The Prudential Use of Capital Controls and Foreign Currency Reserves*

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Abstract

We provide a simple framework to study the prudential use of capital controls and currency reserves that have been explored in the recent literature. We cover the role of both pecuniary externalities and aggregate demand externalities. The model features a central policy dilemma for emerging economies facing large capital outflows: the choice between increasing the policy rate to stabilize the exchange rate and decreasing the policy rate to stabilize employment. Ex ante capital controls and reserve accumulation can help mitigate this dilemma. We use our framework to survey the recent literature and provide an overview of recent empirical findings on the use of these policies.

Keywords: Capital controls, foreign exchange interventions, monetary policy, macro-prudential policies

JEL Codes: F32, F33, F41, F42, G18

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1 Introduction

The defining feature of international capital flows is that they allow an economy to reallocate resources intertemporally and across states. For example, by borrowing externally when domestic absorption exceeds income, a country is able to bring future resources to the present. Throughout history, governments have imposed restrictions on the movement of capital across borders and intervened in foreign exchange markets. One rationale for these restrictions is the view that sharp changes in capital flows can be destabilizing and that prudential policies can avoid the accumulation of financial imbalances that can make a capital flight more likely or more damaging.

The last decade has seen two joint developments in practice and in theory. In practice, countries have been using capital controls more frequently, and the consensus in international policy circles has shifted in favor of considering them a legitimate element of the policy toolbox. At the same time, a new literature has emerged that provides theoretical foundations for this new macro-prudential view of capital controls. Understanding why the government may want to alter capital flows requires a theory that explains why private financing decisions would be suboptimal in the first place. Therefore, the cornerstone of this new literature is to identify macroeconomic externalities—pecuniary externalities and aggregate demand externalities—not internalized by individual agents trading in international financial markets.[1]

An issue closely related to the use of capital controls is the large increase in foreign currency reserves held by emerging economies. The accumulation of international reserves provides governments with another tool to intervene in the event of an external crisis. The literature has identified similarities and differences between the two phenomena.

In this chapter, we cover these new developments. We present basic facts on the use of capital controls and reserve accumulation; we review the theories developed to explain the facts; and we discuss empirical work that has examined some of the key mechanisms identified in the theoretical work.

To cover the theory, we build a simple model of a small open economy that encompasses many of the different arguments presented in the literature. In particular, the model considers a small open economy and looks at the interaction of three elements: nominal rigidities, a fear-of-floating element in the objective of the central bank, and the presence

[1] Seminal contributions include Caballero and Krishnamurthy (2003), Lorenzoni (2008), Bianchi (2011), and Korinek (2018) on pecuniary externalities and Schmitt-Grohe and Uribe (2016), Farhi and Werning (2016), and Korinek and Simsek (2016) on aggregate demand externalities. On the policy side, see Ostry, Ghosh, Habermeier, Chamon, Qureshi, and Reinhardt (2010) and IMF (2020).

of an upward sloping supply of funds to the economy.[2] This combination of elements allows us to put at center stage a policy dilemma that is an important source of concern for emerging economies during external crises: namely, the dilemma between easier monetary policy—to prevent a large recession—and tighter monetary policy—to prevent a large depreciation.[3] We then interpret precautionary policies, both capital controls and reserve accumulation, as ways to either prevent ex ante the severity of this dilemma or to ameliorate it ex post.

In the context of our model, the benefits of reserve accumulation can be interpreted from two angles. In one interpretation, the use of reserves prevents a large contraction in domestic consumption, by allowing for alternate sources of funding when external funding dries up. In an alternative interpretation, the use of reserves allows the central bank more freedom in running expansionary monetary policy, as the reserves can be used to prevent an excessive depreciation of the exchange rate. In our model, under the assumption that monetary policy is set optimally ex post, these two views are a mirror image of each other. This result provides a reconciliation between a precautionary view of reserve accumulation and an exchange rate management view of reserve accumulation.[4]

The chapter begins by providing a descriptive analysis of the historical evolution of the use of capital controls and reserve accumulation. We provide a summary of the empirical findings identified by the literature, with specific focus on emerging markets. We highlight how governments have increased their holdings of reserves since the 1980s. Capital controls were liberalized in the 1990s and resurged since the global financial crisis.

We present a model of a small open economy. The model is set in an infinite horizon, but all the interesting action takes place at two dates: an initial period when risky decisions are made and a second period when uncertainty is realized and a crisis can occur. The economy goes back to a steady state after the second period. The shock we consider is a capital flight triggered by an adverse shock to the supply of foreign credit. When it occurs, domestic absorption contracts, and the economy faces at the same time a recession and a depreciation of the nominal exchange rate.

We allow for monetary policy to respond optimally to the shock, but we introduce a fear-of-floating motive in the objective of the central bank, so the central bank faces a

[2]We use the term "fear of floating" to describe a flexible exchange rate regime with a monetary authority that aims to prevent excessive fluctuations in the nominal exchange rate, following Calvo and Reinhart (2002). The last ingredient, the upward sloping supply of funds, connects this chapter to the large and growing literature on frictions in international banking, spearheaded by Gabaix and Maggiori (2015). That literature is covered in detail in another chapter of this handbook, Maggiori (2021).

[3]See, e.g., Vegh, Morano, Friedheim, and Rojas (2017).

[4]Ilzetzki, Reinhart, and Rogoff (2019) present compelling arguments in favor of the second view.

trade-off between unemployment and currency depreciation. We show how both foreign currency reserves and capital controls in the initial period can mitigate the trade-off ex post by making the effects of a capital flight less severe on both employment and the exchange rate. These are general equilibrium effects, not internalized by individual households, providing a rationale for government intervention.

Finally, after discussing several extensions of the basic framework and taking on other key theoretical developments in the literature, we turn back to the empirical literature and analyze it through the lens of the model.

There are other recent reviews that partially overlap with this paper, including Rebucci and Ma (2019); Bianchi and Mendoza (2020); Erten, Korinek, and Ocampo (2021). The main distinguishing feature of our approach here, is our effort at connecting three dimensions of the problem: financial stability, macroeconomic stabilization, and exchange rate objectives. In this, we follow the lead of Basu, Boz, Gopinath, Roch, and Unsal (2020), who make a forceful argument in favor of looking at these three dimensions of policy within an integrated framework, and explore complementarities and conflicts between different policy instruments. Our simple model captures many of the forces identified in that paper. We will point out more connections with their work in the rest of the chapter.

2 Historical and Empirical Perspective

2.1 Institutional Background

The use of capital controls has a long history. We provide here a snapshot of some key historical developments and how policy views have shifted overtime.[5]

A broad traditional classification of capital controls distinguishes between controls on inflows and controls on outflows. A common example of the former is an imposition of unremunerated reserve requirements on foreign deposits. A common example of the latter is a prohibition on non-residents' repatriation of proceeds from selling domestic securities or for residents' transferring of capital abroad.

In current policy frameworks, capital controls fall into the newly introduced taxonomy of "capital flow management policies" (CFM) policies, which, according to the IMF definition, "are measures that are designed to limit capital flows and to reduce systemic financial risks stemming from such flows." Moreover, the IMF taxonomy distinguishes between (i) residency-based measures affecting cross-border financial activity, which discriminate on

[5] For a detailed chronology of the use of capital controls see Ghosh and Qureshi (2016).

the basis of residency; and (ii) other CFMs, which are measures that do not discriminate by residency but are nonetheless designed to limit capital flows. For example, a rise in banks' reserve requirement for any type of deposit, regardless of the residence of the depositor, is likely to reduce the amount of capital inflows. This type of measure fits within the scope of macroprudential policies.

The overall perception of the desirability of using capital controls has had major shifts over time. The two architects of Bretton Woods, Keynes, and White, saw capital controls as one of the pillars of macroeconomic policies. In their view, a permanent regime of capital controls was supposed to enhance the stability of the fixed exchange rate arrangement by providing flexibility for countries to alter domestic policy rates while retaining a peg with the dollar and without losing international reserves. In this period, controls on capital outflows were more prevalent than controls on capital inflows. To a large extent, capital controls were used to deal with the inconsistency between fiscal policy and the prevailing exchange rate parity. By reducing the ability of domestic agents to invest abroad or by preventing foreigners from repatriating funds, these measures were meant to maintain the demand for the domestic currency and avoid a drain of international reserves. Capital controls were, in a way, a form of financial repression.

As the world approached the demise of Bretton-Woods, a notion started to emerge that associated capital controls with government attempts to fix failed macroeconomic policies. A government's use of capital controls started to be seen as a bad signal of the country's underlying economic fundamentals.[6] In addition, the increase in trade liberalization was somehow deemed to be inconsistent with capital controls. An overall theme was to avoid government interference in the economy.

Meanwhile, emerging markets retained substantial capital controls until they started a process of domestic and an external financial liberalization the early 80s. Following a fast boom, many Latin American economies plunged into a crisis (Diaz-Alejandro, 1985). One lesson that many extracted from these episodes is that a successful liberalization of capital controls require a well-functioning domestic financial markets. However, according to this view, the ultimate goal was to transition towards unrestricted capital mobility.

When the 1997 East Asian crisis struck, skepticism grew about unrestricted capital mobility. The policy support for capital controls grew with the 2008 global financial crisis (see e.g., Ostry, Ghosh, Habermeier, Chamon, Qureshi, and Reinhardt, 2010) and the

[6] Ghosh and Qureshi (2016) also argue that capital controls gained a bad name because capital controls were more frequently employed by autocratic regimes. They call this "guilt by association." In addition, they attribute the shifts away from capital controls to the concentration of financial activity around the US and London which seeked to remove barriers to capital mobility.

emergence of an academic literature that started to provide theoretical foundations for the use of capital controls with a prudential goal. The literature took a normative point of view and explored how a regime of free-capital mobility may lead to overborrowing and make economies more prone to systemic financial crises (see e.g. Bianchi, 2011). The key insight in the new literature is that capital controls on inflows can help prevent the build-up of systemic risks and correct externalities in financial markets. This is the literature that we cover in this chapter.[7] Before we review the theoretical building blocks, we present some basic facts.

2.2 Empirical Observations

This section offers an overview of the evolution of capital controls and reserve accumulation since the 1980s. We present some descriptive statistics, focusing especially on emerging market economies. We also survey a number of established empirical findings in the literature and provide a background for the model presented in the following sections.

1. *Starting in the 1990s, there was a substantial liberalization of capital controls in emerging markets, which partially reversed after the Global Financial Crisis.*

Figure 1, panel (a) presents an index of capital controls for emerging markets, advanced economies and low income countries. The series corresponds to the inverse of the Chinn and Ito (2008) index, which is constructed as the first standardized principal component of four different series capital account restrictions from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). By construction, an increase in the index indicates tighter capital controls.[8] The figure shows a substantial liberalization of capital controls starting in 1990 for emerging markets. A partial reversal is also apparent after the Global Financial Crisis. While some countries, like Brazil and Colombia, have received attention for re-imposing stricter controls, the reversal in the trend is not entirely specific to a few countries. Out of 92 countries in our sample, 21 experienced an increase in the capital control index, 14 had a reduction, and remaining 57 remained constant (see Figure 8). As has been well established, advanced economies have higher degrees of financial openness and liberalized earlier, while low income countries have more restricted

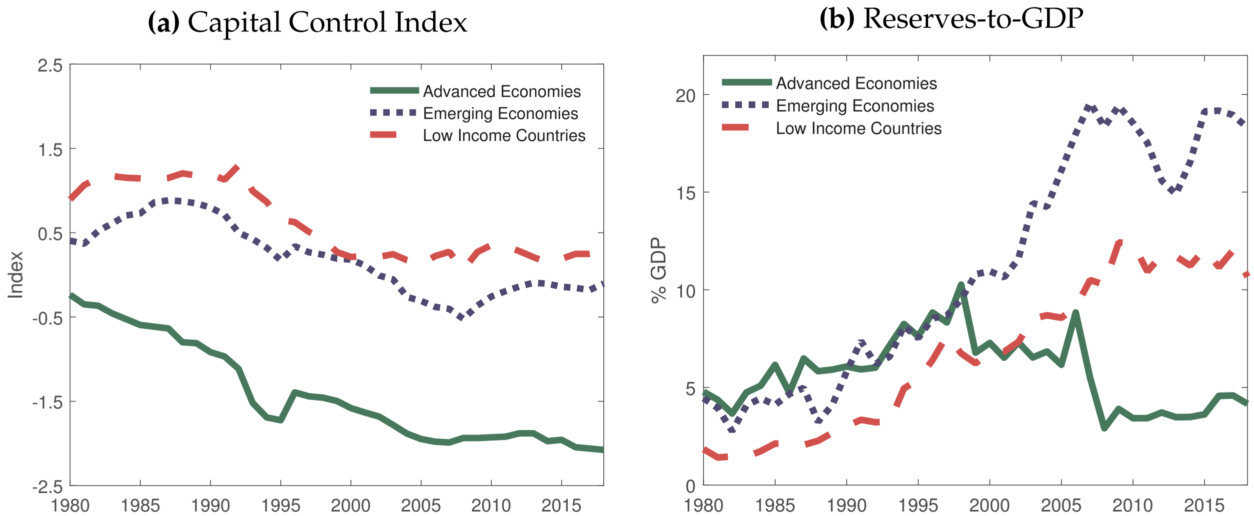


Figure 1: Capital Controls and Reserve Accumulation

capital accounts.

2. *Holdings of foreign currency reserves have experienced a secular upward trend since the 1990s.*

Figure 1, panel (b) shows the upward trend in reserves for the three groups of countries. The surge in reserves is particularly notable for emerging markets starting in the 1990s, which many observers have interpreted as a reaction to the East Asian financial crisis of 1997 (Aizenman and Lee, 2007, see e.g.,). Advanced economies (excluding the G7) also experienced an increase, but it is not as strong or generalized (see Figure 2). Reserves also increased significantly in low income countries and with less variation across countries.

