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Abstract

The IMF recently updated its institutional view on capital flow management and macroprudential policies for emerging markets. The framework advocates a variety of prudential tools to deal with generally complex and heterogeneous financial flows. This paper provides a normative justification for this integrated approach when investors have access to multiple assets. As is well known, the emerging market overborrows in international markets, which justifies to actively manage international capital flows. However, as a novel result, this paper also advocates complementary domestic macroprudential policies: A reallocation of domestic resources towards internationally constrained borrowers improves welfare because it shifts funds to households with a higher marginal propensity to consume. This result emerges independent of any domestic externality. A numerical exercise further shows that partial regulation can increase the severity of a recession relative to no regulation.

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 (see, for example, Forbes and Warnock, 2012). This sparked interest in so called 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, the IMF recently updated its institutional view on capital flows and advocates a holistic approach based on regulatory policies geared towards the domestic and international financial market (Basu et al., 2020).[1] This paper develops a simple model that features both, a domestic and international financial market to analyze this integrated approach from a portfolio allocation perspective.

Figure 1, Panel (a) portrays the prevalence of domestic macroprudential policies and CFMs in EMs (Fernández et al., 2016; Cerutti et al., 2017). 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. Table A1 in the appendix provides a more detailed country-by-country breakdown.

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

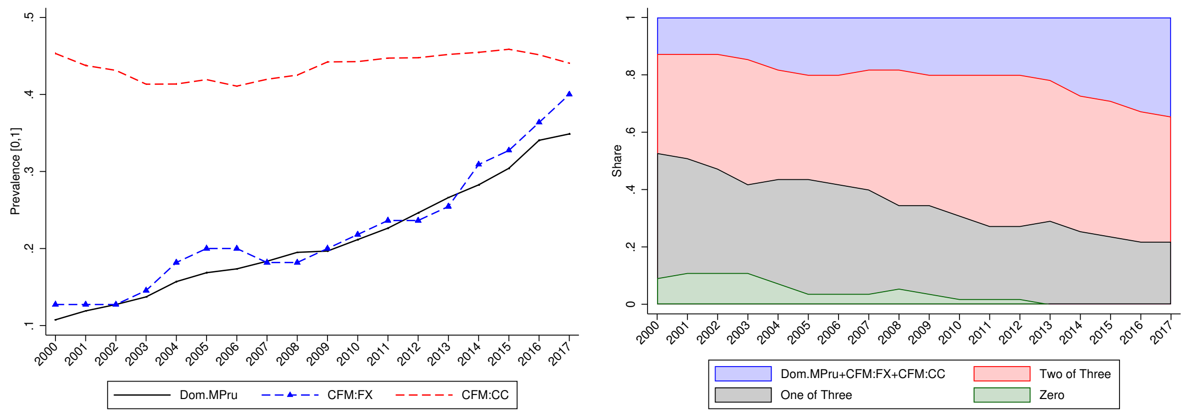
[1] A blog summarizing the institutional view is available via this link: https://www.imf.org/en/Blogs/Articles/2022/03/30/blog033122-why-the-imf-is-updating-its-view-on-capital-flows.

in international capital due to a binding collateral constraint are muted. This result rests on the assumption that borrowers cannot fully 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 and depends on the relative impact of each asset on the underlying externality, implementation costs, and the return of the asset. Domestic and international regulation are therefore imperfect complements.

Figure 1: *Financial Regulation in Emerging Markets and Developing Economies*

(a) *Prevalence over Time* ***(b)*** *Extent of Joint Implementation*



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 as well as country specific details are 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 framework 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 CFMs, which have been extensively studied in the literature. The novel part of this model is that the international borrowing constraint also justifies domestic macroprudential policies. The allocation of domestic bonds matter, because borrowers have a higher marginal propensity to consume. A reallocation of domestic debt can therefore improve the exchange rate. 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 mimic characteristics of sudden stop episodes in smaller emerging markets. Two findings are noteworthy: First, optimal intervention in domestic financial markets can be larger than 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 and borrowers borrow more in the domestic market. This substitution effect towards the more inefficient asset increases the tightness of the international borrowing constraint relative to the unregulated equilibrium and enhances the severity of the recession. Though the numerical exercise is stylized, it shows that a regulatory approach with policies geared towards the international *and* domestic market can be important to limit adverse sudden stop dynamics.

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. For reference, Rebucci and Ma (2019), Bianchi and Mendoza (2020), Erten et al. (2021), and Bianchi and Lorenzoni (2022) provide detailed literature reviews, including applied contributions to the field.

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 for a domestic asset and hence a rationale for domestic regulation. In contrast to Basu et al. (2020) who lay out the foundations for the IMF view, 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). Last but not least, the findings in this paper rest on the interaction between a domestic constraint on financial intermediation and an international collateral constraint. A more comprehensive treatment on the interaction between domestic and an international financial constraints is available in Caballero and Krishnamurthy (2001).

