint becomes

$$c_{i,0}^T + (1 - \tau_i^T)b_{i,1}^T + p_0(c_{i,0}^N + (1 - \tau_i^N)q_0b_{i,1}^N) = y_{i,0}^T + b_{i,0}^T + p_0(y_{i,0}^N + b_{i,0}^N) + T_i. \quad (12)$$

The term $T_i = -\tau_i^T b_{i,1}^T - p_0 \tau_i^N q_0 b_{i,1}^N$ represents lump-sum transfers from tax revenues to avoid wealth effects. The variables $\{\tau_i^T, \tau_i^N\}$ are distortionary policy instruments. If positive, the instrument represents a tax on borrowings or equivalently a subsidy on savings. Either way, a positive value induces households to save more or borrow less, which improves the net worth position in period 1. The Euler equations in the regulated competitive equilibrium are

$$\begin{aligned} \frac{E[u_{i,1}^T]}{u_{i,0}^T} &= 1 - \tau_i^T \\ \frac{E[u_{i,1}^N]}{q_0 u_{i,0}^N} &= 1 - \tau_i^N. \end{aligned}$$

Lemma 2 *The regulated equilibrium implements a constrained efficient allocation if the taxes/subsidies $\{\tau_i^T, \tau_i^N\}$ with $i \in \{B, S\}$ are set to their corresponding wedges as characterized in Proposition 1. The Lagrange multiplier β_3 corresponds to $1 - q_0$ and the ratio of Pareto weights γ_S/γ_B is set to resemble the wealth distribution of savers and borrowers.*

If taxes/subsidies are set appropriately, the Euler equations of the decentralized regulated equilibrium and the social planner equilibrium coincide. In this case, the regulated competitive equilibrium implements one point of the constrained efficient Pareto frontier, which is fully described by the set of Pareto weights (γ_i) . Crucially, these instruments improve the international net worth position and reduce domestic

⁵This argument also carries over to the Ξ s. All four Ξ s are zero absent regulation (see appendix).

debt during benign times, which dampens a potential subsequent recession. They are hence precautionary in nature and resemble macroprudential policies.

Mapping to Capital Flow Measures and Macroprudential Policies

I subsequently map the taxes/subsidies to CFMs and domestic macroprudential regulation. The model implies four distinctive wedges, however the borrowers' tax on domestic debt equals the savers' tax on savings, which reduces the effective number of distinctive interventions to three. As highlighted in the Introduction, CFMs directly target international flows. Both τ_B^T and τ_S^T therefore represent CFMs. Further, CFMs can be classified into capital controls that drive a wedge between domestic and foreign agents, and international macroprudential policies that specifically address exposure to foreign risk. International transactions by savers are not directly tied to international sudden stop dynamics. The wedge τ_S^T therefore represents (prudential) capital controls. The difference between τ_B^T and τ_S^T resembles specific foreign currency restrictions for at-risk borrowers in international markets and therefore correspond to international macroprudential policies. Domestic macroprudential policies in contrast relate to domestic currency arrangements between domestic savers and domestic borrowers and are hence similar to τ_B^N .

Corollary 1 *The taxes/subsidies in the regulated decentralized equilibrium $\{\tau_B^T, \tau_S^T, \tau_B^N\}$ resemble capital flow measures $\{\tau_{CFM}^{CC}, \tau_{CFM}^{FX}\}$ and domestic macroprudential policies $\{\tau_{MP}\}$. The mapping is as follows:*

$$\begin{aligned}\tau_{CFM}^{CC} &= \tau_S^T \\ \tau_{CFM}^{FX} &= \tau_B^T - \tau_S^T \\ \tau_{MP} &= \tau_B^N.\end{aligned}$$

τ_{CFM}^{CC} resemble (prudential) capital controls and τ_{CFM}^{FX} restrictions on foreign currency borrowings.

Relationship between Domestic and International Regulation

Proposition 2 *Capital flow measures and domestic macroprudential regulation are related:*

$$\underbrace{\tau_B^N}_{\text{Dom.MPru}} = \underbrace{\alpha_i}_{\text{Intercept}} + \underbrace{\kappa_i}_{\text{Multiplier}} \underbrace{\tau_i^T}_{\text{CFM}}$$

where $i \in \{B, S\}$. α_i is an intercept and κ_i is a multiplier, both defined in the appendix.