3. *Within emerging markets, countries with a more open capital account have larger holdings of reserves.*

Emerging countries with larger capital account restriction have smaller holdings of reserves than countries with more liberalized capital accounts. That is, the negative relationship between capital controls and reserves is not only apparent in the aggregate (as observed in the first two empirical observations) but is also present in the cross-section.

[7] On the policy arena, the new integrated policy framework proposed in IMF (2020) assigns capital controls and macroprudential policies a central role, in line with the findings of Basu, Boz, Gopinath, Roch, and Unsal (2020).

[8] A more disaggregated analysis of capital controls is provided in Schindler (2009). See also the analysis in Fernandez, Klein, Rebucci, Schindler, and Uribe (2015).

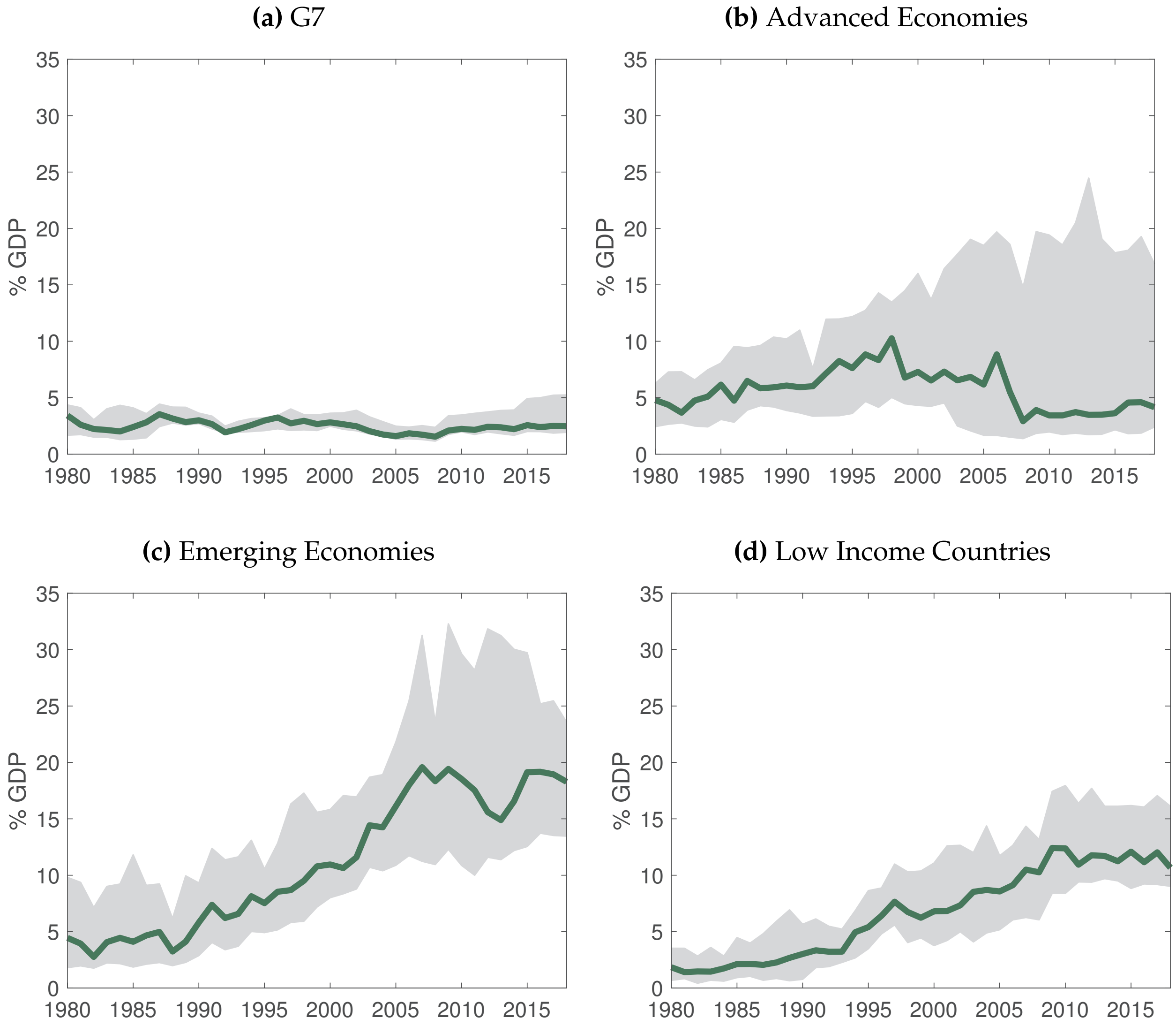


Figure 2: Trends in International Reserves

This finding is emphasized in Aizenman and Lee (2007), Bussiere, Cheng, Chinn, and Lisack (2013), and Arce, Bengui, and Bianchi (2019).

Taken together, facts 1-3 suggest an important connection between reserves and capital controls, a central observation in the analysis and perspective of Ilzetzki, Reinhart, and Rogoff (2019).

4. *Capital controls are fairly acyclical and have low volatility.*

Fernandez, Rebucci, and Uribe (2015) and Eichengreen and Rose (2014) document that capital controls display very little volatility and are fairly acyclical. While their analysis is based on measures on the extensive margin, Acosta-Henao, Alfaro, and Fernández (2020) significantly expand upon the available empirical databases of capital controls and find that capital controls display little variability using intensity measures of capital controls.

5. *The accumulation of reserves is procyclical for most emerging markets.*

The procyclicality of reserves is documented in Broner, Didier, Erce, and Schmukler (2013) and Bianchi, Hatchondo, and Martinez (2018). During good times, governments tend to accumulate reserves, whereas during bad times, especially around episodes of sudden stops, reserves fall.

6. *Emerging economies with a fixed exchange rate accumulate more reserves, but capital controls are not correlated with the exchange rate regime.*

Figure 3 shows the evolution of reserves for fixed and flexible exchange rates. While both experience an upward trend, the accumulation is more substantial for the fixed regime, as documented by Bianchi and Sosa-Padilla (2020).[9] On the other hand, Eichengreen and Rose (2014) show that the correlation between capital controls and exchange rate regimes is close to zero.

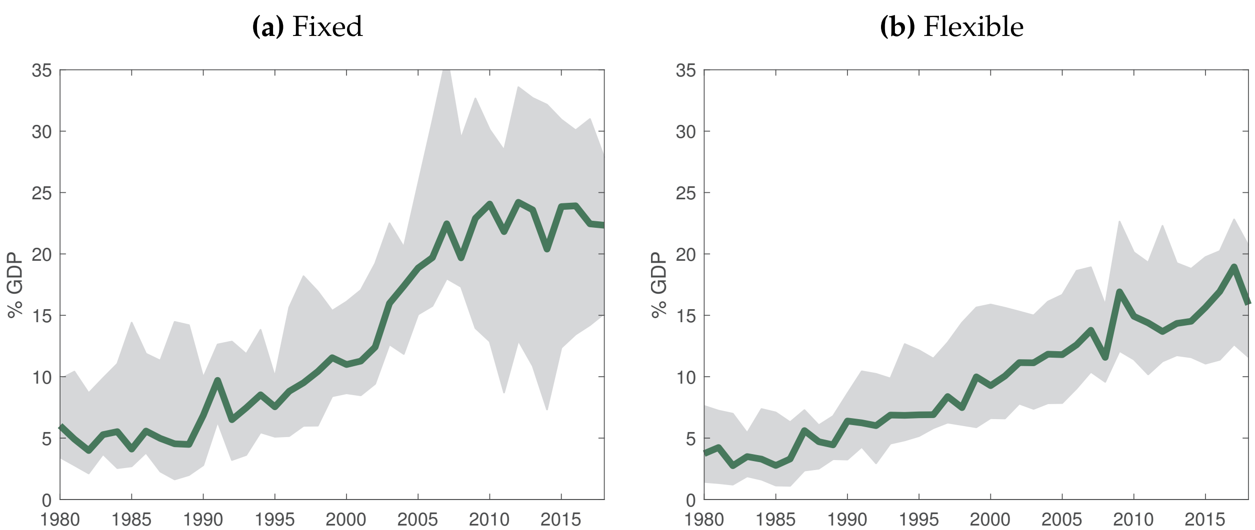


Figure 3: Reserve Accumulation and Exchange Rate Regime (Emerging Economies)

Note: We classify countries by foreign exchange regime, using the coarse classification by Ilzetzki, Reinhart, and Rogoff (2019). Details can be found in Appendix B

[9] A different pattern is present for advanced economies, with flexible exchange rate economies at the zero lower bound accumulating more reserves (Amador, Bianchi, Bocola, and Perri, 2020).

3 Model

Consider a small open economy populated by an infinitely lived representative consumer who consumes two goods, a tradable good T and a non-tradable good N. Preferences are represented by the utility function

$$\mathbf{E}\sum_{t=0}^{\infty}\beta^t U\left(c_t^T, c_t^N\right),$$

where

$$U\left(c_t^T, c_t^N\right) = \frac{1}{1-\sigma}\left(\phi^\rho\left(c_t^T\right)^{1-\rho} + (1-\phi)^\rho\left(c_t^N\right)^{1-\rho}\right)^{\frac{1-\sigma}{1-\rho}},$$

so there is constant intertemporal elasticity of substitution $1/\sigma$ and constant elasticity of substitution $1/\rho$ between tradable and non-tradable goods.

The domestic consumer receives an endowment of tradables y_t^T every period and supplies a fixed amount of labor $\bar{n}$ to firms that produce non-tradables.[10].

The technology to produce non-tradables is linear:

$$y_t^N = n_t.$$

Firms are competitive, so the price of the non-tradable good is

$$p_t^N = w_t,$$

where w_t is the nominal wage rate. Given linearity, in equilibrium firms are indifferent among all levels of production.

There are two currencies that serve as units of account, the domestic currency (pesos) and the foreign currency (dollars). The price of tradables in the rest of the world is normalized to one in dollars, so using the law of one price, the price of tradable goods in pesos is

$$p_t^T = e_t,$$

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

[10]The assumption of a fixed supply of tradables has some similar features as the assumption of sticky prices with invoicing in dollars where exports are insensitive to domestic devaluations (see, Auclert, Rognlie, Souchier, and Straub, 2021). Gopinath and Itskhoki (2021) in this handbook surveys the literature on international pricing. Basu, Boz, Gopinath, Roch, and Unsal (2020) analyzes the importance of the type of pricing frictions and how the role of dollar currency pricing matter for policy predictions on capital controls and other policies

Consumers have access to bonds denominated in dollars and in pesos. Consumers can borrow or lend domestically in pesos at the rate i_t, which is set by the domestic central bank. Their net peso position is denoted by a_t. Consumers can lend externally in dollars at the world interest rate i_t^*, which is exogenously given. Consumers can borrow externally in dollars, but they have to go through international intermediaries, which charge an interest rate $\hat{i}_t^* \geq i_t^*$, which will be determined in equilibrium. The consumers' lending position in dollars at the beginning of the period is denoted by $a_t^* \geq 0$; their borrowing position is denoted by $b_t^* \geq 0$. The budget constraint of the domestic consumers is then written as follows:

$$\frac{1}{1+i_t}a_{t+1} + \frac{1}{1+i_t^*}e_t a_{t+1}^* - \frac{1}{1+\hat{i}_t^*}e_t b_{t+1}^* + p_t^T c_t^T + p_t^N c_t^N = e_t y_t^T + w_t n_t + a_t + e_t\left(a_t^* - b_t^*\right).$$

Because peso bonds are only traded domestically, we have that in equilibrium $a_{t+1} = 0$. Moreover, in equilibrium the domestic consumer will be either a net lender or a net borrower versus the rest of the world, so either a_{t+1}^* or b_{t+1}^* is equal to zero.

If the country is a net borrower and $b_{t+1}^* > 0$, this borrowing is intermediated by two-period lived risk neutral intermediaries that consume only the tradable good. Time t intermediaries lend $b_{t+1}^*/\left(1+\hat{i}_t^*\right)$ at time t in exchange for a repayment b_{t+1}^* at time $t+1$, and face convex costs of intermediation, incurred at $t+1$. The intermediation cost is given by the function $(1/\omega_t)\,\Phi\left(b_{t+1}^*/\left(1+\hat{i}_t^*\right)\right)$, with $\Phi(0) = 0$ and $\Phi'(0) = 0$. Convex intermediation costs are a simple way of obtaining an elastic, but not perfectly elastic, supply of funds. The variable ω_t captures shocks to intermediation capacity.

Wages are downward rigid: the labor supply is inelastic at $\bar{n}$ and the following non-Walrasian labor market equilibrium conditions must hold,

$$n_t \leq \bar{n}, \quad w_t \geq \underline{w},$$

with at least one equality. That is, the economy can have unemployed labor $n_t < \bar{n}$ if the nominal wage is at its lower bound $\underline{w}$.

We focus on analyzing the economy in two periods: $t-1$ and t. Period $t-1$ is the ex ante period in which prudential capital controls are imposed and in which reserve accumulation takes place. Period t is the period in which the country can be hit by shocks leading to a capital flight, we will specify the nature of the shock shortly. We assume that there are no other shocks and, in particular the tradable endowment y_t^T is constant and equal to y^T.

We make two simplifying assumptions on periods $t+1, t+2, ...$, to capture the fact that these periods represent the long run. First, we assume that prices and wages are fully flexible. Given that this implies that money is neutral from $t+1$ onward, we assume for simplicity that monetary policy will keep the exchange rate constant for t+1,t+2...at a level $\bar{e}$, to be specified below. Second, we assume intermediation costs are zero, $\omega_{t+1} = \omega_{t+2} = ... = 0$, and that the world interest rate is equal to the inverse of the domestic discount factor, $i^*_{t+1} = i^*_{t+2} = ... = 1/\beta - 1$.