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 ($c^T_{i,t}$) and nontradable goods ($c^N_{i,t}$) 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 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 ($b^T_{i,t}$) is traded with international investors. Domestic bonds ($b^N_{i,t}$) are traded between borrowers and savers. Domestic and international financial markets are hence segmented. Both financial markets are subject to frictions: International borrowing is limited to a fraction of available income. The domestic bond market is shallow, which restricts the 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 $\{c^T_{i,t}, c^N_{i,t}\}$ and one-period international ($b^T_{i,t+1}$) or domestic bonds ($b^N_{i,t+1}$) where positive values indicate savings:

$$\max_{c^T_{i,t}, c^N_{i,t}, b^T_{i,t+1}, b^N_{i,t+1}} \left\{ u(c_{i,0}) + E\left[u(c_{i,1}) + u(c^T_{i,2})\right] \right\}. \tag{P}$$

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:

$$c_{i,t} = (c^T_{i,t})^{\omega}(c^N_{i,t})^{1-\omega}.$$

The parameter ω determines the expenditure share of tradable consumption. The functional forms on utility and consumption are made to simplify the exposition. Both agents receive exogenous endowments of $\{y^T_{i,t}, y^N_{i,t}\}$ at date 0 and 1 as well as tradable endowment $y^T_{i,2}$ 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. However, because agents do not value nontradable consumption in the third period, agents only trade domestic bonds in the first, but not the second period. This can be interpreted as a rather extreme friction on the functioning of the domestic market as it implies zero domestic debt issuance in t=1.

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

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

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

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

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:

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

The specific functional form follows Mendoza (2002) and is common in the literature on financial crises and ex-ante regulation.[2] The collateralizable income share ϕ is uncertain and follows a two state process with realizations $\{\underline{\phi}, \overline{\phi}\}$. The constraint binds if $\phi = \underline{\phi}$, which occurs with probability p. I assume that 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 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 consumption would relax the borrowing constraint by more than one unit.

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.

Discussion of Assumptions

Four sets of assumptions deserve further attention: the constraints on domestic and international borrowing, financial market segmentation, the stochastic process determining the collateralizable share of income and the functional forms on utility/ the consumption aggregator.

[2]The 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 only willing to provide loans up to ϕ times the 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 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.

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, which are by definition geared towards international transactions. 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, if international investors purchase domestic bonds.

The two state stochastic process provides a tractable characterization of the optimal policy intervention. In particular, the two states $\{\underline{\phi}, \overline{\phi}\}$ and two assets imply perfect risk sharing in the unregulated equilibrium.[3] As a consequence, a regulator has no incentive to distort the competitive equilibrium to improve risk sharing and only intervenes due to the pecuniary externality embedded in the international borrowing

[3] This result emerges even though both assets are non-state-contingent: The relevant payoff of the nontradable bond depends on the exchange rate, which varies by state.

constraint. 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 a recession. It is well known in the literature that macroprudential policies generally decrease *both* the likelihood and the severity of a recession. This drawback has no implications on the characterization of the optimal policy.

Last but not least, I choose log utility and a Cobb-Douglas consumption aggregator. These restrictions are merely imposed to gain analytical tractability. The justification for domestic regulation in addition to international regulation rests on a higher marginal propensity to consume for borrowers when they are constrained, which does not depend on the specific functions for utility and consumption.

Outline

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 to determine the exchange rate (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 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) and provide insights from a numerical exercise (Section 3.3).

2.2. How Portfolios Impact the Exchange Rate

In this section, I first derive an expression for the exchange rate and subsequently relate the exchange rate to initial borrowing and saving decisions. 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 $B = \{B^T_{B,1}, B^N_{B,1}, B^T_{S,1}, B^N_{S,1}\}$ with $b^T_{i,1} = B^T_{i,1}$ and $b^N_{i,1} = B^N_{i,1}$ in equilibrium as households are of measure one. Agents in period 1 solve:

$$V_i(b^T_{i,1}, b^N_{i,1}; B) = \max_{c^T_{i,1}, c^N_{i,1}, b^T_{i,2}, c^T_{i,2}} \left\{ u\left((c^T_{i,1})^{\omega} (c^N_{i,1})^{1-\omega} \right) + u\left(c^T_{i,2} \right) \right\}, \quad \text{(P1)}$$

subject to:

$$c^T_{i,1} + b^T_{i,2} + p_1 c^N_{i,1} = y^T_{i,1} + b^T_{i,1} + p_1(y^N_{i,1} + b^N_{i,1}) \tag{5}$$
$$c^T_{i,2} = y^T_{i,2} + b^T_{i,2} \tag{6}$$
$$-b^T_{B,2} \leq \phi(y^T_{B,1} + p_1 y^N_{B,1}). \tag{7}$$

Definition 1: (Continuation Equilibrium) *The continuation equilibrium is characterized by the real exchange rate p_1 and endogenous quantities $\{c^T_{i,1}, c^N_{i,1}, b^T_{i,2}, c^T_{i,2}\}$ 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, $\sum_i C^N_{i,1} = \sum_i Y^N_{i,1}$.*

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

$$u^T_{i,1} = u^T_{i,2} + \lambda_i$$
$$u^N_{i,1} = p_1 u^T_{i,1}.$$

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 relates tradable to 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:

$$p_1 = \frac{1-\omega}{\omega} \frac{\sum_i C^T_{i,1}}{\sum_i Y^N_{i,1}}.$$

The exchange rate improves with economy-wide tradable consumption. More tradable consumption increases demand for nontradables which are in fixed supply. Therefore, the price of nontradable goods, or equivalently, the real exchange rate appreciates. 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 Equilibrium