1. The multiplier is positive, but generally unequal to one. CFMs and domestic macroprudential policies are therefore imperfect complements;

2. *The comovement, as represented by the positive multiplier, depends on the inefficiency of domestic versus international borrowing, the return on bonds, and the relative cost of regulation.*

The second Proposition characterizes the relationship between domestic macroprudential policies and CFMs. All objects are determined in general equilibrium. Because $\kappa_i > 0$, domestic and international regulation comove. Thus, if a country considers to tighten the regulation of international financial flows, there may be a strong case to tighten domestic regulation as well. In this framework, the result emerges as both assets contribute to the same externality. If the international borrowing constraint is likely to be tight, it is optimal to appreciate the exchange rate. Both, an increase in the external wealth position, and a reallocation of domestic wealth towards borrowers achieves this goal. More generally, a regulator should focus on assets that are tied to the inefficiency in the economy. The substitutability of assets on its own does not justify a balanced regulatory approach.

The multiplier κ_i is generally different from one. There are several reasons: First, domestic and international bonds have a distinctive impact on the underlying pecuniary externality as measured by the partial derivative of the exchange rate with respect to bond holdings if the constraint binds. Not surprisingly, κ_i increases if the real exchange rate is more sensitive to domestic debt. Second, domestic and international regulation have distinctive costs. The costs in this framework are captured by two terms: the period 0 ratio of tradable and nontradable marginal utilities and the "Ex-Post Adjustment" as characterized in Proposition 1. If tradable consumption is scarce at date 0 (high $u_{B,0}^T$), it is more desirable to tax/regulate the domestic financial market or equivalently nontradable bonds. As a separate argument, if exchange rate adjustments from international bonds support savers when the constraint does not bind ex-post, international regulation is overall less harmful, which in turn reduces the multiplier. Third, the multiplier also depends on the investment profitability. Domestic regulation is more desirable, if domestic currency bonds provide a high return, or equivalently sell at a lower price (q_0). The reason is that more profitable investment opportunities support the reallocation of wealth across periods. Since macroprudential policies by design reallocate resources towards distressed periods, regulators have an incentive to tax investments with a higher return.

Numerical Illustration

Before concluding, I calibrate the model to a small emerging market. The framework in this paper is stylized, hence a quantitative exercises should be treated with caution. Nevertheless, this exercise provides a rough estimate on the comovement of domestic

macroprudential policies and CFMs (κ_i), and eludes on the importance of a joint regulatory approach, by contrasting the severity of a recession (λ_B) in an unregulated equilibrium with a partially regulated equilibrium, characterized by CFMs only, and a regulated equilibrium with the full set of macroprudential policies.

The model is defined by three parameters. The expenditure share of tradable consumption ω is set to 0.6, a reasonable value for small open economies (Lombardo and Ravenna, 2012). The crisis probability p corresponds to 0.05, consistent with the long-run crisis probability per year as found by Reinhart and Rogoff (2009). The tightness of the international borrowing constraint (ϕ) is difficult to determine empirically. I hence calibrate this value and the endowments of both households to roughly match the sudden stop dynamics during the East Asian crisis of 1997. The crisis affected primarily small emerging markets, which provides an ideal setting to study the implications of the model. The calibration implies a value of 0.1 for ϕ . In contrast, $\bar{\phi}$ is set to infinity. Consequently, the borrowing constraint only binds when $\phi = \bar{\phi}$. I set initial savings of savers to zero, both for domestic and international bonds and subsequently vary the external debt share of borrowers, such that the economy has an initial international debt to GDP ratio between 5 and 18%. Overall, this calibration results in a real exchange depreciation of slightly above 40% between period 0 and the crisis state in period 1, as well as a current account reversal of roughly 30% relative to GDP. The depreciation is close to the actual depreciation during the East Asian crisis, while the current account reversal is slightly higher.

Figure 3, Panel (a) plots "optimal" domestic macroprudential policies (τ_{MP}), (prudential) capital controls (τ_{CFM}^{CC}), and restrictions on foreign currency borrowings (τ_{CFM}^{FX}) as defined by Proposition 1 and Corollary 1. When borrowers hold more external debt, the economy becomes more vulnerable to sudden stop dynamics and the wedges increase. In other words it becomes more desirable to reduce domestic and international borrowings ex-ante. Overall, taxes are relatively small and range between 0.05 and 0.1%. These values are roughly in line with the literature conditional on similar external debt burdens. Overall though, the main insight from this chart pertains to the relative strength of domestic macroprudential policies versus CFMs. The tax on domestic bonds equals roughly 50% of the tax on international borrowings. While smaller, optimal intervention in domestic markets is still sizable and as I show in Panel (b) crucial to avoid undesired portfolio adjustments that could undermine the intention of CFMs.