4 A Capital Flight Shock and the Optimal Response

We begin by analyzing the equilibrium at time t, when the shock hits, focusing on a shock to the supply of funds by international lenders. We then analyze the optimal policy response ex post, including the use of monetary policy and of capital controls.

In this section, we take as given the country's initial net position, $a^*_t - b^*_t$. In the next section, we take an ex ante perspective and look at the equilibrium determinants of a^*_t and b^*_t.

4.1 Equilibrium in the international loan market

We begin by characterizing the equilibrium with no capital flows restrictions, in which the nominal interest rate is the only policy tool. Let us start from equilibrium conditions in the market for international loans, in which international intermediaries supply funds to domestic consumers.

Supply of funds. The supply of funds is given by the behavior of optimizing intermediaries. Consider an intermediary who lends $b^*_{t+1}/\left(1+\hat{i}^*_t\right)$ to consumers at date t in exchange for b^*_{t+1} at $t+1$. The intermediary raises the needed funds on the international capital markets, borrowing at the interest rate i^*_t. The net profits of the intermediary at time $t+1$ are then

$$b^*_{t+1} - \frac{1+i^*_t}{1+\hat{i}^*_t} b^*_{t+1} - \frac{1}{\omega_t} \Phi\left(\frac{b^*_{t+1}}{1+\hat{i}^*_t}\right).$$

The optimal choice of b^*_{t+1} is then characterized by the first order condition

$$\hat{i}^*_t - i^*_t = \frac{1}{\omega_t} \Phi'\left(\frac{b^*_{t+1}}{1+\hat{i}^*_t}\right).$$

With the assumption of quadratic adjustment costs, $\Phi(x) = \frac{1}{2}x^2$, we obtain a linear supply of funds

$$\frac{b^*_{t+1}}{1+\hat{i}^*_t} = \omega_t \left(\hat{i}^*_t - i^*_t\right). \tag{1}$$

To attract capital inflows, the small open economy needs to compensate international investors with a premium over the world interest rate. Moreover, this premium is increasing in the country's borrowing position. In the limit case of no intermediation costs, when $\omega_t \to \infty$, there is a perfectly elastic supply of funds at $\hat{i}^*_t = i^*_t$. At the other extreme, if $\omega_t = 0$ the economy is closed to foreign borrowing. Recall also that consumers can always save externally at a rate i^*, and, so, in equilibrium b^*_{t+1} is never negative and we never have $\hat{i}^*_t < i^*_t$.

A similar upward sloping supply of funds can be derived through several other approaches. One approach is limited commitment constraint, as proposed in Gabaix and Maggiori (2015) and used in subsequent work (among others, see Cavallino, 2019; Davis, Devereux, and Yu, 2020; Basu, Boz, Gopinath, Roch, and Unsal, 2020). In Gabaix and Maggiori, intermediaries can abscond a fraction of the value of their asset holdings. To the extent that a higher rate of return on loans decreases their incentives to default, this allows intermediaries to lever up more and in turn, lend more to the small open economy. A similar condition can be derived from risk-averse intermediaries that face exchange rate risk, as in Jeanne and Rose (2002); Itskhoki and Mukhin (2020). If intermediaries borrow and lend in different currencies and are risk averse, they will demand a risk premium to take positions and supply an amount of funds that increases with the risk premium. Fanelli and Straub (2021) and Amador, Bianchi, Bocola, and Perri (2020) consider models with limited intermediary capital. In particular, Fanelli and Straub (2021) introduce heterogeneous participation costs, as in Alvarez, Atkeson, and Kehoe (2009). In their environment, a higher rate of return raises the share of intermediaries that enter the market, giving rise to more capital inflows to the small open economy. Finally, there is a reduced-form approach that posits an exogenous schedule for interest rate that depends on the country's aggregate debt level (Schmitt-Grohé and Uribe, 2003). The crucial element for our purposes here is that the supply of funds be upward sloping.[11]

[11] These different modeling approaches may have different macro-finance implications, in particular regarding deviations from uncovered interest parity (UIP) or covered interest parity (CIP) (see Amador, Bianchi, Bocola, and Perri, 2020; Maggiori, 2021; Du and Schreger, 2021; Kalemli-Özcan and Varela, 2021; Fanelli and Straub, 2021). The implications of these modeling choices for normative analysis has received relatively less attention.

Demand of funds. We now turn to the demand for funds, working under the hypothesis that the country is a net borrower at date t, so $b^*_{t+1} > 0$ and $a^*_{t+1} = 0$. The interest rate $\hat{i}^*_t$ is taken as given by the individual consumer, as the upward supply of funds applies to the country as a whole. Optimality gives the following Euler equation for tradable consumption:

$$U_T\left(c^T_t, c^N_t\right) = \beta\left(1 + \hat{i}^*_t\right) U_T\left(c^T_{t+1}, \bar{n}\right), \tag{2}$$

where U_T denotes the partial derivative of U with respect to its first argument. Given that prices are flexible in period $t+1$, there is always full employment in the N sector, which is why we set $c^N_{t+1} = \bar{n}$.

Using the equilibrium in the non-tradable goods market, we can write country-level budget constraints in periods t and $t+1$ as

$$c^T_t = y^T + a^*_t - b^*_t + \frac{b^*_{t+1}}{1+\hat{i}^*_t},$$
$$c^T_{t+1} = y^T - (1-\beta)\, b^*_{t+1}.$$

To get the second constraint, we use the fact that from $t+1$ onward, the economy goes into a steady state where consumers choose constant tradable consumption. With the world interest rate in tradables constant and equal to $1/\beta$, each period the consumers make interest payments $1-\beta$ on their debt. Combining the last two equations yields the country-level intertemporal budget constraint

$$(1-\beta)\left(c^T_t - y^T - a^*_t + b^*_t\right) + \frac{1}{1+\hat{i}^*_t}\left(c^T_{t+1} - y^T\right) = 0. \tag{3}$$

Equilibrium. To sum up, the conditions that ensure an equilibrium in the international loan market are (1)-(3).

For the general case, we can define a competitive equilibrium as follows.

Definition 1. A competitive equilibrium, given an initial asset position $\{b^*_{t-1}, a^*_{t-1}, a_{t-1}\}$ and a process for the interest rate $\{i_t\}$, is a sequence of prices $\{p^N_{s-1}, e_{t-1}\}^\infty_{s=t}$, allocations $\{c^T_s, c^N_s, n_s\}^\infty_{s=t-1}$, bond positions $\{b^*_{s+1}, a^*_{s+1}, a_{s+1},\}^\infty_{s=t}$ such that:

(i) Consumers maximize utility

(ii) Firms and intermediaries maximize profits.

(iii) Market clears for non-tradable goods and the international loan market. That is,

$$c^N_s = y^N_s,$$

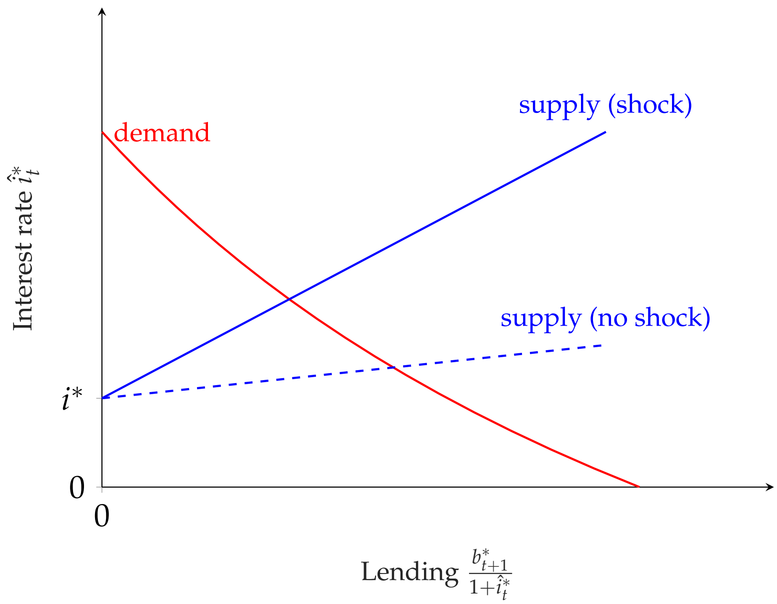


Figure 4: Equilibrium in the loans market at date t

and

$$\frac{b_{s+1}^*}{1+\hat{i}_s^*} = \omega_s \left(\hat{i}_s^* - i_s^*\right).$$

(iv) Labor market conditions hold.

In general, the loan market equilibrium must be analyzed in combination with the non-tradable goods market and the labor market equilibrium. However, there is a special case in which the loan market can be analyzed separately. It arises when preferences are separable in tradable and non-tradable consumption, that is, when $\sigma = \rho$. In this case, conditions (2)-(3) give the demand curve for loans in closed form:

$$\frac{b_{t+1}^*}{1+\hat{i}_t^*} = \frac{\left[1 - \left[\beta(1+\hat{i}_t^*)\right]^{1/\sigma}\right] y^T - \left[\beta\left(1+\hat{i}_t^*\right)\right]^{1/\sigma}\left(a_t^* - b_t^*\right)}{(1-\beta)\left(1+\hat{i}_t^*\right) + \left[\beta\left(1+\hat{i}_t^*\right)\right]^{1/\sigma}}$$

In Figure 4, we plot the demand curve under this special case and the supply curve derived above. The figure shows the effects of a capital flight shock, that is, a reduction in ω_t. The shock shifts the supply curve to the left, leading to a reduction in lending and in domestic tradable consumption c_t^T, and to an increase in the rate $\hat{i}_t^*$ at which domestic consumers borrow. As we will see, this may also generate a recession depending on the monetary policy response.

4.2 A monetary policy dilemma

What is the role of monetary policy here? As just showed, with separable preferences ($\sigma = \rho$), monetary policy has no effect on the allocation of tradables. Nonetheless, the choice of the domestic policy rate i_t matters for total spending by domestic consumers and so their spending on non-tradables.

Let us first show how the choice of i_t determines the real exchange rate. The foreign consumer price index expressed in domestic currency is e_t, as the foreign price index in dollars is normalized at 1. The domestic consumer price index P_t is

$$P_t = \left(\phi e_t^{1-\frac{1}{\rho}} + (1-\phi)\, w_t^{1-\frac{1}{\rho}}\right)^{\frac{1}{1-\frac{1}{\rho}}},$$

where we use the equilibrium condition $p_t^N = w_t$. The real exchange rate is defined as the ratio of these two price indexes, e_t/P_t.

The consumption levels at $t+1$, c_{t+1}^N and c_{t+1}^T, are pinned down independently of monetary policy, the first by the assumption of flexible prices and full employment so $c_{t+1}^N = \bar{n}$, and the second by the fact that the tradable allocation at t and $t+1$ is fully determined by the international loans market equilibrium. Therefore, the long-run real exchange rate e_{t+1}/P_{t+1} is given by[12]

$$\frac{e_{t+1}}{P_{t+1}} = \phi \left(c_{t+1}^T\right)^{-\rho} \left(\phi^\rho \left(c_{t+1}^T\right)^{1-\rho} + (1-\phi)^\rho \bar{n}^{1-\rho}\right)^{-\frac{\rho}{1-\rho}},$$

While the international loan markets determines the interest rate in dollars at which the country can borrow externally, or, equivalently, the real interest rate in terms of tradable goods, the domestic central bank can affect the real interest rate in terms of domestic consumption, which is defined as follows[13]

$$1 + r_t = (1 + i_t)\,\frac{P_t}{P_{t+1}}.$$

[12]This equation can be derived from the consumer expenditure minimization problem

$$\min\left\{e_{t+1}c_{t+1}^T + p_{t+1}^N c_{t+1}^N : \left(\phi^\rho \left(c_{t+1}^T\right)^{1-\rho} + (1-\phi)^\rho \left(c_{t+1}^N\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \leq C_{t+1}\right\}.$$

Taking the first order condition with respect to c_{t+1}^T, noticing that the Lagrange multiplier is equal to the consumer price index—by the definition of price index—and substituting $c_{t+1}^N = \bar{n}$ yields the equation.

[13]Once we reach full employment at $n_t = \bar{n}$, then it is not feasible for monetary policy to further reduce the real rate.

Since domestic consumers have to be indifferent between borrowing in dollars or borrowing in pesos, we have the arbitrage relation

$$1 + i_t = (1 + \hat{i}_t^*)\frac{e_{t+1}}{e_t} \tag{4}$$

where recall that we assume the central bank sets $e_{t+1} = \bar{e}$.

Equation (4) is similar to a standard UIP condition, although, owing to imperfect intermediation, $\hat{i}_t^*$ is not equal to i_t^* and is endogenous in our model. The effect of the policy rate on the real exchange rate has a "disequilibrium" currency market intuition. If the central bank reduces i_t, it induces domestic consumers to borrow more and to switch from dollar borrowing to peso borrowing; as consumers spend more on tradables and bring in fewer dollars from international intermediaries, dollar demand to buy tradables goes up and dollar supply goes down, putting upward pressure on the exchange rate e_t; the increase in e_t discourages spending on tradables by consumers and encourages borrowing in dollars because of a decrease in $(\frac{e_{t+1}}{e_t})$ on the right-hand side of (4) (an expected appreciation of the peso). This restores the equilibrium in the currency market.

We now turn to the real effects of monetary policy on activity and employment in the N sector. From the definition of the domestic price index, we can derive a decreasing relation between the real exchange rate e_t/P_t and the relative price of non-traded goods in terms of traded goods w_t/e_t:

$$\left(\frac{e_t}{P_t}\right)^{\frac{1}{\rho}-1} = \phi + (1-\phi)\left(\frac{w_t}{e_t}\right)^{1-\frac{1}{\rho}}. \tag{5}$$

Moreover, consumer optimality implies the following relative demand function for non-tradables and tradables :

$$\frac{c_t^N}{c_t^T} = \frac{1-\phi}{\phi}\left(\frac{w_t}{e_t}\right)^{-\frac{1}{\rho}}. \tag{6}$$

Combining conditions (4)-(6) we get a decreasing relation between i_t and c_t^N: a reduction in the nominal rate (lower i_t) leads to a real depreciation (higher e_t), a reduction in the relative price of non-tradables to tradables (lower w_t/e_t), and an increase in non-tradable consumption (higher c_t^N). If $n_t < \bar{n}$ then monetary easing can reduce unemployment.