The unconstrained equilibrium emerges when $\phi = \overline{\phi}$. The borrowing constraint does not bind. Both households perfectly smooth tradable consumption, that is, $u^T_{i,1} = u^T_{i,2}$. As a result, period 1 tradable consumption is:

$$c^{T,un}_{i,1} = \frac{\omega}{2}\left(y^T_{i,1} + b^T_{i,1} + p_1(y^N_{i,1} + b^N_{i,1}) + y^T_{i,2}\right).$$

The terms in the bracket represent available income in periods 1 and 2. Half of the income is spent for consumption in period 1, the other half on period 2 consumption. A fraction ω of all period 1 expenditures is spent on tradable consumption, and the rest on nontradable consumption. The expression for tradable consumption can be plugged into the formula for the real exchange rate:

$$p^{un}_1(B^T_{B,1}, B^T_{S,1}) = \frac{(1-\omega)\left[\sum_i (Y^T_{i,1} + B^T_{i,1} + Y^T_{i,2})\right]}{(1+\omega)[\sum_i Y^N_{i,1}]}.$$

The real exchange rate increases 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 does not depend on 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 when borrowers are not constrained. Domestic savings and borrowings therefore cancel out. However, this is about to change once the international borrowing constraint binds.

Constrained Equilibrium

The 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, $u^T_{B,1} > u^T_{B,2}$. Borrowers are no longer able to smooth tradable consumption. Period 1 tradable consumption for borrowers is pinned down via the budget and borrowing constraints:

$$c^{T,con}_{B,1} = \omega\left(y^T_{B,1} + b^T_{B,1} + p_1(y^N_{B,1} + b^N_{B,1}) + \phi(y^T_{B,1} + p_1 y^N_{B,1})\right).$$

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:

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

I summarize the impact of the date 0 borrowing/saving decisions on the exchange rate in the first Proposition.

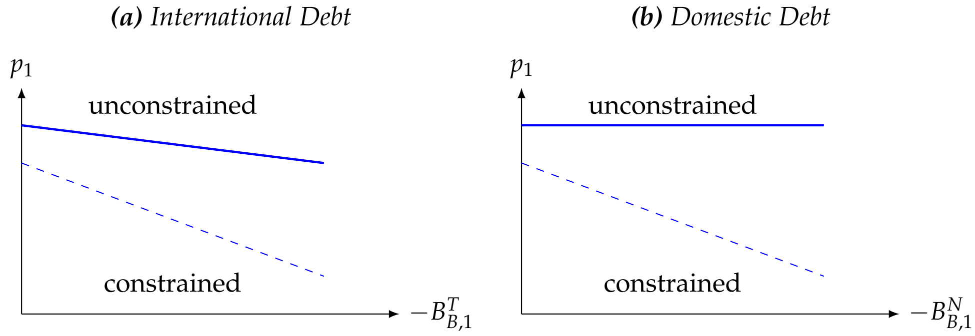
Proposition 1

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

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.*

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. Domestic borrowing and saving decisions hence materially affects aggregate tradable consumption, which in turn affects the real exchange rate and the tightness of the international borrowing constraint.

2.3. Unregulated Equilibrium

In period 0, savers and borrowers maximize date 0 utility and the value function from the continuation equilibrium $V_i(b^T_{i,1}, b^N_{i,1}; B)$ 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:

$$\max_{c^T_{i,0}, c^N_{i,0}, b^T_{i,1}, b^N_{i,1}} \left\{ u\left((c^T_{i,0})^{\omega} (c^N_{i,0})^{1-\omega} \right) + E\left[V_i(b^T_{i,1}, b^N_{i,1}; B) \right] \right\}, \qquad \text{(Po:CE)}$$

subject to:

$$c^T_{i,0} + b^T_{i,1} + p_0(c^N_{i,0} + q_0 b^N_{i,1}) = y^T_{i,0} + b^T_{i,0} + p_0(y^N_{i,0} + b^N_{i,0}). \qquad (8)$$

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 $\{c^T_{i,0}, c^N_{i,0}, b^T_{i,1}, b^N_{i,1}\}$ 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 period* 0 *market for nontradables clears,* $\sum_i \{C^N_{i,0} + B^N_{i,1}\} = \sum_i \{Y^N_{i,0} + B^N_{i,0}\}$*;*

3. *the domestic bond market clears,* $\sum_i B^N_{i,1} = 0$*.*

The derivatives of the date 1 value function correspond to $\frac{\partial V_i(\cdot)}{\partial b^T_{i,1}} = u^T_{i,1}$ and $\frac{\partial V_i(\cdot)}{\partial b^N_{i,1}} = p_1 u^T_{i,1} = u^N_{i,1}$. Hence:

$$
\begin{aligned}
u^T_{i,0} &= E\left[u^T_{i,1}\right] \\
q_0 u^N_{i,0} &= E\left[u^N_{i,1}\right] \\
u^N_{i,0} &= p_0 u^T_{i,0}.
\end{aligned}
$$

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 condition yields:

$$
q_0 = \frac{E\left[p_1\right]}{p_0} + \underbrace{\frac{Cov(\frac{p_1}{p_0}, u^T_{i,1})}{E[u^T_{i,1}]}}_{<0}.
$$

The covariance term is negative. As portrayed in Figure 2, the exchange rate deprecates 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

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.[4] The solution is second best in the sense that the social

[4]For 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.

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). A numerical exercise highlights the importance of domestic regulation in addition to international regulation (Section 3.3).