Figure 3, Panel (b) displays the Lagrange multiplier λ_B during the crisis state as a function of the initial external debt position. Not surprisingly, the borrowing constraint

Figure 3: Numerical Illustration

Notes: Panel (a): Optimal macroprudential intervention (in %) as a function of the external debt to GDP ratio (in %). The chart distinguishes between (prudential) capital controls (τ_{CFM}^{CC}), restrictions on foreign currency borrowings (τ_{CFM}^{FX}), and domestic macroprudential policies (τ_{MP}). Panel (b): Severity of recession (λ_B) as a function of the external debt to GDP ratio (in %). "Full Regulation" implements the planner allocation. "No Domestic Regulation" considers a variant with $\tau_{MP} = 0$, and hence only CFMs. "No Regulation" features the unregulated equilibrium. Calibration: $\phi=0.1$, $p=0.05$, $\omega=0.6$.

tightens, or equivalently, sudden stop episodes worsen with the external debt position. The chart plots λ_B under three different scenarios: "Full Regulation" implements the social planner outcome. "No Domestic Regulation" sets taxes/subsidies on international borrowings/savings optimally, but does not impose regulation on the domestic bond market. "No Regulation" refers to the laissez-faire equilibrium. As apparent, the crisis is somewhat more muted with the full set of instruments, but overall the tightness of the borrowing constraint only decreases by about 0.3% relative to the unregulated equilibrium. Consumption during the recession improves also by about 0.3%. While these numbers are on the smaller end relative to the literature, they are not surprising given the relatively small tax wedges.

The striking feature of this plot is the difference between the unregulated and partially regulated equilibrium: The introduction of CFMs creates distortions that makes sudden stops in partially regulated emerging markets worse than without any regulation. Intuitively, borrowers and savers have an incentive to transition to domestic bonds. This substitution effect is accompanied by general equilibrium exchange rate and price effects that reduce the available net worth in period 1. Hence with this model specification, no regulation is better than partial regulation. Though an in-depth analysis of conditions under which this result emerges is beyond the scope of this paper, it appears meaningful to combine CFMs with domestic macroprudential policies.

4. CONCLUSION

Most emerging markets use a combination of macroprudential regulatory policies that affect international and domestic financial flows. Yet, there is limited knowledge about how domestic macroprudential policies interact with their international counterparts, frequently referred to as capital flow measures (CFMs). The contribution of this paper is to provide a simple framework that studies both policies.

The key result is that emerging markets should resort to domestic macroprudential policies and CFMs. CFMs limit foreign currency expose and improve the external wealth position of the domestic economy. As a consequence, they enhance financial stability and mitigate sudden stops when international creditors restrict access to foreign financing. This finding is extensively documented in the literature. What is new is that the aforementioned policies should be accompanied by purely domestic macroprudential policies. Intuitively, domestic financial flows provide an additional margin to shift resources towards constrained agents.

The reallocation of domestic wealth from savers to borrowers is welfare enhancing because it shifts resources towards agents who are limited in their ability to borrow internationally and as a consequence have a higher propensity to consume. This in turn appreciates the exchange rate and increases the value of collateral, which mutes sudden stop dynamics in foreign capital. The distinctive marginal propensities to consume only arise when borrowers cannot bypass the international borrowing constraint with additional domestic borrowing. Thus, this analysis is most suitable to countries with less developed domestic financial markets. To the contrary, emerging markets with well established domestic financial markets are able to circumvent the international borrowing constraint. In this case, regulatory intervention, either on domestic or international markets, would not be necessary.

Last but not least, the numerical exercise in this paper suggests that partial regulation can backfire, in the sense that an economy with just international but no domestic regulation may actually be worse off during a recession as investors adjust their portfolio accordingly. It would be worthwhile to explore this idea further and more formally derive conditions under which this outcome arises.

A. APPENDIX

Table A1: List of Emerging Markets and Developing Economies for Figure 1

Argentina	Guatemala	Moldova	South Africa
Bahrain	Hungary	Morocco	Sri Lanka
Bolivia	India	Nigeria	Tanzania
Brazil	Indonesia	Oman	Thailand
Brunei Darussalam	Iran	Pakistan	Tunisia
Bulgaria	Jamaica	Panama	Turkey
Chile	Kazakhstan	Paraguay	Uganda
China	Kenya	Peru	Ukraine
Colombia	Kuwait	Philippines	United Arab Emirates
Costa Rica	Kyrgyz Republic	Poland	Uruguay
Dominican Republic	Lebanon	Qatar	Venezuela
Ecuador	Malaysia	Romania	Vietnam
Egypt	Mauritius	Russia	Zambia
Georgia	Mexico	Saudi Arabia	.