Fear of floating. We can now look at the how monetary policy is chosen. Assume that monetary policy is chosen by a planner with the objective function

$$(1-\beta)\left(U\left(c_t^T, c_t^N\right) - \Psi\left(e_t\right)\right) + \beta U\left(c_{t+1}^T, \bar{n}\right), \tag{7}$$

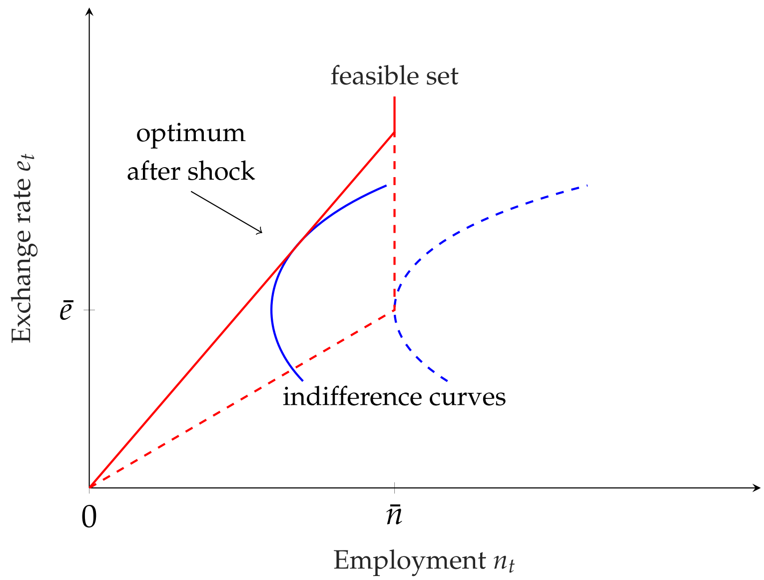


Figure 5: Optimal Monetary Policy

Note: Blue lines: indifference curves. Red dashed line: feasible set before the shock. Red solid line: feasible set after the shock.

where $\Psi(\cdot)$ is a convex function with its minimum at $\bar{e}$. That is, the planner's objective includes the welfare of the representative consumer and an ad-hoc cost of exchange rate volatility. The role of the function Ψ is to add an element of "fear of floating" to the model. We interpret it as capturing a variety of unmodelled disruptions caused by large movements in the nominal exchange rate.[14]

If we set $c_t^N = n_t$ in (6) and impose the inequalities $n_t \leq \bar{n}$ and $w_t \geq \underline{w}$ with a complementary slackness condition, we can trace the feasible set of pairs (n_t, e_t) that monetary policy can achieve. In Figure 5, we plot the feasible set (red dashed line before the shock; red solid line after the shock) and the indifference curves of the planner (blue dashed line) based on the objective (7). The feasible set is upward sloping—as a higher depreciation leads to higher employment—up to the point at which the nominal rigidity is not binding and the feasible set becomes vertical at $n_t = \bar{n}$. The indifference curves are upward sloping for $e > \bar{e}$ and downward sloping for $e < \bar{e}$. The interesting case is the first, as in that region the central bank has to trade-off the employment benefits of a depreciated exchange against the costs of the depreciation. It is easy to show that the optimum always occurs in the region $e \geq \bar{e}$.

Figure 5 also shows that the effects of the capital flight. The reduction in borrowing (and c_t^T) due to the shock to international lending shifts downward the demand for non-tradables, causing a recession for a given e_t. At the same time, for a given nominal rate i_t and a given e_{t+1}, the increase in the tradable interest rate $\hat{i}_t^*$ at which consumers borrow from abroad pushes towards a depreciation of the exchange rate, through the UIP mechanism described above. Then the monetary authority has to choose between tightening policy to prevent the depreciation of the exchange rate or easing to address the recession. The following proposition illustrates this result.

Proposition 1. *Assume that $\sigma = \rho$, $a_t^* - b_t^* < 0$ and suppose the nominal rate i_t is the only policy instrument and is chosen optimally at t. Then, $\hat{i}_t^*$ is strictly decreasing in ω_t. In addition, if $\underline{w} \geq \left[\left(\frac{y_t^T + (a_t^* - b_t^*)(1-\beta)}{\bar{n}}\right)\left(\frac{1-\phi}{\phi}\right)\right]^\rho \bar{e}$, then there is a cutoff $\hat{\omega}$ such that if $\omega_t < \hat{\omega}$ the government cannot achieve an allocation with $n_t = \bar{n}$ and $e_t = \bar{e}$. Moreover, if the fear of floating Ψ is strong enough, the optimal policy features $n_t < \bar{n}$ and $e_t > \bar{e}$.*

4.3 Can ex post capital controls help?

We now enlarge the set of tools available to the policy maker by introducing a tax/subsidy on international borrowing τ_t. For the analysis that follows, we go back to the general formulation of the problem, allowing for general values of ρ and σ.

The capital control tax τ_t can be set to ensure that the Euler equation of the domestic consumer is satisfied. Therefore, the optimal combination of monetary policy and capital controls can be analyzed by studying the following planner's problem:

$$V\left(a_t^* - b_t^*, \omega_t\right) = \max_{c_t^T, c_{t+1}^T, c_t^N, e_t, \hat{i}_t^*} (1-\beta)\left(U\left(c_t^T, c_t^N\right) - \Psi\left(e_t\right)\right) + \beta U\left(c_{t+1}^T, \bar{n}\right), \tag{8}$$

[14]For empirical evidence of fear of floating by policy makers in emerging markets see Calvo and Reinhart (2002). The various dilemmas that emerging markets face in the conduct of monetary policy have been discussed prominently by Rey (2015) and Kalemli-Özcan (2019). See the handbook chapter by Miranda-Agrippino and Rey (2021).

subject to the constraints

$$
\begin{aligned}
(1-\beta)\left(c_t^T - y_t^T - a_t^* + b_t^*\right) + \frac{1}{1+\hat{i}_t^*}\left(c_{t+1}^T - y^T\right) &= 0, \\
c_t^T - y_t^T - a_t^* + b_t^* &= \omega_t\left(\hat{i}_t^* - i_t^*\right), \qquad (9) \\
\frac{c_t^N}{c_t^T} &= \frac{1-\phi}{\phi}\left(\frac{w_t}{e_t}\right)^{-\frac{1}{\rho}}, \\
c_t^N \le \bar{n}, \quad w_t &\ge \underline{w}.
\end{aligned}
$$

where one of the last two inequalities has to hold as an equality.

The analysis of this problem allows us both to study the optimal use of capital controls ex post and to set the stage for the ex ante analysis in the next section.

The presence of capital controls provides some additional flexibility in the response to the capital flight shock. However, it also presents the policy maker with additional trade-offs, as shown in the next proposition. Consider in particular the optimal choice of c_t^T. If the social planner wants to ameliorate the trade-off between depreciation and recession illustrated in Figure (5), then a higher demand for consumption of both tradables and non-tradables is desirable. However, given the upward sloping supply of funds, increasing c_t^T also has the effect of increasing the rate $\hat{i}_t^*$ at which the country borrows internationally, as captured by constraint (9). Therefore, when choosing the optimal tax/subsidy on borrowing by domestic consumers, the planner now has to trade off the welfare benefits of a smaller recession against the increased foreign debt burden.

The competing forces just described are captured in the following equation, which follows from the first-order conditions of problem (8):

$$
U_T\left(c_t^T, c_t^N\right) + U_N\left(c_t^T, c_t^N\right)\frac{c_t^N}{c_t^T} = \beta U_T\left(c_{t+1}^T, \bar{n}\right)\left(1 + \hat{i}_t^* + \frac{1}{\omega_t}\frac{b_{t+1}^*}{1+\hat{i}_t^*}\right). \qquad (10)
$$

The positive term $U_N\left(c_t^T, c_t^N\right) c_t^N / c_t^T$ on the left-hand side captures the general equilibrium benefits in terms of increased employment and activity in the non-tradable sector as a result of the increase in external borrowing. Given a fixed relative price of non-tradables, one unit of borrowing gives rise to an increase in the demand for non-tradable consumption in proportion to the ratio of non-tradable to tradable consumption. The uninternalized marginal benefits are given by the increase in non-tradable consumption times the marginal utility U_N.

The term $\frac{1}{\omega_t}\frac{b_{t+1}^*}{1+\hat{i}_t^*}$ on the right-hand side captures the cost in terms of increased interest payments on the country's net debt position. Notice that $\frac{1}{\omega_t}$ is the slope of the supply curve, so all else equal, a larger shock to ω_t increases this term. Comparing this condition to the individual Euler equation yields the following result.

Proposition 2. *If at the planner optimum there is unemployment $n_t < \bar{n}$ and the country is a net borrower $b^*_{t+1} > 0$, the optimal ex post tax on borrowing τ_t satisfies*

$$1 - \tau_t = \frac{\beta \left(1 + \hat{i}^*_t\right) U_T \left(c^T_{t+1}, \bar{n}\right)}{\beta U_T \left(c^T_{t+1}, \bar{n}\right) \left(1 + \hat{i}^*_t + \frac{1}{\omega_t} \frac{b^*_{t+1}}{1+\hat{i}^*_t}\right) - U_N \left(c^T_t, c^N_t\right) \frac{c^N_t}{c^T_t}},$$

and depending on the economy's parameters, it is possible to have $\tau_t > 0$ or $\tau_t < 0$.

Notice that when $\tau_t > 0$ is optimal, the use of capital controls leads to a larger contraction in c^T_t than under no capital controls, therefore worsening the trade-off faced by monetary policy that was illustrated in Figure 5.

The scope for capital controls to reduce the interest rate premia paid to external creditors in environments with limited intermediary capital is analyzed in Amador, Bianchi, Bocola, and Perri (2020) and Basu, Boz, Gopinath, Roch, and Unsal (2020). The latter, in particular, highlights the importance of the residence of intermediaries, a point also highlighted by Fanelli and Straub (2021). Essentially, the result is that the government chooses to restrict borrowing because it internalizes that when consumers borrow more, this ends up raising the interest rate premia on all consumers to the benefit of the foreign intermediaries.[15]

In a more indirect way, this result is also related to the ex post use of another policy tool, which we do not model here: fiscal policy. Expansionary fiscal policy may be another way of dealing with the monetary policy dilemma of Section 4.2. But if the country is facing a steep supply of foreign funds, fiscal expansion may be too costly on that front. There is, in fact, a growing body of work that models tensions between interest rate premia and macro stabilization, including Corsetti, Kuester, Meier, and Müller (2013, 2014); Na, Schmitt-Grohé, Uribe, and Yue (2018); Bianchi, Ottonello, and Presno (2019); Anzoategui (2019); Arellano, Bai, and Mihalache (2020); Bianchi and Mondragon (2022); Bianchi and Sosa-Padilla (2020). In particular, Bianchi, Ottonello, and Presno (2019) finds the optimal fiscal policy under sovereign risk to be overall procyclical. Moreover, they show that

[15] In some respect, this can be seen as a form of market power, which is linked to the work of capital controls by Obstfeld and Rogoff (1996); Costinot, Lorenzoni, and Werning (2014) where the upward supply of funds emerges in the absence of any frictions when the country is large in international capital markets. In these cases, it is worth noting that from a global welfare perspective, the use of capital controls to reduce borrowing may be inefficient. The implications of capital controls for global welfare in a context of market power analyzed in Korinek (2016).

stimulus may be optimal in a recession when the level of government debt is very low and that keeping fiscal space help ameliorate recessions.

The bottom line is that countries facing an upward sloping supply of funds may have limited policy options to get out of a difficult choice between depreciation and recession. There are more drastic options that can help ex post but require more heavy-handed intervention in capital markets relative to the tax/subsidy τ_t discussed above. The restrictions on capital outflows are discussed in Section 6.2.

5 Prudential Policies

We now turn to period $t-1$ and analyze how the state variables a_t^* and b_t^* are determined in equilibrium and what are the planner's motives for ex ante intervention.

5.1 Equilibrium borrowing

In the absence of government interventions, the position of the country $a_t^* - b_t^*$ is determined at date $t-1$ by the following equilibrium conditions. In terms of credit markets, steps analogous to those in 4.1 lead to the supply of funds

$$\frac{b_t^*}{1+\hat{i}_{t-1}^*} = \omega_{t-1}\left(\hat{i}_{t-1}^* - i_{t-1}^*\right).$$

If $b_t^* = 0$ the supply function implies $\hat{i}_{t-1}^* = i_{t-1}^*$, so this optimality condition covers both the case in which $b_t^* > 0, a_t^* = 0$ and the case in which $b_t^* = 0, a_t^* > 0$.