3.1. Social Planner Equilibrium

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

$$\max_{C^T_{i,0}, C^N_{i,0}, B^T_{i,1}, B^N_{i,1}} \left\{ \sum_i \gamma_i \left\{ u\left((C^T_{i,0})^{\omega} (C^N_{i,0})^{1-\omega} \right) + E\left[V_i(B) \right] \right\} \right\}, \tag{P0:SP}$$

subject to:

$$\sum_i \left\{ C^T_{i,0} + B^T_{i,1} \right\} = \sum_i \left\{ Y^T_{i,0} + B^T_{i,0} \right\} \tag{9}$$

$$\sum_i \left\{ C^N_{i,0} + B^N_{i,1} \right\} = \sum_i \left\{ Y^N_{i,0} + B^N_{i,0} \right\} \tag{10}$$

$$\sum_i B^N_{i,1} = 0. \tag{11}$$

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* $\{C^T_{i,0}, C^N_{i,0}, B^T_{i,1}, B^N_{i,1}\}$ *with* $i \in \{B, S\}$ *such that*

1. *the social planner maximizes the weighted utility (P0: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: $\gamma_i u^T_{i,0} = \gamma_j u^T_{j,0}$ and $\gamma_i u^N_{i,0} = \gamma_j u^N_{j,0}$ for $i \neq j$. Further, combining the first order conditions for tradable and nontradable consumption implies $u^N_{i,0} = \eta_2 u^T_{i,0}$. Households hence consume tradable and nontradables proportionally, determined by the Lagrange multiplier η_2.[5] The optimality conditions regarding the accumulation of foreign and domestic bonds are summarized as:

$$\underbrace{\gamma_i u^T_{i,0} = E\left[\gamma_i u^T_{i,1}\right]}_{\text{Consumption Smoothing}} + \underbrace{E\left[\frac{\partial p_1}{\partial B^T_{i,1}}\left(\gamma_i u^T_{i,1} - \gamma_j u^T_{j,1}\right)\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right]}_{\text{Redistribution}} + \underbrace{E\left[\frac{\partial p_1}{\partial B^T_{i,1}}\gamma_B \lambda_B \phi Y^N_{B,1}\right]}_{\text{Externality}} \quad (12)$$

$$\underbrace{\gamma_i u^N_{i,0}(1-\eta_3) = E\left[\gamma_i u^N_{i,1}\right]}_{\text{Consumption Smoothing}} + \underbrace{E\left[\frac{\partial p_1}{\partial B^N_{i,1}}\left(\gamma_i u^T_{i,1} - \gamma_j u^T_{j,1}\right)\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right]}_{\text{Redistribution}} + \underbrace{E\left[\frac{\partial p_1}{\partial B^N_{i,1}}\gamma_B \lambda_B \phi Y^N_{B,1}\right]}_{\text{Externality}}. \quad (13)$$

The variable η_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.

[5]The Lagrange multipliers of equations (9), (10) and (11) are η_1, $\eta_1\eta_2$ and $\eta_1\eta_2\eta_3$ respectively. With this definition, η_2 reflects the value of nontradables in terms of tradables, just as p_0 in the decentralized equilibrium. η_3 represents the tightness of the domestic bond resource constraint in units of nontradables.

Proposition 2 *A constrained efficient solution satisfies:*

$$\frac{E\left[u^T_{B,1}\right]}{u^T_{B,0}} = 1 - \tau^T_B$$
$$\frac{E\left[u^T_{S,1}\right]}{u^T_{S,0}} = 1 - \tau^T_S$$
$$\frac{E\left[u^N_{B,1}\right]}{u^N_{B,0}(1-\eta_3)} = 1 - \tau^N_B$$
$$\frac{E\left[u^N_{S,1}\right]}{u^N_{S,0}(1-\eta_3)} = 1 - \tau^N_S.$$

The terms $\{\tau^T_B, \tau^T_S, \tau^N_B, \tau^N_S\}$ *represent wedges that characterize the difference between the social planner and unregulated equilibrium and are explicitly defined in the appendix.*

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,* $\tau^T_B = \tau^T_S = \tau^N_B = \tau^N_S = 0$*;*

2. *If the borrowing constraint binds with positive probability, the planner introduces wedges for international bonds. The two wedges encourage international savings (less borrowings). Thus,* $\tau^T_B > 0$ *and* $\tau^T_S > 0$*;*

3. *The planner also introduces wedges for domestic bonds. The borrowing constraint discourages domestic borrowing for borrowers and discourages domestic savings for savers. Hence,* $\tau^N_B > 0$ *and* $\tau^N_S < 0$*. The domestic wedges are equivalent in absolute terms,* $\tau^N_B = |\tau^N_S|$*.*

The second 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 as households already perfectly share risk in the unregulated equilibrium. In other words, the "Redistribution" argument in equations (12) and (13) does not drive regulation.

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^T_B, τ^T_S) 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 internationally. 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 Proposition 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.

3.2. Implementation and Mapping to Actual Policy Instruments

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:

$$c_{i,0}^T + (1-\tau_i^T)b_{i,1}^T + p_0(c_{i,0}^N + (1-\tau_i^N)q_0 b_{i,1}^N) = y_{i,0}^T + b_{i,0}^T + p_0(y_{i,0}^N + b_{i,0}^N) + T_i. \quad (14)$$

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.