Social Planner Euler Equations

The first order condition with respect to international bonds is characterized as

$$\gamma_i u_{i,0}^T = E \left[\gamma_i \frac{\partial V_i(B)}{\partial B_{i,1}^T} \right] + E \left[\gamma_j \frac{\partial V_j(B)}{\partial B_{i,1}^T} \right] \quad (\text{FOC: } B_{i,1}^T)$$

with $i \neq j$. An application of the Envelope Theorem yields

$$\begin{aligned} \frac{\partial V_i(B)}{\partial B_{i,1}^T} &= u_{i,1}^T \left(1 + \frac{\partial p_1}{\partial B_{i,1}^T} (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right) + \frac{\partial p_1}{\partial B_{i,1}^T} \lambda_i \phi Y_{i,1}^N \\ \frac{\partial V_j(B)}{\partial B_{i,1}^T} &= u_{j,1}^T \left(\frac{\partial p_1}{\partial B_{i,1}^T} (Y_{j,1}^N + B_{j,1}^N - C_{j,1}^N) \right) + \frac{\partial p_1}{\partial B_{i,1}^T} \lambda_j \phi Y_{j,1}^N. \end{aligned}$$

Market clearing of nontradables implies $Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N = -(Y_{j,1}^N + B_{j,1}^N - C_{j,1}^N)$. Further, only borrowers face a collateral constraint. We can therefore write

$$\gamma_i u_{i,0}^T = E \left[\gamma_i u_{i,1}^T \right] + E \left[\frac{\partial p_1}{\partial B_{i,1}^T} (\gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right] + E \left[\frac{\partial p_1}{\partial B_{i,1}^T} \gamma_B \lambda_B \phi Y_{B,1}^N \right].$$

The first order condition with respect to domestic bonds is

$$\gamma_i u_{i,0}^N (1 - \beta_3) = E \left[\gamma_i \frac{\partial V_i(B)}{\partial B_{i,1}^N} \right] + E \left[\gamma_j \frac{\partial V_j(B)}{\partial B_{i,1}^N} \right] \quad (\text{FOC: } B_{i,1}^N)$$

with $i \neq j$. The derivatives of the value functions are equal to

$$\begin{aligned}\frac{\partial V_i(B)}{\partial B_{i,1}^N} &= u_{i,1}^T \left(p_1 + \frac{\partial p_1}{\partial B_{i,1}^N} (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right) + \frac{\partial p_1}{\partial B_{i,1}^N} \lambda_i \phi Y_{i,1}^N \\ \frac{\partial V_j(B)}{\partial B_{i,1}^N} &= u_{j,1}^T \left(\frac{\partial p_1}{\partial B_{i,1}^N} (Y_{j,1}^N + B_{j,1}^N - C_{j,1}^N) \right) + \frac{\partial p_1}{\partial B_{i,1}^N} \lambda_j \phi Y_{j,1}^N.\end{aligned}$$

The intratemporal first order condition in period 1 implies $u_{i,1}^N = p_1 u_{i,1}^T$. Imposing nontradable market clearing subsequently yields

$$\gamma_i u_{i,0}^N (1 - \beta_3) = E \left[\gamma_i u_{i,1}^N \right] + E \left[\frac{\partial p_1}{\partial B_{i,1}^N} (\gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right] + E \left[\frac{\partial p_1}{\partial B_{i,1}^N} \gamma_B \lambda_B \phi Y_{B,1}^N \right].$$

Proposition 1

Subtracting the tradable Euler equations for both households from each other and utilizing the nontradable resource constraint implies

$$E \left[\gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T \right] = \frac{-E \left[\left(\frac{\partial p_1}{\partial B_{i,1}^T} - \frac{\partial p_1}{\partial B_{j,1}^T} \right) \gamma_B \lambda_B \phi Y_{B,1}^N \right] - \text{Cov} \left(\left(\frac{\partial p_1}{\partial B_{i,1}^T} - \frac{\partial p_1}{\partial B_{j,1}^T} \right) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N), \gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T \right)}{1 + E \left[\left(\frac{\partial p_1}{\partial B_{i,1}^T} - \frac{\partial p_1}{\partial B_{j,1}^T} \right) (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right]}$$

where $i \neq j$. We plug this equation into the tradable Euler equation and make use of Lemma 1, including $\frac{\partial p_1^{\text{con}}}{\partial B_{S,1}^T} = \frac{1}{2} \frac{\partial p_1^{\text{con}}}{\partial B_{B,1}^T}$.