On the demand side, the optimality condition for the consumer is

$$U_T\left(c_{t-1}^T, c_{t-1}^N\right) = \beta\left(1+\hat{i}_{t-1}^*\right)\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right)\right]. \tag{11}$$

5.2 Optimal policy ex ante: capital controls

The government has access to two policy instruments at date $t-1$: the domestic policy rate i_{t-1} and a tax/subsidy on foreign borrowing and lending τ_{t-1}.[16] To characterize

[16]The budget constraint of the individual consumer is

$$\frac{1}{1+i_{t-1}}a_t + (1-\tau_{t-1})\frac{1}{1+i_{t-1}^*}e_{t-1}a_t^* - (1-\tau_{t-1})\frac{1}{1+\hat{i}_{t-1}^*}e_{t-1}b_t^* + p_{t-1}^T c_{t-1}^T + p_{t-1}^N c_{t-1}^N =$$
$$e_{t-1}y_{t-1}^T + w_{t-1}n_{t-1} + a_{t-1} + e_{t-1}\left(a_{t-1}^* - b_{t-1}^*\right) - T_{t-1}.$$

optimal policy, we solve the following primal planner problem. The planner chooses $c^T_{t-1}, c^N_{t-1} a^*_t, b^*_t, e_{t-1}$ and w_{t-1} to maximize

$$(1-\beta)\, U\left(c^T_{t-1}, c^N_{t-1}\right) + \beta \mathbf{E}_{t-1}\left[V\left(a^*_t - b^*_t, \omega_t\right)\right], \tag{12}$$

subject to the constraints

$$\begin{aligned}
\frac{1}{1+i^*_{t-1}} a^*_t - \frac{1}{1+\hat{i}^*_{t-1}} b^*_t + c^T_{t-1} &= y^T_{t-1}, \\
\frac{c^N_{t-1}}{c^T_{t-1}} &= \frac{1-\phi}{\phi}\left(\frac{w_{t-1}}{e_{t-1}}\right)^{-\frac{1}{\rho}}, \\
c^T_{t-1} - y^T_{t-1} &= \omega_t\left(\hat{i}^*_t - i^*_t\right), \\
c^N_{t-1} \leq \bar{n}, \quad w_{t-1} &\geq \underline{w}.
\end{aligned}$$

We have assumed that the country starts with a zero financial position. The value function V is defined as in (8).

In the problem at $t-1$, we do not add the ad-hoc cost of depreciations Ψ. A simple motivation for this choice is that we interpret $t-1$ as a period of low shock volatility, in which contracts set at $t-2$ are not subject to uncertainty. An alternative motivation is that we focus on cases in which in period $t-1$, conditions are such that full employment can be achieved with $e = \bar{e}$. Without a concern with nominal variables, it is easy to show that part of an optimal plan is to set $c^N_{t-1} = \bar{n}$ and w_{t-1} and e_{t-1} to satisfy (6) for any value of c^T_{t-1}. Given this argument, it is possible to characterize the optimal choice of a^*_t, b^*_t as follows.

Proposition 3. *The planner optimum is characterized by the condition*

$$U_T\left(c^T_{t-1}, \bar{n}\right) = \beta\left(1 + \hat{i}^*_{t-1} + \frac{1}{\omega_{t-1}} \frac{b^*_t}{1+\hat{i}^*_{t-1}}\right) \mathbf{E}_{t-1}\left[U_T\left(c^T_t, c^N_t\right) + \iota_{n_t < \bar{n}} U_N\left(c^T_t, c^N_t\right) \frac{c^N_t}{c^T_t}\right]. \tag{13}$$

The rest of this section is devoted to providing intuition for this condition and comparing it to its laissez-faire counterpart (11). The expression in round brackets on the right-hand side of (13) is analogous to the expression in (10) and captures the monopolistic incentive of the country to reduce borrowing to lower total interest payments. The novel

where T_t is a lump sum tax that ensures the government budget balance. Consider the case $\tau_{t-1} > 0$. If the consumer is a net foreign borrower, $b^*_{t+1} > 0$, then τ_{t-1} acts a tax on borrowing, by reducing the funds received at t. If the consumer is a net foreign lender, $a^*_{t+1} > 0$, then τ_{t-1} acts as a subsidy on savings, by reducing the funds paid to buy foreign bonds. The case $\tau_{t-1} < 0$ is symmetric.

part is the expression in expectation on the right-hand side. This expression includes the marginal utility of tradable consumption $U_T\left(c_t^T, c_t^N\right)$. This term is internalized by private consumers and also appears in (11). The next term captures the general equilibrium effect that the net resources $a_t^* - b_t^*$ have on employment and activity in the N sector. If there is unemployment in the N sector—captured by the indicator function $\iota_{n_t<\bar{n}}$—increasing $a_t^* - b_t^*$ raises aggregate demand and employment in N. This term is not internalized by private consumers and does not appear in (11), because individual consumers do not take into account the effect of their financial decisions on aggregate activity. Effects of this type are usually labeled "aggregate demand externalities" and play a central role in the recent literature on macro-prudential policy discussed in the introduction. In particular, the model here is closest to that of Schmitt-Grohe and Uribe (2016), which considers a fixed exchange rate regime. Here, we allow for a floating regime, but the scope for capital controls still arises from the central bank's concern with exchange rate volatility. The case with fixed exchange rates is nested in this framework by setting $\Psi'(e_t) = \infty$ for all $e_t \neq \bar{e}$.

There is an alternative interpretation of the externality on the right-hand side of (11). By increasing the country's financial resources ex post, individual consumers are ameliorating the trade-off faced by the central bank during a capital flight. So they are also helping prevent a larger currency depreciation. An equivalent way of writing (11) is

$$U_T\left(c_{t-1}^T, \bar{n}\right) = \beta\left(1 + \hat{i}_{t-1}^* + \frac{1}{\omega_{t-1}}\frac{b_t^*}{1+\hat{i}_{t-1}^*}\right)\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right) + \Psi'\left(e_t\right)\rho\frac{e_t}{c_t^T}\right].$$

The term the consumers are not internalizing now shows up as the benefit of achieving a lower e_t (a less depreciated exchange rate), captured by the term $\Psi'\left(e_t\right)\rho e_t/c_t^T$. The intuition for this way of looking at the problem is the following: by increasing the net foreign asset position of the country, the consumers reduce their resources to spend ex post. Therefore, achieving the same level of economic activity can be achieved only by a larger depreciation. This way of interpreting the result emphasizes the externality that consumers impose by altering the domestic monetary policy stance.

The reason why the two interpretations above are interchangeable is that the planner is optimizing ex post on all margins, so the marginal social cost of a depreciation is equalized to the marginal social benefit of more employment. It is useful to remark that if there were imperfections in policy setting ex post (e.g., because of to limited information or political economy constraints), that would not necessarily reduce the desirability of ex ante prudential policies. . In fact, by presenting the policy maker with an "easier" ex post trade-off, the ex ante policy may limit the potential for large policy "mistakes."

The following result characterizes the tax on borrowing that implements the optimum allocations.

Proposition 4. *The allocation that solves the planner's problem (12) can be implemented as a competitive equilibrium in which the government chooses i_{t-1}, τ_{t-1} and the tax satisfies*

$$1+\tau_{t-1}=\frac{\left(1+\hat{i}_t^*+\frac{1}{\omega_{t-1}}\frac{b_{t+1}^*}{1+\hat{i}_{t-1}^*}\right)\mathbf{E}_{t-1}\left[U_T\left(c_t^T,c_t^N\right)+\iota_{n_t<\bar{n}}U_{N,t}\frac{c_t^N}{c_t^T}\right]}{\left(1+\hat{i}_t^*\right)\mathbf{E}_{t-1}\left[U_T\left(c_t^T,c_t^N\right)\right]}.$$

Because the numerator on the right-hand side is larger than the denominator, the tax is weakly positive. The tax is positive if at the planner's optimum, at least one of these conditions is satisfied: (i) the country is a net borrower; (ii) there is unemployment with positive probability at t. Notice that unlike the case of ex post capital control in Proposition (2), the tax here is always positive, at least weakly so. In the previous case, stabilizing aggregate demand called for $\tau<0$ while the upward supply of funds called for $\tau>0$. In this case, instead, stabilizing aggregate demand at time t call for a positive tax on borrowing at $t-1$ so both motives go in the same direction.

It is worth highlighting here that capital controls here are second-best policy instruments. They distort an intertemporal optimization condition relative to the first-best allocation to achieve a first-order gain by reducing unemployment. We also note that we are abstracting in the background from fiscal instruments that could mitigate the wage rigidities. However, to the extent that there are relevant restrictions that prevent from fully offsetting these rigidities, the findings here would apply more generally when those richer instruments are available.

At this point, the aim of optimal policy is to do anything that increases the net foreign asset position of the country ex post $a_t^*-b_t^*$. In the next subsection, we consider foreign currency reserves as an alternative to taxes on borrowing.

5.3 Optimal policy ex ante: foreign currency reserves

Consider a government that purchases foreign reserves $A_t^*\geq 0$ at $t-1$ and finances the purchase with lump sum taxes.[17] In period t, the reserves are rebated to consumers through a lump sum transfer. Combining the government budget constraint and the household

[17] Assuming the government borrows to finance the reserve accumulation would deliver identical outcomes to the lump-sum tax as long as it borrows domestically or borrows externally from the same intermediaries that lend to consumers.

budget constraint, we arrive at a country's budget constraint in period $t-1$:

$$\frac{1}{1+i^*_{t-1}}(A^*_t + a^*_t) - \frac{1}{1+\hat{i}^*_{t-1}} b^*_t + c^T_{t-1} = y^T_{t-1}. \tag{14}$$

If $b^*_t > 0$ and $a^*_t = 0$, an increase in government reserves induces a loss of resources for the small open economy. To see this, notice that if the government increases A^*_t by one unit and the consumers keep the same level of consumption, they need to increase borrowing by $(1+\hat{i}^*_{t-1})/(1+i^*_{t-1})$. Hence, the net positions in period t deteriorate by $(\hat{i}^*_{t-1} - i^*_{t-1})/(1+i^*_{t-1})$. To the extent that consumers wish to smooth consumption, the taxes required to finance the FX intervention will induce consumers to borrow more indeed and generate a loss of resources for the small open economy. This cost of FX interventions emerge because the interest rate at which consumers borrow from intermediaries is larger than the return on reserves that the government earns, a point made in Cavallino (2019), Amador, Bianchi, Bocola, and Perri (2020) and Fanelli and Straub (2021) which microfounds the argument on the quasi-fiscal costs of FX interventions in an earlier literature (Calvo, 1991; Kletzer and Spiegel, 2004; Devereux and Yetman, 2014).[18]

The potential role for the accumulation of foreign reserves emerges because by accumulating foreign currency reserves, the government can increase the net foreign asset position of the country and help mitigate the trade-offs described above. Notice that consumers are not borrowing-constrained, so they can in principle offset the accumulation of reserves by borrowing more. However, as consumers collectively increase their borrowing, they move up the interest rate in the schedule, making it more expensive for an individual household to borrow at the margin. Overall, consumers end up borrowing more in equilibrium, but there is still an increase in the net foreign asset position. In this sense, reserves have a macroprudential role, as examined in Arce, Bengui, and Bianchi (2019), Davis, Devereux, and Yu (2020) and Kim and Zhang (2020), which study pecuniary externalities like the ones we will discuss in Section 5.5.

Formally, the planner's problem that can choose the nominal interest and foreign currency reserves can be formulated as follows

$$\max_{c^T_{t-1}, c^N_{t-1}, A^*_t, b^*_t, e_{t-1}, w_{t-1}} (1-\beta)\, U\left(c^T_{t-1}, c^N_{t-1}\right) + \beta \mathbf{E}_{t-1}\left[V\left(A^*_t - b^*_t, \omega_t\right)\right], \tag{15}$$

[18]The presence of endogenous sovereign risk can generate additional costs of intervention, even if the expected return on borrowing and savings are the same for the small open economy. See Alfaro and Kanczuk (2009), Bianchi, Hatchondo, and Martinez (2018), Bianchi and Sosa-Padilla (2020) and Samano (2021) for models with government debt and reserve accumulation.

subject to the constraints

$$
\begin{aligned}
\frac{1}{1+i^*_{t-1}}A^*_t - \frac{1}{1+\hat{i}^*_{t-1}}b^*_t + c^T_{t-1} = y^T_{t-1}, \\
\frac{c^N_{t-1}}{c^T_{t-1}} = \frac{1-\phi}{\phi}\left(\frac{w_{t-1}}{e_{t-1}}\right)^{-\frac{1}{\rho}}, \\
c^T_{t-1} + \frac{A^*_t}{1+i^*_{t-1}} - y^T_{t-1} = \omega_t\left(\hat{i}^*_t - i^*_t\right), \\
c^N_{t-1} \le \bar{n}, \quad w_{t-1} \ge \underline{w}, \\
U_T\left(c^T_{t-1}, c^N_{t-1}\right) = \beta\left(1+\hat{i}^*_{t-1}\right)\mathbf{E}_{t-1}\left[U_T\left(c^T_t, c^N_t\right)\right].
\end{aligned}
\tag{16}
$$

where the value function V is defined as in (8).

Relative to the planner's problem in 12, the FX planner's problem features an additional constraint, (16), which is the consumers' Euler equation. Lacking a tax on debt, the government cannot choose, in effect, borrowing on behalf of consumers. It should be clear that to the extent that the government uses a strictly positive tax on debt in the previous section, constraint (16) will bind and the level of welfare would be strictly lower under FX than under taxes on debt. The government here can achieve an increase in the net foreign asset position by accumulating reserves, like in the case of taxes, but in the presence of the losses described above, an FX intervention is dominated by capital controls. FX intervention constitutes in a sense a third-best policy instrument, an argument also made in Amador, Bianchi, Bocola, and Perri (2020); Fanelli and Straub (2021).

In general, the optimal policy can be consistent with an intervention or lack thereof. Intuitively, the government is trading-off in principle two first-order welfare effects: the aggregate demand externality and the FX losses. However, starting from an allocation in which $b^*_{t+1} = 0$ and with a probability of positive unemployment in period t, one can show that the government will accumulate reserves as the costs are second order evaluated at the allocation without intervention.

It also follows that if the government could use here both capital control taxes and FX intervention, the latter would actually not be used. In practice, governments do use both instruments—and as observed in Ilzetzki, Reinhart, and Rogoff (2019) and discussed in Section 2.2, currently the level of capital controls is lower and the level of FX reserves is higher than in the 80s, suggesting a revealed preference of policy makers for FX intervention.