Definition 4: (Regulated Equilibrium) *The regulated 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 (14) taking the real exchange rates in* $t=0,1$ *and the bond price as given;*

2. *the period* 0 *market for nontradables clears,* $\sum_i \{C_{i,0}^N + B_{i,1}^N\} = \sum_i \{Y_{i,0}^N + B_{i,0}^N\}$*;*

3. *the domestic bond market clears,* $\sum_i B_{i,1}^N = 0$*.*

The Euler equations in the regulated competitive equilibrium are:

$$\frac{E\left[u_{i,1}^T\right]}{u_{i,0}^T} = 1 - \tau_i^T$$
$$\frac{E\left[u_{i,1}^N\right]}{q_0 u_{i,0}^N} = 1 - \tau_i^N.$$

Corollary 1 *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 derived in Proposition 2.*

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

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 2 *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 borrowing.*

Proposition 3 *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 third Proposition characterizes the relationship between domestic macroprudential policies and CFMs. All objects are determined in 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 achieve this goal.

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. If tradable consumption is scarce at date 0 (high $u^T_{B,0}$), it is more desirable to tax/regulate the domestic financial market or equivalently nontradable bonds. 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 ease 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.

3.3. Numerical Illustration

Before concluding, I calibrate the model to a small emerging market. The framework in this paper is stylized, hence a quantitative exercise should be treated with caution. Nevertheless, this section 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) and welfare in an unregulated equilibrium with a partially regulated equilibrium, characterized by CFMs only, and a regulated equilibrium with the full set of macroprudential policies.

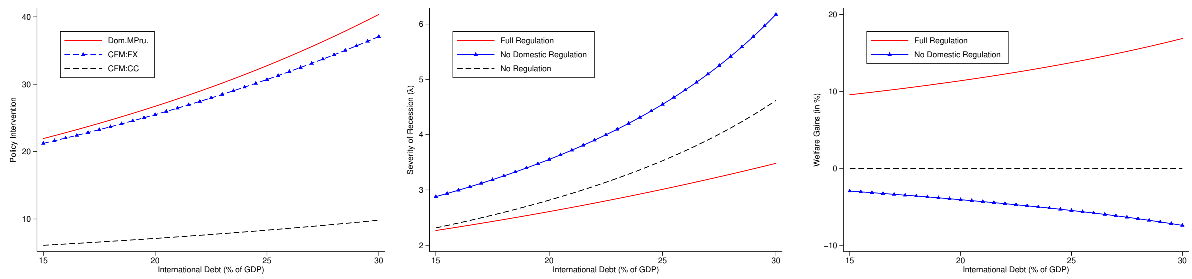
The model is defined by three parameters. The expenditure share of tradable consumption ω equals 0.6, a reasonable value for small open economies (Lombardo and Ravenna, 2012). The crisis probability p is set to 0.8. A crisis is hence imminent, which provides a pivotal role for macroprudential policies (Schmitt-Grohé and Uribe, 2017). The tightness of the international borrowing constraint ($\underline{\phi}$) is difficult to determine empirically. I choose a value of 0.1 for $\underline{\phi}$, which implies a real exchange rate depreciation of slightly above 10% and a current account reversal of about 3.5 percentage points between period 0 and the crisis state in period 1. Both values are slightly lower than the average dynamics during the East Asian crisis of 1997, which is frequently referred to as a prime example of a sudden stop episode in EMs. Last but not least, 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 15 and 30%.

Figure 3, Panel (a) plots "optimal" domestic macroprudential policies (τ_{MP}), (prudential) capital controls (τ^{CC}_{CFM}), and restrictions on foreign currency borrowings (τ^{FX}_{CFM}) as defined by Corollary 2. 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 borrowing ex-ante. Overall, tax interventions are relatively large and range between 6% and 46% depending on the instrument, as well as the international debt position. These values are high since a financial crisis is likely to emerge in the next period, which justifies substantial wealth transfers towards period 1. Overall though, the main insight from this chart pertains to the relative strength of domestic macroprudential policies versus CFMs. The tax on domestic bonds is the highest among the three instruments and much higher than the capital control tax. Regulatory intervention therefore primarily targets borrowers and not savers. As I show in Panel (b), domestic regulation is crucial to avoid undesired portfolio adjustments that could undermine the intention of CFMs.

Figure 3: *Numerical Illustration*

(a) *Optimal Regulation* ***(b)*** *Severity of Recession* ***(c)*** *Welfare*



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. Panel (c): Welfare gains (losses) relative to the unregulated equilibrium (in %). Welfare is defined as expected utility over the three periods. Calibration: $\underline{\phi}$=0.1, p=0.8, ω=0.6.*

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 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 regulated equilibrium. "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 unregulated equilibrium. As apparent, the crisis is more muted with the full set of instruments. The striking feature of this plot is the difference between the unregulated and partially regulated equilibrium: The introduction of CFMs creates distortions that, at least for the particular calibration, make sudden stops in partially regulated emerging markets worse than without any regulation. There are two factors contributing to this finding: First, with international taxes only, borrowers transition to domestic bonds. Second, at the margin and in general equilibrium, domestic bonds are more inefficient. This is also apparent from Panel (a), which shows that the domestic tax is the most important instrument. Hence with this model specification, no regulation is better than partial regulation when it comes to reducing the severity of a crisis. This is also reflected in the welfare analysis in Panel (c).