$$\begin{aligned}\gamma_i u_{i,0}^T &= E \left[\gamma_i u_{i,1}^T \right] + \frac{E \left[\frac{\partial p_1}{\partial B_{i,1}^T} \gamma_B \lambda_B \phi Y_{B,1}^N \right] \left(1 - \frac{1}{2} (1 - p) \frac{\partial p_1^{\text{un}}}{\partial B_{i,1}^T} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N) \right)}{D} + \text{Cov} \left(\frac{\partial p_1}{\partial B_{i,1}^T} (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N), \gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T \right) \\ &\quad - \underbrace{\frac{\text{Cov} \left(\left(\frac{\partial p_1}{\partial B_{B,1}^T} - \frac{\partial p_1}{\partial B_{S,1}^T} \right) (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), \gamma_B u_{B,1}^T - \gamma_S u_{S,1}^T \right) E \left[\frac{\partial p_1}{\partial B_{i,1}^T} (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N) \right]}{D}}_{\Xi_i^T \gamma_B u_{B,0}^T}\end{aligned}$$

The equation is subsequently divided by $\gamma_i u_{i,0}^T$ and rearranged which leads to the first two equations of Proposition 1. Regarding Ξ_i^T , notice that

$$\begin{aligned}\text{Cov} \left(\left(\frac{\partial p_1}{\partial B_{B,1}^T} - \frac{\partial p_1}{\partial B_{S,1}^T} \right) (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), \gamma_B u_{B,1}^T - \gamma_S u_{S,1}^T \right) &= \\ \text{Cov} \left(\frac{\partial p_1}{\partial B_{B,1}^T} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), \gamma_B u_{B,1}^T - \gamma_S u_{S,1}^T \right) - \text{Cov} \left(\frac{\partial p_1}{\partial B_{S,1}^T} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), \gamma_B u_{B,1}^T - \gamma_S u_{S,1}^T \right) &\approx 0.\end{aligned}$$

This result emerges as $\frac{\partial p_1}{\partial B_{B,1}^T}$ and $\frac{\partial p_1}{\partial B_{S,1}^T}$ only differ when the constraint binds.

Following the same steps we derive the Euler equation for nontradable bonds as

$$\begin{aligned} \gamma_i u_{i,0}^N (1 - \beta_3) = & E \left[\gamma_i u_{i,1}^N \right] + \frac{E \left[\frac{\partial p_1}{\partial B_{i,1}^N} \gamma_B \lambda_B \phi Y_{B,1}^N \right]}{D} + \text{Cov} \left(\frac{\partial p_1}{\partial B_{i,1}^N} (Y_{i,1}^N + B_{i,1}^N - C_{i,1}^N), \gamma_i u_{i,1}^T - \gamma_j u_{j,1}^T \right) \\ & - \underbrace{\frac{\text{Cov} \left(\left(\frac{\partial p_1}{\partial B_{B,1}^N} - \frac{\partial p_1}{\partial B_{S,1}^N} \right) (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N), \gamma_B u_{B,1}^T - \gamma_S u_{S,1}^T \right) E \left[\frac{\partial p_1}{\partial B_{i,1}^N} (Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N) \right]}{D}}_{\Xi_i^N \gamma_B u_{B,0}^N}, \end{aligned}$$

which we divide by $\gamma_i u_{i,0}^N (1 - \beta_3)$ to obtain the last two equations of Proposition 1.

Notice that $\frac{\partial p_1}{\partial B_{B,1}^N} = -\frac{\partial p_1}{\partial B_{S,1}^N}$. This immediately implies $\tau_B^N = -\tau_S^N$.

Subsequently I argue that $\tau_B^T \geq 0$, $\tau_S^T \geq 0$ and $\tau_B^N = -\tau_S^N \geq 0$. The inequalities are strict inequalities if the borrowing constraint binds with positive probability (p). Suppose $p = 0$. Therefore, $\lambda_B = 0$. Further, there is no uncertainty and all covariance terms are zero. Hence all four wedges are zero. Now suppose that $p > 0$ and the wedges are not implemented. The externality component is nonzero, while the covariance terms are still zero due to perfect risk sharing if $\gamma_S/\gamma_B = \psi$ where ψ is defined by the risk sharing condition $u_{B,1}^T = \psi u_{S,1}^T$ in the unregulated equilibrium. The nonzero externality component implies $\tau_B^T > 0$, $\tau_S^T > 0$ and $\tau_B^N = -\tau_S^N > 0$. Further, because of continuity, the covariance terms do not offset intervention due to the externality. Related, the "ex-post adjustment" is larger than zero. Otherwise, intervention would enhance the tightness of the borrowing constraint, which increases the inefficiency embedded in the model.