In the integrated policy framework of Basu, Boz, Gopinath, Roch, and Unsal (2020), the government does use both policies actively under what they refer to as "shallow" capital markets. Like in Gabaix and Maggiori (2015), their framework allows for noisy traders and for the government can access international financial markets without necessarily going through the intermediaries. The former implies that the government is actually able to profit by intervening in the FX market. The latter implies that the government is able to circumvent the costs for consumers of borrowing through intermediaries in a shallow capital market. Here instead we have maintained the assumption that all investors are fully rational and the government has access to the same foreign bond as the private sector, and so capital controls dominate FX intervention.

Clearly, however, we are abstracting from aspects that may make capital controls costly. For example, if capital controls are costly to enforce, this can lead to circumvention costs, as in Bengui and Bianchi (2018). They show how the optimal tax on debt has to be designed to account for the presence of leakages and find that quantitatively, capital controls remain quite effective in reducing the likelihood of sudden stops for moderately large leakages. Similarly, a capital control that applies equally to all agents, may lead to other unintended heterogeneous consequences on firms, as in Andreasen, Bauducco, Dardati, and Mendoza (2021). While capital controls remain desirable, capital controls do not necessarily dominate FX intervention in these circumstances. At the same time, the costs of FX intervention are mitigated when domestic agents face themselves credit constraints. If consumers cannot offset the accumulation of reserves by increasing borrowing, this would limit the costs of FX interventions. In fact, Arce, Bengui, and Bianchi (2019) establish an equivalence between capital controls and FX intervention in a framework with borrowing constraints on consumers and "deep" international capital markets.

Finally, it is worth highlighting that the argument that restrictions in borrowing help to reduce unemployment and the devaluation costs, as two sides of the same coin, apply to reserve accumulation. In this vein, Bianchi and Sosa-Padilla (2020) show that in response to an adverse shock, a government with a higher fear of floating cost and subject to sovereign risk finds it optimal to deplete a larger share of the stock of accumulated reserves and to depreciate by less the exchange rate. By the same token, a government with a larger stock of reserves depreciates less the exchange rate and faces lower unemployment and sovereign spreads.

5.4 Prudential Policies: Numerical Examples

In this section, we provide a numerical illustration of the role of prudential policies. To motivate borrowing at the initial period, we assume a temporarily low discount factor from $t-1$ to time t. We compare the economy under laissez-faire with the economies with

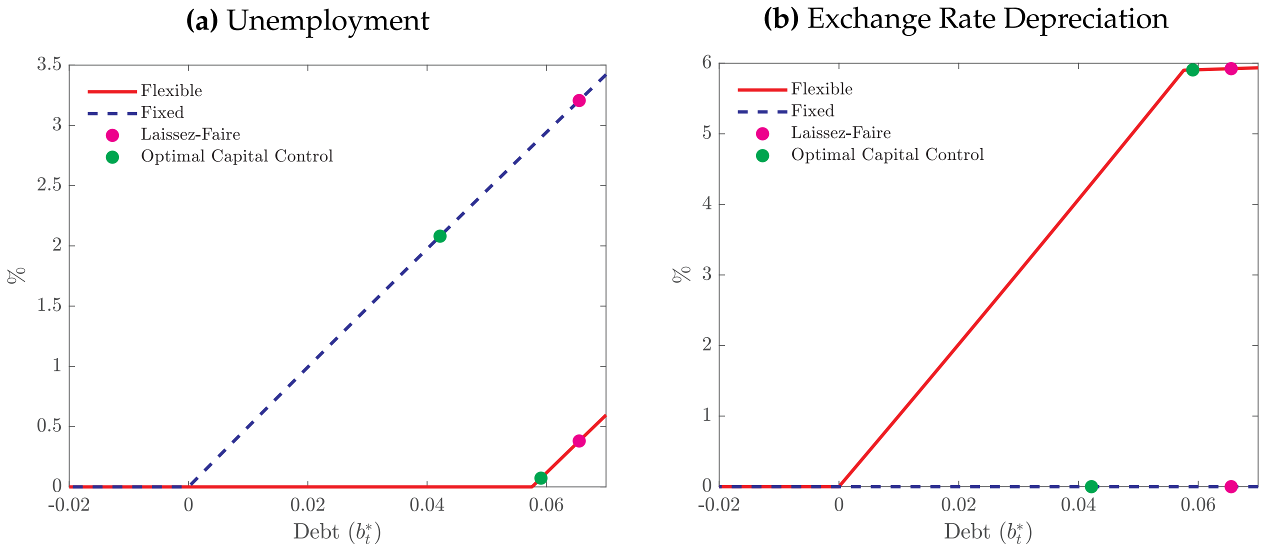


Figure 6: Numerical Simulations of Capital Controls

Note: *The lines in the figure show unemployment and the exchange rate for continuation equilibrium in period t as a function of initial foreign debt* b_t^* *when* $\omega_t = \omega^L$. *The solid dots indicate the debt choices of period* $t-1$ *under laissez faire and optimal capital controls . Parameter values are as follows:* $\bar{w} = 1.0, R^* = 1.04; \beta = 0.96; \beta_0 = 0.87; \psi = 2; \phi = 0.5; \rho = 2; \sigma = 2; \pi = 0.1; \omega^L = 0.5; \omega^H = \infty$.

optimal prudential capital controls and FX intervention.

We analyze first prudential capital controls. In this case, we assume that in period $t-1$, the economy faces a perfectly elastic supply of funds, $\omega = \infty$. This way, the only externality at $t-1$ is the aggregate demand externality. Meanwhile, the shock ω in period t can take two values, $\omega = 0.5$ or $\omega = \infty$, with probabilities π and $1-\pi$. In case of the adverse shock, the economy experiences a capital flight in period t and after $t+1$ the economy is in steady state. In case of the favorable shock, the economy's state variables remain constant from period t onward. For illustration, we compare our baseline economy with a fear of floating cost with a fixed exchange rate economy, which corresponds to $\Psi = \infty$.

Figure 6 shows the results. The figure presents the time t optimal policies by the government as a function of foreign currency debt accumulated in period $t-1$ when the negative shock to ω is realized. The left panel presents the level of unemployment, and the right panel shows the exchange rate depreciation. As described above, a higher level of debt worsens the dilemma for the government. This is reflected in the fact that both unemployment and the exchange rate are increasing in b_t^*. Meanwhile, the solid dots indicate the actual choices in an unregulated equilibrium and in the economy with optimal capital controls.

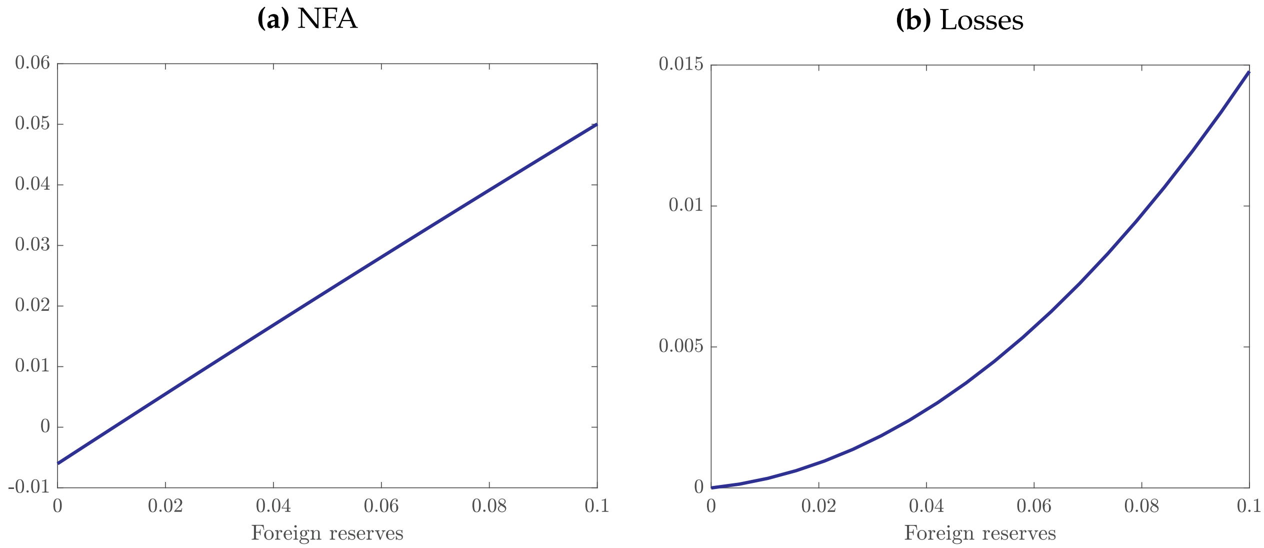


Figure 7: Numerical Simulations of FX interventions

Note: *The figure shows the net foreign asset position at the end of period $t-1$ (panel a) and the losses incurred from the interventions (panel b).*

Consider the economy with a fixed exchange rate, represented by the blue dotted line. As long as the economy has positive net foreign assets (i.e., negative b^*), the economy is at full employment. Without any leverage, the negative shock to ω does not generate any contractionary effects on economic activity: while demand falls, the wage has room to fall before it hits $\bar{w}$. When the economy is leveraged, however, the negative shock to ω generates a larger contraction in aggregate demand which translates into a binding wage rigidity. Absent an exchange rate depreciation, this translates into positive levels of unemployment. In terms of optimal prudential policy, as the solid dots in the figure indicate, the planner (green dot) chooses a lower value of debt in period $t-1$ and therefore is able to reduce the level of unemployment from about 3% to 2%.

Consider the economy under a flexible exchange rate. While the government can now potentially achieve full employment by depreciating the currency, this is not necessarily optimal in the presence of fear of floating costs. For debt levels below 0.05, the government does depreciate enough to achieve full employment, but for higher levels of debt, the government moderates the depreciation and tolerates higher unemployment. The solid dots indicate that, the planner again chooses lower debt in period $t-1$ compared with the debt levels under laissez-faire. This results not only in lower unemployment but also in lower exchange rate depreciation. Notice that as the solid pink dots indicate, b^* is the same under fixed and flexible exchange rates for the laissez-faire economy. This result is a consequence of the parameterization we use with separable preferences.

We now analyze the effects of FX intervention and now consider a finite value for ω_{t-1}. As analyzed in Section 5.3, the presence of an upward supply of funds imply that when the government accumulates reserves, consumers increase borrowing but less than one to one. Panel (a) of Figure 7 shows that indeed the level of the equilibrium net foreign asset position (NFA) increases when the government accumulates reserves, but at a slope lower than one. Meanwhile, panel (b) shows the FX losses as a result of the intervention.

5.5 Pecuniary Externalities

We now turn to analyze pecuniary externalities as a rationale for prudential policies. As we will see, pecuniary externalities and aggregate demand externalities share a common blueprint. Namely, consumers do not internalize how their borrowing decisions affect certain aggregate general equilibrium effects. In turn, the presence of nominal frictions, in the case of aggregate demand externalities, and financial frictions, in case of pecuniary externalities imply that fluctuations in borrowing decisions may mitigate or exacerbate those frictions. In particular, a social planner internalizes how higher resources in a state with depressed demand may help boost output or relax financial frictions.

To isolate the scope for pecuniary externalities, we now consider a real version of the model presented above and abstract from financial intermediaries. That is, prices are flexible, monetary policy is neutral and the SOE faces a perfectly elastic interest rate. We introduce financial frictions by following a workhorse model in the literature and assume that consumers can borrow up to a fraction of their individual current income (Mendoza, 2002; Bianchi, 2011). Aside from these features, the model is identical to the one presented above.

In this case, now household borrowing is limited by

$$\frac{b^*_{t+1}}{1+i^*_t} \leq \kappa_t \left(y^T_t + \frac{p^N_t}{e_t} y^N \right), \tag{17}$$

a constraint we assume may bind in period t depending on the realization of the shock κ_t. Equation (17) can be motivated from a contractual problem in which default occurs at the end of the period and consumers lose a fraction κ of their income if they choose to default. Empirically, it captures that income is a key determinant of credit market access.[19] In addition, this a feature that has been shown to be key in accounting for the magnitudes of sudden stops and the cyclicality of capital flows (Mendoza, 2002; Bianchi, 2011).

[19]Notice that even if investors do not value non-tradable goods, they can sell the goods in domestic markets in exchange for tradable goods and repatriate the proceeds abroad.

From the balance of payments equation (10), we can see again that a contraction in the right-hand side of (17) will generate a reduction in demand for consumption. In equilibrium, the decline in demand must lead to a reduction in the relative price of non-tradables because the market for non-tradables clears domestically. In turn, the decline in the relative price of non-tradables triggers a contraction in the borrowing capacity, which leads to an even larger collapse in the relative price. Through this vicious circle, often called Fisherian deflation, a small shock can lead to strong amplification.

The externality here arises because consumers do not internalize how borrowing more in good times, when the borrowing constraint does not bind, imply that they will cut more demand in bad times, when the constraint binds, thus triggering a sharper contraction in the borrowing capacity of all consumers. Formally, proceeding analogously to Proposition 3, we obtain, as shown in Bianchi (2011), the following optimality condition for the planner at $t-1$:

$$U_T\left(c_{t-1}^T, c_{t-1}^N\right) = \left(1+i_{t-1}^*\right)\beta\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right) + \kappa\left(\frac{p_t^N c_t^N}{e_t c_t^T}\right)\rho\mu_t\right], \tag{18}$$

where $(1-\beta)\mu_t$ denotes the Lagrange multiplier on (17). The intuition for this optimality condition is similar to the one provided above. When the government borrows one less unit at $t-1$, it internalizes that lower debt repayments in time t will increase consumption and have a positive macroeconomic externality—in this case, through a higher relative price of non-tradables, which helps relax the borrowing constraint for all consumers.