Figure 3, Panel (c) mirrors the insights from Panel (b) in welfare terms (expected utility over the three periods). In more detail, the chart plots welfare gains (losses) of the fully regulated and partially regulated equilibrium relative to the unregulated equilibrium. There is a one-to-one mapping between the severity of a recession and welfare. The regulated equilibrium yields on average 12% welfare gains, while the partially regulated equilibrium results in welfare losses of about 5%.

4. Conclusion

The IMF recently updated its institutional view on capital flows and advocates a holistic approach based on regulatory policies geared towards the domestic and international financial market. Indeed, 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 a simple framework that studies both policies from a normative perspective.

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, large emerging markets with well established domestic financial markets might be able to circumvent the international borrowing constraint. In this case, regulatory intervention, either in 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. Two factors contribute to this finding: Without domestic regulation, borrowers transition to the domestic bond market. However, domestic borrowing is in equilibrium (and subject to the limitations of a calibrated three period model) worse than international borrowing in terms of its impact on the underlying externality in the model. A more thorough quantitative exploration of these issues, as well as a formal derivation of the necessary conditions under which this result emerges, is left for future research.

A. Appendix

Table A1: *Financial Regulation: Details*

Country	Dom.MPru	CFM:FX	CFM:CC	Total
Argentina	1	1	0	2
Bahrain	1	0	1	2
Bolivia	1	0	1	2
Brazil	1	1	1	3
Brunei Darussalam	1	0	0	1
Bulgaria	1	0	0	1
Chile	1	1	1	3
China, P.R.: Mainland	1	1	1	3
Colombia	1	1	1	3
Costa Rica	1	0	1	2
Dominican Republic	1	1	1	3
Ecuador	1	0	1	2
Egypt	1	0	1	2
Georgia	1	0	0	1
Guatemala	1	0	0	1
Hungary	1	1	0	2
India	1	0	1	2
Indonesia	1	0	1	2
Iran, Islamic Republic of	1	1	1	3
Jamaica	1	0	1	2
Kazakhstan	1	0	0	1
Kenya	1	0	1	2
Kuwait	1	1	1	3
Kyrgyz Republic	1	1	1	3
Lebanon	1	0	1	2
Malaysia	1	0	1	2
Mauritius	1	0	0	1
Mexico	1	0	1	2
Moldova	1	1	1	3
Morocco	1	1	1	3
Nigeria	1	1	1	3
Oman	1	1	1	3
Pakistan	1	1	1	3
Panama	1	0	0	1
Paraguay	1	0	1	2
Peru	1	0	0	1
Philippines	1	0	1	2
Poland	1	1	1	3
Qatar	1	0	1	2
Romania	1	0	0	1
Russian Federation	1	0	1	2
Saudi Arabia	1	0	1	2
South Africa	1	0	1	2
Sri Lanka	1	0	1	2
Tanzania	1	1	1	3
Thailand	1	0	1	2
Tunisia	1	1	1	3
Turkey	1	1	1	3
Uganda	1	1	0	2
Ukraine	1	1	1	3
United Arab Emirates	1	0	1	2
Uruguay	1	0	0	1
Venezuela	0	0	1	1
Vietnam	1	1	1	3
Zambia	1	0	0	1

Notes*: The table lists all emerging markets and developing economies related to Figure 1. The table also provides a disaggregated country-by-country breakdown of the various instruments in use (=1: implemented). The breakdown is for the year 2017, the last year of available data. Similar to Figure 1, restrictions for each category must be above the 25% percentile, else a policy is considered "not implemented".*

Social Planner Euler Equations

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

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

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

$$\begin{aligned}\frac{\partial V_i(B)}{\partial B^T_{i,1}} &= u^T_{i,1}\left(1 + \frac{\partial p_1}{\partial B^T_{i,1}}\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right) + \frac{\partial p_1}{\partial B^T_{i,1}}\lambda_i \phi Y^N_{i,1} \\ \frac{\partial V_j(B)}{\partial B^T_{i,1}} &= u^T_{j,1}\left(\frac{\partial p_1}{\partial B^T_{i,1}}\left(Y^N_{j,1} + B^N_{j,1} - C^N_{j,1}\right)\right) + \frac{\partial p_1}{\partial B^T_{i,1}}\lambda_j \phi Y^N_{j,1}.\end{aligned}$$

Market clearing of nontradables implies $Y^N_{i,1} + B^N_{i,1} - C^N_{i,1} = -(Y^N_{j,1} + B^N_{j,1} - C^N_{j,1})$. Further, only borrowers face a collateral constraint. Therefore:

$$\gamma_i u^T_{i,0} = E\left[\gamma_i u^T_{i,1}\right] + E\left[\frac{\partial p_1}{\partial B^T_{i,1}}\left(\gamma_i u^T_{i,1} - \gamma_j u^T_{j,1}\right)\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right] + E\left[\frac{\partial p_1}{\partial B^T_{i,1}}\gamma_B \lambda_B \phi Y^N_{B,1}\right].$$

The first order condition with respect to domestic bonds is:

$$\gamma_i u^N_{i,0}(1-\eta_3) = E\left[\gamma_i \frac{\partial V_i(B)}{\partial B^N_{i,1}}\right] + E\left[\gamma_j \frac{\partial V_j(B)}{\partial B^N_{i,1}}\right], \qquad \text{(FOC: } B^N_{i,1}\text{)}$$