Lemma 2

The regulated equilibrium is constrained efficient and part of the social planner Pareto frontier if two conditions are met: First, the regulated allocation must be feasible for a social planner. Second, the regulated allocation must not violate the optimality conditions of a social planner. The latter is a sufficient condition for optimality due to the concavity of the optimization problem.

I summarize the allocation of the decentralized regulated equilibrium in vector $\mathbb{Y}^{RE}$. Because the social planner only intervenes in $t = 0$, it is sufficient to show that $\mathbb{Y}^{RE}$ does not violate the social planner constraints (9), (10) and (11). Nontradable goods market clearing and bond market clearing in the regulated equilibrium (see Definition 2 for an identical formulation in the unregulated equilibrium) are equivalent to the social planner constraints (10) and (11). Aggregating over the period 0 budget constraint (12), imposing the definition of lump-sum transfers, and nontradable bonds/goods market clearing immediately yields Equation (9). The allocation $\mathbb{Y}^{RE}$ is therefore feasible for a

social planner.

Suppose the social planner implements $\mathbb{Y}^{RE}$. I subsequently show that this allocation does not violate the optimality conditions of the planner. $\mathbb{Y}^{RE}$ immediately pins down the Pareto weights $\{\gamma_B, \gamma_S\}$ as $\gamma_i u_{i,0}^T = \gamma_j u_{j,0}^T$ and $\gamma_i u_{i,0}^N = \gamma_j u_{j,0}^N$ for $i \neq j$. The ratio of γ_S and γ_B is unique because tradable on nontradable consumption are proportional to each other following the intratemporal optimality condition $u_{i,0}^N = p_0 u_{i,0}^T$. The latter condition also implies $\beta_2 = p_0$, since $u_{i,0}^N = \beta_2 u_{i,0}^T$ in the social planner equilibrium. Following a similar logic, the Euler equations yield $1 - \beta_3 = q_0$. The allocation $\mathbb{Y}^{RE}$ is therefore consistent with the first order conditions of the social planner and represents a point on the Pareto frontier.

The taxes/subsidies in the regulated solution are a function of γ_S/γ_B . In other words, $\mathbb{Y}^{RE}$ depends on the Pareto weights. The Pareto weights are a fixed point and can be recursively calculated: First, fix a candidate $\tilde{\gamma}_S/\tilde{\gamma}_B$. This fully characterizes the taxes/subsidies and hence the consumption allocation. Second, back out the implied ratio of Pareto weights according to $\gamma_S/\gamma_B = u_{B,0}^T/u_{S,0}^T$. If γ_S/γ_B does not coincide with $\tilde{\gamma}_S/\tilde{\gamma}_B$, set $\tilde{\gamma}_S/\tilde{\gamma}_B = \gamma_S/\gamma_B$ and repeat.

Proposition 2

To ease notation, denote the "Ex-Post Adjustment" effect from Proposition 1 as E . This term is identical for savers and borrowers. To simplify the notation further, define H_i^T as the hedging motive of household i in the equation for τ_i^T . Similarly, H_B^N refers to the hedging motive of borrowers in the formula for τ_B^N . We can then solve for the common components in the tax formulas and substitute. This yields

$$\tau_B^N = \frac{1}{q_0} \underbrace{\left(H_B^N - \Xi_B^N - (H_i^T - \Xi_i^T) \frac{u_{B,0}^T}{u_{B,0}^N} \frac{\partial p_1^{con}/\partial B_{B,1}^N}{\partial p_1^{con}/\partial B_{i,1}^T} \frac{1}{E} \right)}_{\alpha_i} + \underbrace{\left(\frac{u_{B,0}^T}{u_{B,0}^N} \frac{\partial p_1^{con}/\partial B_{B,1}^N}{\partial p_1^{con}/\partial B_{i,1}^T} \frac{1}{q_0 E} \right)}_{\kappa_i} \tau_i^T.$$

The marginal utilities, exchange rate derivatives, q_0 and the ex-post adjustment E are positive (see proof of Proposition 1 for the latter result). Therefore, $\kappa_i > 0$.

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