Underlying this externality, often labeled a "pecuniary fire-sale externality" or "systemic risk externality" is a large literature on macroprudential policy in both open and closed economies. Similar externalities emerge for example when assets rather than income serve as collateral, as in Bianchi and Mendoza (2018) and Jeanne and Korinek (2019), or more generally when there is a financial accelerator mechanism by which lower demand feeds back into financial markets by tightening financial constraints.[20,21]

The optimal policy in this environment is to tax borrowing at $t-1$, when the constraint does not bind, whenever there is a positive probability of a binding constraint in period t. In short, the government prudentially restricts the build-up of credit to reduce the frequency and severity of financial crises.

5.6 Interactions between aggregate demand and pecuniary externalities

In Sections 5.2-5.3, the fear of floating component Ψ was critical to generate a monetary policy dilemma, which provides a rationale for the use of prudential policies. In this section, we argue that a monetary policy dilemma may emerge endogenously from the interaction between aggregate demand externalities and pecuniary externalities.

To explore this, we combine the nominal rigidity from our baseline model (setting $\Psi = 0$) and the financial friction from the previous section. We follow in this regard the lead of Ottonello (2021); Farhi and Werning (2016); Coulibaly (2021); Basu, Boz, Gopinath, Roch, and Unsal (2020). As they have argued, the optimal policy under a flexible exchange rate does not necessarily achieve full employment. The reason is that a nominal depreciation would lead to a real depreciation and possibly tighten financial constraints. This occurs in particular under the assumption that $\rho > 1$, so that price effects dominate quantity effects.[22]

[20] As noted in the literature, it is crucial for the existence of a pecuniary externality that the current price enters the borrowing constraint. If future prices were to enter the constraint instead, there would be no Fisherian deflation amplification mechanism because there would be no feedback between the contraction in demand today and consumers' borrowing capacity. Lacking this feedback, the model would fail to account for a current account reversal in response to an income shock. In line with this, Lian and Ma (2021) provide a granular empirical analysis documenting the prevalence of borrowing constraints linked to current earnings. In general, the borrowing constraint could depend both on current and future prices. Ottonello, Perez, and Varraso (2021) compare the normative implications of specifications where only the current price enters the borrowing constraint and where only the future price does. They show that when only future prices enter the constraint, the planner under discretion does not use capital controls.

[21] Other dimensions of this externality, reviewed in Bianchi and Mendoza (2020), are the subject of a large literature including Benigno, Chen, Otrok, Rebucci, and Young (2013; 2016; 2019); Ottonello (2021); Basu, Boz, Gopinath, Roch, and Unsal (2020); Coulibaly (2021); Schmitt-Grohé and Uribe (2016); Chi, Schmitt-Grohé, and Uribe (2021). Basu, Boz, Gopinath, Roch, and Unsal (2020) in particular, explore interactions between aggregate demand externalities and pecuniary externalities and cover a broad set of policies, including monetary policy, FX intervention and capital controls.

[22] In addition to the references mentioned above, the challenges of using monetary policy to stabilize the economy in the presence of dollar debt and balance sheet constraints has been studied prominently in an earlier literature following the East Asian crisis (Cook, 2004; Cespedes, Chang, and Velasco, 2004; Christiano, Gust, and Roldos, 2004; Krugman, 1999; Aghion, Bacchetta, and Banerjee, 2001). Another related literature emphasizes contractionary depreciations originated from the adverse effects of higher production on terms of trade (Corsetti, Pesenti, Roubini, and Tille, 2000; Tille, 2001; Auclert, Rognlie, Souchier, and Straub, 2021)

Let us consider the optimal exchange rate policy at time t. Analogously to the ex post problem (8), we can write

$$V_t(a_t^* - b_t^*, \kappa_t) = \max_{c_t^T, c_t^N \le \bar{n}, e_t, w_t} (1-\beta)\, U\left(c_t^T, c_t^N\right) + \beta U\left(c_{t+1}^T, \bar{n}\right)$$

subject to the constraints

$$(1-\beta)\left(c_t^T - y_t^T - a_t^* + b_t^*\right) + \frac{1}{1+i_t^*}\left(c_{t+1}^T - y^T\right) = 0,$$

$$c_t^N = \frac{1-\phi}{\phi}\left(\frac{w_t}{e_t}\right)^{-\frac{1}{\rho}} c_t^T,$$

$$c_t^T - y_t^T - a_t^* + b_t^* \le \kappa_t\left(y^T + \frac{w_t}{e_t} c_t^N\right).$$

Replacing c_t^N in the last constraint shows that for given c^T, a depreciation tightens the collateral constraint when $\rho > 1$. Assuming that the constraint $c_t^N \le \bar{n}$ is slack, we obtain the following first-order condition with respect to w_t/e_t

$$-U_N\left(c_t^T, c_t^N\right) + \kappa\mu_t\,(\rho - 1)\,\frac{w}{e_t} = 0 \tag{19}$$

where $(1-\beta)\mu_t$ denotes the shadow value from relaxing the collateral constraint.

Equation (19) shows that if the collateral constraint is sufficiently binding, the optimal allocation is consistent with a departure from full employment.

Going back to the problem the government at $t-1$, we can then examine what this implies for the optimal prudential policy. Following the same steps above, we can obtain again the overborrowing pecuniary externality, embedded in (18). Furthermore, if we use (19), we can also obtain the following intertemporal Euler equation:

$$U_T\left(c_{t-1}^T, c_{t-1}^N\right) = \beta(1+i_{t-1}^*)\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right) + \frac{\rho}{\rho-1}\iota_{n<\bar{n}} U_N\left(c_t^T, c_t^N\right)\frac{c_t^N}{c_t^T}\right] \tag{20}$$

Notice that this is a similar expression to (13), which highlighted the aggregate demand externality. Although the government can potentially implement full employment, it may choose not to do so. In this case, the government takes into account how ex ante reallocating consumption over time affects the degree of unemployment.[23]

[23] Bianchi and Coulibaly (2022) develop a theory of fear of floating using a related model allowing for the possibility of multiple equilibria. They establish that a fixed exchange rate may help avoid self-fulfilling crisis and that depreciations may be contractionary.

6 Extensions and Connections

In this section, we use the simple framework developed to discuss various advances in the literature around the prudential use of capital capital controls and foreign currency reserves.

6.1 Prudential monetary policy

Can monetary policy be used prudentially at $t-1$ to help with the policy dilemma at time t? In other words, is leaning against the wind desirable?

In the presence of capital controls, as in Section 5.2, the answer is no: monetary policy is a redundant instrument—the optimal monetary policy is to simply stabilize full employment. However, in the absence of capital controls, monetary policy may potentially have a role.

The interaction between capital controls and macroprudential policy is a theme tackled in Bianchi and Coulibaly (2021) in a similar setting to the one developed here, but where the government faces the possibility of a liquidity trap. The critical issue is that whether an increase in the interest rate is desirable or not, in the absence of capital controls, depends on two opposing forces. First, there is an intertemporal substitution effect by which given prices and income, households save more externally, tilting consumption towards the future. Second, there is an income general equilibrium effect by which the resulting contraction in current aggregate demand reduces output and leads to higher external borrowing. When the elasticity substitution over time exceeds the elasticity of substitution across goods, raising the interest rate can indeed help reduce borrowing and indirectly mitigate the aggregate demand externality. In Bianchi and Coulibaly (2021), there is also a possibility that a lower interest rate is welfare improving ahead of a liquidity trap. This is because overheating the economy leads to lower borrowing in a parameterization in which the elasticity substitution over time is lower than the elasticity of substitution across goods. This possibility does not emerge in the framework developed here because the labor supply is inelastic.

To make the intuition concrete, consider again the Euler equation for consumers(11). As argued above, if $\sigma = \rho$, tradable consumption would be independent of the path of non-tradables and therefore monetary policy would not affect capital flows, as observed by Lane (2001). On the other hand, if $U_{TN} > 0$, which under CES and CRRA, is given by $\sigma < \rho$, a decrease in non-tradable consumption generates a lower marginal utility from tradables and an increase in the trade surplus. Under these conditions, a tight monetary policy helps partially substitute for the use of capital controls by reducing capital inflows.

Monetary policy, however, is third-best in the sense that to achieve the desired reduction in capital inflows, it must generate a deviation from full employment.[24]

6.2 Outright Restrictions on Capital Outflows

We analyzed above a policy of taxing outflows or subsidizing inflows in period t as a way to stimulate aggregate demand and reduce unemployment. We argued that this policy has a side effect of raising the interest rate at which consumers borrow (and increasing the profits of intermediaries), and therefore has limited scope.

We now consider a different form of capital controls: we study a policy of outright restriction on capital outflows of the kind used by Malaysia during the East Asian crisis or by Iceland in 2008-2011. We assume that the government prevents investors from repatriating a fraction Λ_t of the proceeds from the loans that mature in period t. It is important to highlight that this government policy does not imply a default on foreign investors: investors can obtain the funds they are owed, but they cannot repatriate them abroad. Moreover, they can either roll over those bonds or lend domestically to other borrowers.

With the capital control on outflows, the investors' problem at time t is as follows. Taking as given $\hat{i}^*$, they must choose b_{t+1} so that

$$\max_{b^*_{t+1}} b^*_{t+1} - \frac{1+i^*_t}{1+\hat{i}^*_t} b^*_{t+1} - \frac{1}{\omega_t}\Phi\left(\frac{b^*_{t+1}}{1+\hat{i}^*_t}\right),$$

$$\text{subject to}$$

$$\frac{b_{t+1}}{1+\hat{i}^*_t} \geq \Lambda_t b_t$$

If the capital control constraint does not bind, we reach (1) as before. However, if the interest rate premia is such that $\hat{i}^*_t - i^*_t < \frac{1}{\omega_t}\Phi'\left(\Lambda_t b_t\right)$, banks will be at a corner where the government restriction is binding. Given the demand for loans, a tighter restriction reduces

[24] Bianchi and Coulibaly (2021)'s quantitative results suggest that this distinction is quantitatively important: the welfare costs of a liquidity trap are reduced by around 0.4 percentage points of permanent consumption when the government uses capital controls relative to the case in which the government uses only monetary policy. Schmitt-Grohe and Uribe (2016) also find substantial welfare gains from using capital controls under a fixed exchange rate.

the interest rate at which consumers borrow.[25] By imposing restrictions on capital outflows, the government is therefore able to boost private consumption and ameliorate the trade-off between the depreciation costs and unemployment.

There are of course reputation costs from these policies that we are not modelling explicitly. The point we make here is to articulate the benefits of such policies and to note that these benefits are especially large when there is a capital flight and the economy suffers from unemployment. Indeed, when the economy is facing a recession, the type of aggregate demand externality we discussed above, implies that there is a larger amplification resulting from the reduction in the interest rate premia. A further understanding of the workings of these type of capital control restrictions and the time inconsistency issues it raises is an interesting avenue for future research.

It is worth highlighting the differences in this type of capital control compared with other approaches in the literature. In Section 4.3, we describe a policy by which the government could tax outflows (or subsidize inflows). Under that policy, the government alters the return perceived by domestic consumers new lending/borrowing abroad, but foreign investors continue to receive the market rate without facing any restrictions. Existing studies featuring this policy are Schmitt-Grohe and Uribe (2016); Farhi and Werning (2017); Basu, Boz, Gopinath, Roch, and Unsal (2020); Bianchi and Coulibaly (2021). Perhaps, a closer mechanism to the outright capital control described here can be found in the sovereign default literature with nominal rigidities (Bianchi, Ottonello, and Presno, 2019; Arellano, Bai, and Mihalache, 2020; Bianchi and Mondragon, 2022; Bianchi and Sosa-Padilla, 2020; Na, Schmitt-Grohé, Uribe, and Yue, 2018). In the studies in this literature, repaying the external debt reduces aggregate demand and makes repayment more costly.[26] Thus, there are higher benefits to renege on investors during recessions. The key difference is that the capital control we describe here affects the interest rate on *new* bond issuances rather than the value of previous issuances.

[25]In the context of the analysis in Section 4.1, the market clearing rate is given by equating the supply of loans $\Lambda_t b_t^*$ to demand for loans derived. That is,

$$\Lambda_t b_t^* = \frac{\frac{y^T}{1+\hat{i}_t^*} - \beta^{\frac{1}{\sigma}} \left(1+\hat{i}_t^*\right)^{\frac{1}{\sigma}-1} \left(y^T - b_t^*\right)}{1 - \beta + \beta^{\frac{1}{\sigma}} \left(1+\hat{i}_t^*\right)^{\frac{1}{\sigma}-1}}.$$

[26]See Bianchi and Mondragon (2022) for a formal proof of how the default region expands under a fixed exchange rate regime.

6.3 Coordination problems

For the purpose of this chapter, we have focused on a small open economy. However, there have also been advances in the literature addressing questions such as: Are capital controls beggar thy neighbor or prosper thy neighbor? Are capital controls excessive from a global point of view? These are key issues at the heart of many debates on currency wars and capital control wars. As argued forcefully by Obstfeld, Shambaugh, and Taylor (2010); Blanchard (2021), the presence of spillovers do not warrant the need for coordination as Pareto improving policies may not be feasible. In this regards, Korinek (2016), considers a generic setting with various frictions and provides conditions for the need for coordination.

In the context of aggregate demand externalities, Acharya and Bengui (2018) studies a model with currency interventions and find that the coordinated optimal solution features larger capital flows towards the region that is outside a liquidity trap. Absent coordination, the region outside the liquidity trap desires to limit the imports to achieve an improvement in the terms of trade, hence limiting capital flows relative to the socially optimal allocation. Fornaro and Romei (2019) studies macroprudential policies and show they may backfire when applied at the world scale level. The logic is that macroprudential policies lead to a lower interest rate driving economies closer to the zero lower bound. Bianchi and Coulibaly (2021) provide a more benign view. They argue that capital controls may actually help prevent currency wars by endowing countries with another instrument to respond to foreign policies, and that the optimal coordinated policy calls for stimulating capital flows. In Caballero and Simsek (2020), national regulators have incentives to restrict capital inflows. This reduces the ability of other countries to deal with insufficient demand by retrenching capital flows from abroad, generating excessive capital controls at the aggregate level.