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

$$\begin{aligned}\frac{\partial V_i(B)}{\partial B^N_{i,1}} &= u^T_{i,1}\left(p_1 + \frac{\partial p_1}{\partial B^N_{i,1}}\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right) + \frac{\partial p_1}{\partial B^N_{i,1}}\lambda_i \phi Y^N_{i,1} \\ \frac{\partial V_j(B)}{\partial B^N_{i,1}} &= u^T_{j,1}\left(\frac{\partial p_1}{\partial B^N_{i,1}}\left(Y^N_{j,1} + B^N_{j,1} - C^N_{j,1}\right)\right) + \frac{\partial p_1}{\partial B^N_{i,1}}\lambda_j \phi Y^N_{j,1}.\end{aligned}$$

The intratemporal first order condition in period 1 implies $u^N_{i,1} = p_1 u^T_{i,1}$. Imposing nontradable market clearing subsequently yields:

$$\gamma_i u^N_{i,0}(1-\eta_3) = E\left[\gamma_i u^N_{i,1}\right] + E\left[\frac{\partial p_1}{\partial B^N_{i,1}}\left(\gamma_i u^T_{i,1} - \gamma_j u^T_{j,1}\right)\left(Y^N_{i,1} + B^N_{i,1} - C^N_{i,1}\right)\right] + E\left[\frac{\partial p_1}{\partial B^N_{i,1}}\gamma_B \lambda_B \phi Y^N_{B,1}\right].$$

Proposition 2

The wedges follow from equations (12) and (13), which are combined with the consumption smoothing conditions of the social planner and nontradable market clearing:

$$\tau_B^T = \frac{E\left[\frac{\partial p_1}{\partial B_{B,1}^T}\left(u_{B,1}^T - \frac{u_{B,0}^T}{u_{S,0}^T}u_{S,1}^T\right)\left(Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N\right)\right]}{u_{B,0}^T} + \frac{E\left[\frac{\partial p_1}{\partial B_{B,1}^T}\lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^T}$$
$$\tau_S^T = \frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^T}\left(u_{B,1}^T - \frac{u_{B,0}^T}{u_{S,0}^T}u_{S,1}^T\right)\left(Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N\right)\right]}{u_{B,0}^T} + \frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^T}\lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^T}$$
$$\tau_B^N = \frac{E\left[\frac{\partial p_1}{\partial B_{B,1}^N}\left(u_{B,1}^T - \frac{u_{B,0}^T}{u_{S,0}^T}u_{S,1}^T\right)\left(Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N\right)\right]}{u_{B,0}^N(1-\eta_3)} + \frac{E\left[\frac{\partial p_1}{\partial B_{B,1}^N}\lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^N(1-\eta_3)}$$
$$\tau_S^N = \frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^N}\left(u_{B,1}^T - \frac{u_{B,0}^T}{u_{S,0}^T}u_{S,1}^T\right)\left(Y_{B,1}^N + B_{B,1}^N - C_{B,1}^N\right)\right]}{u_{B,0}^N(1-\eta_3)} + \frac{E\left[\frac{\partial p_1}{\partial B_{S,1}^N}\lambda_B \phi Y_{B,1}^N\right]}{u_{B,0}^N(1-\eta_3)}.$$

Suppose that the planner does not implement any wedges. Then, because of perfect risk sharing, $u_{B,1}^T = \psi u_{S,1}^T$ state-by-state and $u_{B,0}^T/u_{S,0}^T = \gamma_S/\gamma_B = \psi$. The first term in the wedge formulas is therefore zero and regulation is driven by the second term (the externality). Consequently, if there is no externality, all wedges are zero. Further, because $\frac{\partial p_1}{\partial B_{B,1}^T} > 0$ and $\frac{\partial p_1}{\partial B_{S,1}^T} > 0$, and because of continuity, it must be that $\tau_B^T > 0$ and $\tau_S^T > 0$. Similarly, because $\frac{\partial p_1}{\partial B_{B,1}^N} \geq 0$, with a strict inequality if the borrowing constraint binds, it must be that $\tau_B^N > 0$. Last but not least, notice that $\frac{\partial p_1}{\partial B_{B,1}^N} = -\frac{\partial p_1}{\partial B_{S,1}^N}$. This immediately implies $\tau_B^N = -\tau_S^N$.

Corollary 1

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

4) are equivalent to the social planner constraints (10) and (11). Aggregating over the period 0 budget constraint (14), 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.

I subsequently show that $\mathbb{Y}^{RE}$ does not violate the optimality conditions of the social planner. $\mathbb{Y}^{RE}$ pins down the ratio of Pareto weights according to $\gamma_B u^T_{B,0} = \gamma_S u^T_{S,0}$. The intratemporal optimality conditions of the planner $u^N_{i,0} = \eta_2 u^T_{i,0}$ for $i \in \{B, S\}$ are also satisfied and immediately imply $\eta_2 = p_0$. The tradable Euler equations in the regulated and social planner equilibrium coincide. Last but not least, the nontradable Euler equations of the planner are also fulfilled and imply $1 - \eta_3 = q_0$. 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.

Proposition 3

To derive the relationship between domestic and international regulation I first solve for the common component in the formulas for τ^T_i and τ^N_B and subsequently substitute. It follows that:

$$\tau^N_B = \underbrace{-\frac{1}{u^N_{B,0} q_0}\left((1-p)\left(u^{T,un}_{B,1} - \frac{u^T_{B,0}}{u^T_{S,0}} u^{T,un}_{S,1}\right)\left(Y^N_{B,1} + B^N_{B,1} - C^{N,un}_{B,1}\right)\left(\frac{\partial p^{con}_1/\partial B^N_{B,1}}{\partial p^{con}_1/\partial B^T_{i,1}} \frac{\partial p^{un}_1}{\partial B^T_{i,1}}\right)\right)}_{\alpha_i} + \underbrace{\left(\frac{u^T_{B,0}}{u^N_{B,0}} \frac{\partial p^{con}_1/\partial B^N_{B,1}}{\partial p^{con}_1/\partial B^T_{i,1}} \frac{1}{q_0}\right)}_{\kappa_i} \tau^T_i.$$

The marginal utilities, exchange rate derivatives and q_0 are all greater than zero. Therefore, $\kappa_i > 0$.

References

Basu, S., Boz, E., Gopinath, G., Roch, F., Unsal, F., 2020. A Conceptual Model for the Integrated Policy Framework. IMF Working Papers 2020/121. International Monetary Fund.

Benigno, G., Chen, H., Otrok, C., Rebucci, A., Young, E., 2013. Financial crises and macro-prudential policies. Journal of International Economics 89, 453–470.

Benigno, G., Chen, H., Otrok, C., Rebucci, A., Young, E.R., 2016. Optimal capital controls and real exchange rate policies: A pecuniary externality perspective. Journal of Monetary Economics 84, 147–165.

Bianchi, J., 2011. Overborrowing and systemic externalities in the business cycle. American Economic Review 101, 3400–3426.

Bianchi, J., Lorenzoni, G., 2022. The prudential use of capital controls and foreign currency reserves, in: Gopinath, G., Helpman, E., Rogoff, K. (Eds.), Handbook of International Economics: International Macroeconomics, Volume 6. Elsevier. volume 6 of *Handbook of International Economics*, pp. 237–289.

Bianchi, J., Mendoza, E., 2020. A Fisherian Approach to Financial Crises: Lessons from the Sudden Stops Literature. Review of Economic Dynamics 37, 254–283.

Bocola, L., Lorenzoni, G., 2020. Financial crises, dollarization, and lending of last resort in open economies. American Economic Review 110, 2524–57.

Caballero, R., Krishnamurthy, A., 2001. International and domestic collateral constraints in a model of emerging market crises. Journal of Monetary Economics 48, 513–548.

Cerutti, E., Claessens, S., Laeven, L., 2017. The use and effectiveness of macroprudential policies: New evidence. Journal of Financial Stability 28, 203–224.

Erten, B., Korinek, A., Ocampo, J.A., 2021. Capital Controls: Theory and Evidence. Journal of Economic Literature 59, 45–89.

Fernández, A., Klein, M.W., Rebucci, A., Schindler, M., Uribe, M., 2016. Capital control measures: A new dataset. IMF Economic Review 64, 548–574.

Forbes, K.J., Warnock, F.E., 2012. Capital flow waves: Surges, stops, flight, and retrenchment. Journal of International Economics 88, 235–251.

Geanakoplos, J., Polemarchakis, H.M., 1986. Existence, Regularity, and Constrained Suboptimality of Competitive Allocations When the Asset Market Is Incomplete. Camebridge University Press. volume 3.

Gopinath, G., Stein, J.C., 2020. Banking, Trade, and the Making of a Dominant Currency*. The Quarterly Journal of Economics 136, 783–830.

Jeanne, O., Korinek, A., 2020. Macroprudential Regulation versus mopping up after the crash. Review of Economic Studies 87, 1470–1497.

Kiyotaki, N., Moore, J., 1997. Credit Cycles. Journal of Political Economy 105, 211–248.

Korinek, A., 2018. Regulating capital flows to emerging markets: An externality view. Journal of International Economics 111, 61–80.

Korinek, A., Sandri, D., 2016. Capital controls or macroprudential regulation? Journal of International Economics 99, 27–42.

Lombardo, G., Ravenna, F., 2012. The size of the tradable and non-tradable sectors: Evidence from input–output tables for 25 countries. Economics Letters 116, 558–561.

Lucas, R.J., Stokey, N.L., 1983. Optimal fiscal and monetary policy in an economy without capital. Journal of Monetary Economics 12, 55–93.

Mendoza, E.G., 2002. Credit, Prices, and Crashes: Business Cycles with a Sudden Stop, in: Preventing Currency Crises in Emerging Markets. National Bureau of Economic Research, Inc. NBER Chapters, pp. 335–392.

Rebucci, A., Ma, C., 2019. Capital Controls: A Survey of the New Literature. NBER Working Papers 26558. National Bureau of Economic Research, Inc.

Salomao, J., Varela, L., 2021. Exchange Rate Exposure and Firm Dynamics. The Review of Economic Studies .

Schmitt-Grohe, S., Uribe, M., 2021. Multiple Equilibria in Open Economies with Collateral Constraints. The Review of Economic Studies 88, 969–1001.

Schmitt-Grohé, S., Uribe, M., 2017. Is Optimal Capital Control Policy Countercyclical in Open Economy Models with Collateral Constraints? IMF Economic Review 65, 498–527.

Stiglitz, J.E., 1982. The Inefficiency of the Stock Market Equilibrium. The Review of Economic Studies 49, 241–261.