In the context of pecuniary externalities, Bengui (2014) studies a two-country model of international liquidity demand that features underinvestment in liquid assets. He shows that as national regulators use prudential capital controls to correct the externality, they also have incentives to manipulate the world interest rate during crises to shift surplus from foreign to domestic agents. Kara (2016) c find that relaxing regulatory standards in one country increases both the cost and the severity of crises for both countries. This is because more fire sales in one country reduce the absorbing financial capacity of global investors and lead to negative spillovers for another country facing fire sales. Jin and Shen (2020) tackle some of these mechanisms quantitatively. They show how restrictions in capital flows in some countries push capital flows to other countries by inducing a lower world interest rate and call for stronger interventions by other countries. Clayton and

Schaab (2020) consider a model with multinational banks and fire sales and examine the scope for coordination of various financial policies. They argue that Pigouvian taxation may obviate the need for coordination.

6.4 Alternative motives for capital controls

Our framework focused on aggregate demand externalities and pecuniary externalities as a rationale for the use of prudential capital controls. We discuss here other motives for capital controls not present in the framework we presented—this discussion is not meant to be exhaustive as the literature on capital controls is too vast to cover entirely.

Booms in capital inflows can create real exchange rate appreciation pressures, hurting the export sector and creating a Dutch disease that can generate a scope for capital controls to mitigate ex ante the appreciation (Caballero and Lorenzoni, 2014). Schmitt-Grohé and Uribe (2016) show that when there is a possibility of self-fulfilling crisis, capital controls may be necessary as off-equilibrium threats to rule out bad equilibrium. When there are expectations of bailouts, prudential capital controls can be displayed optimally to reduce moral hazard (McKinnon and Pill, 1999; Bianchi, 2016).

Another model that emphasizes the role of multiple equilibria in producing a capital flight crisis is Bocola and Lorenzoni (2020). The main observation in that paper is that prudential reserves may play a useful role even if they are never used on the equilibrium path, as their presence ensures a credible commitment by the government to intervene and eliminate the bad equilibrium.

On a more behavioral side, capital inflows can be excessive due to optimistic beliefs, generating scope for capital controls to moderate the increase in consumption (Bianchi, Boz, and Mendoza, 2012).[27]

In addition to prudential reasons, capital controls can also help offset potential negative redistribution effects from financial integration. In Mendoza, Quadrini, and Rios-Rull (2009), for example, financial market integration leads to a reduction in investment and wages, leaving consumers with low wealth worse off. The analysis of Fanelli and Straub (2021) also suggests a scope for capital controls when poor households allocate a higher share of consumption towards tradables.

[27] For behavioral models of capital flows and capital flights see also Laibson and Mollerstrom (2010).

7 Empirical Findings on Effectiveness

The models presented provide clear policy prescriptions: capital controls or foreign currency reserves should be deployed when there is an expectation that lower aggregate demand in the future will generate damage to the real economy, arising from either nominal rigidities or financial frictions. Based on this theoretical perspective, we can now re-examine the empirical findings highlighted in Section 2.2 and address two key questions: First, are these policies deployed in practice in the way suggested by the theory? And, empirically, do they have the effects predicted by the theory?

The key hurdle in addressing these questions is that in practice, capital controls come in very different forms. While in models it is possible to conceptualize the stance of capital controls based on an effective tax on capital flows, the high level of aggregation in the theory prevents a detailed institutional analysis regarding the observed rich variety of capital flows and capital controls. Moreover, the aggregated measures of capital controls in empirical work are to a large extent qualitative and based on how extensive they are used but not how intensively. This is in contrast with the fiscal and monetary policy literature, in which the mapping from the model to the data is relatively more straightforward.

Notwithstanding this hurdle, there is an active literature at this intersection. Fernandez, Rebucci, and Uribe (2015) observe that against the backdrop of theoretical prescriptions from the literature (e.g. Bianchi, 2011; Schmitt-Grohe and Uribe, 2016), capital controls vary very little over the business cycle or with movements in capital flows. One possible answer of course, is that theoretical developments on the prudential use of these policies are fairly recent, and not yet reflected in the available data. But is also possible that theoretical models fail to capture important elements considered by policymakers, either those regarding the intricacies of the financial cycle or those concerned with political economy. Quantitative advances in the literature are critical to improving our understanding of this apparent disconnect.[28] For example, Flemming, L'Huillier, and Piguillem (2019) and Seoane and Yurdagul (2019) argue that incorporating trend shocks can make capital controls more countercyclical.

Turning to the second question, a vast literature has studied how effective capital flow management policies are in ultimately affecting capital flows. The evidence suggests that capital controls and foreign currency interventions are effective in influencing aggregate variables, but there is a wide range of quantitative estimates on the magnitude and the

[28] Erten, Korinek, and Ocampo (2021) highlight that the disconnect may be exacerbated by data limitations—in particular, because of the use of annual data and the reliance on capital control measures on the extensive margin.

persistence of the effects depending on samples and variables. A usual concern is that agents may be able to circumvent the regulation and undermine the effectiveness of capital controls.

Overall, the evidence on aggregate effects of capital controls provides a wide range of quantitative estimates depending on the type of capital control considered (e.g., inflows, outflow, FX-related interventions, financial sector restrictions), the type of capital flow (bond, equities, short-term, long-term), the duration of the controls (temporary vs. permanent), the prices of study (nominal and real exchange rate, stock returns), and the quantities of study (credit, investment, employment). The pre-GFC conventional wisdom on the effectiveness of capital controls is perhaps best summarized in the work of Magud, Reinhart, and Rogoff (2011), who provide a systematic analysis of 30 available studies. They conclude that capital controls affect the composition of capital flows towards longer maturity (but have modest effects on the current account), reduce real exchange rate pressures, and allow for a more independent monetary policy by raising the domestic real rate.

The post-GFC literature on the effectiveness of capital controls is large and growing fast. Like all the empirical evidence on the effects of macroeconomic policies, this literature suffers from an endogeneity problem. In particular, it is likely that the measured effects of capital controls are biased downwards as countries apply capital controls at points in time when they are facing too many capital inflows. The literature has attempted to find ways to alleviate these endogeneity concerns, among other ways, by using propensity score matching (Forbes, Fratzscher, and Straub, 2015; Forbes, Fratzscher, Kostka, and Straub, 2016) or comparing the effects of exogenous credit supply shocks for countries that start with low or high capital controls (Zeev, 2017), among other ways.

The literature has increasingly resorted to micro data to assess the effects of capital controls. One of the first papers in this vein is Forbes (2007), who argued that the Chilean capital control "encaje" lead to a tightening of financial conditions that disproportionately affected small- and medium-sized firms. Andreasen, Bauducco, and Dardati (2020) examines also the Chilean example and find heterogenous effects across exporting and non-exporting firms. In particular, they argue that exporting firms operating in more capital-intensive sectors were more negatively affected than exporting firms operating in less capital-intensive sectors, but the opposite pattern was observed across non-exporting firms. Alfaro, Chari, and Kanczuk (2017) finds that there is a statistically significant drop in cumulative abnormal returns following capital control announcements in Brazil. In addition, they argue that large firms and the largest exporting firms appear less negatively affected compared with firms dependent on external finance.

Several papers are also examining granular firm-level bank data from the credit register to evaluate the effects of capital controls. For example, using granular data on firm-level bank-debt inflows and the Colombian credit registry, Fabiani, López, Peydró, and Soto (2018a) that the application of unremunerated reserve requirements (URR) in Colombia in 2007 was successful in reducing foreign debt inflows, with stronger effects for companies that used to rely heavily on this form of external financing. On the other hand, Keller (2018) found that restrictions in forward contracts in Peru had the unintended consequence of generating an increase in dollar denominated lending. Using a database similar to the one in Fabiani, López, Peydró, and Soto (2018a), Fabiani, López, Peydró, and Soto (2018b) argue that capital controls have strengthened the pass through from monetary policy to domestic lending rates.

The reallocation effects and the tightening of financial conditions that have been documented in the literature are often regarded, in policy spheres, as a negative consequence of capital control and evidence that capital controls are ineffective. This conclusion is not warranted in our view. The fact that we see reallocation effects and a tightening of financial conditions implies that capital controls are not entirely leaked and deliver precisely the desired outcome of tightening the expansion in credit.

Although studies that resort to micro data are not immune to endogeneity concerns highlighted for studies using aggregate data, they can provide richer information about the mechanisms by which policies ultimately affect aggregate outcomes. The increasing availability of micro-level data suggests that this is an area of research that will be growing over the coming years. A promising area for research is to leverage upon the empirical findings to build structural models that can be disciplined in terms of the partial equilibrium effects to tackle the aggregate effects of capital flow management policies. Research efforts in this direction are pursued in Andreasen, Bauducco, and Dardati (2020). Another interesting area for future research regards a better understanding of the empirical links between capital controls and other policies. See for example Takáts and Temesvary (2021) for recent work assessing the interaction between monetary and macroprudential policy.

The literature on the effectiveness of foreign exchange interventions is also quite vast (see Maggiori 2021 in this volume). Most of the literature has focused on the effects over the level and volatility of exchange rates (e.g. Blanchard, Adler, and de Carvalho Filho, 2015). Fratzscher, Gloede, Menkhoff, Sarno, and Stöhr (2019) use daily data to provide a broad analysis of FX interventions in 33 countries and find evidence that interventions do have significant effects on exchange rates. They are particularly significant when interventions are large and announced. Arango-Lozano, Menkhoff, Rodríguez-Novoa, and Villamizar-Villegas (2020) provide a meta-analysis based on 279 reported effects from 74 distinct empirical studies and covering 19 countries from 1970 to the present. They also report that FX interventions have significant effects and find they are larger in advanced economies than in emerging economies and in economies with more limited financial openness.

Overall, the evidence suggests that capital controls and foreign exchange interventions do affect macro variables. However, the jury is still out in terms of how large and persistent the effects are. As countries continue to use these policies and researchers are able to exploit richer data and empirical methods, we expect that the field will gain a better understanding of the transmission channels of capital controls.

8 Conclusions

The last decade has seen the emergence of a growing body of research on prudential capital controls and foreign currency reserves. In this chapter, we review the historical background of these policies, present the main stylized facts on their use, and provide a simple model to articulate the main theoretical insights of the new literature.

Much work remains to be done. On the empirical front, we expect to see more work examining the short-term and long-term effects of capital controls and foreign currency reserves, especially considering the increasing experience in the use of the policies and the availability of richer micro and macro data sets. On the theoretical front, a deeper understanding of the fear of floating phenomenon is warranted. We also see it as a promising avenue to bring additional micro-level data for the quantitative development of theoretical models. Finally, following the paradigm of integrated policy frameworks of Basu, Boz, Gopinath, Roch, and Unsal (2020), a vital agenda is to investigate further how the presence of multiple frictions affects the optimal mix of policies.

References

ACHARYA, S., AND J. BENGUI (2018): "Liquidity traps, capital flows," *Journal of International Economics*, 114, 276–298.

ACOSTA-HENAO, M., L. ALFARO, AND A. FERNÁNDEZ (2020): "Sticky Capital Controls," Discussion paper, National Bureau of Economic Research.

AGHION, P., P. BACCHETTA, AND A. BANERJEE (2001): "Currency crises and monetary policy in an economy withcredit constraints," *European Economic Review*, 45, 1121–1150.

AIZENMAN, J., AND J. LEE (2007): "International Reserves: Precautionary Versus Mercantilist Views, Theory and Evidence," *Open Economies Review*, 18(2), 191–214.

ALFARO, L., A. CHARI, AND F. KANCZUK (2017): "The real effects of capital controls: Firm-level evidence from a policy experiment," *Journal of International Economics*, 108, 191–210.

ALFARO, L., AND F. KANCZUK (2009): "Optimal reserve management and sovereign debt," *Journal of International Economics*, 77(1), 23–36.

ALVAREZ, F., A. ATKESON, AND P. J. KEHOE (2009): "Time-varying risk, interest rates, and exchange rates in general equilibrium," *The Review of Economic Studies*, 76(3), 851–878.

AMADOR, M., J. BIANCHI, L. BOCOLA, AND F. PERRI (2020): "Exchange rate Policies at the Zero Lower Bound," *The Review of Economic Studies*.

ANDREASEN, E., S. BAUDUCCO, AND E. DARDATI (2020): "Capital controls and firm performance," ILADES-UAH Working Papers inv331, Universidad Alberto Hurtado/School of Economics and Business.

ANDREASEN, E., S. BAUDUCCO, E. DARDATI, AND E. G. MENDOZA (2021): "Beware the Side Effects: Capital Controls Cause Misallocation and Reduce Welfare," Mimeo, Central Bank of Chile.

ANZOATEGUI, D. (2019): "Sovereign Spreads and the Effects of Fiscal Austerity," .

ARANGO-LOZANO, L., L. MENKHOFF, D. RODRÍGUEZ-NOVOA, AND M. VILLAMIZAR-VILLEGAS (2020): "The effectiveness of FX interventions: A meta-analysis," *Journal of Financial Stability*, p. 100794.

ARCE, F., J. BENGUI, AND J. BIANCHI (2019): "A macroprudential theory of foreign reserve accumulation," Discussion paper, National Bureau of Economic Research.

ARELLANO, C., Y. BAI, AND G. P. MIHALACHE (2020): "Monetary policy and sovereign risk in emerging economies (nk-default)," Discussion paper, National Bureau of Economic Research.

AUCLERT, A., M. ROGNLIE, M. SOUCHIER, AND L. STRAUB (2021): "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel," Discussion paper, National Bureau of Economic Research.

BASU, S. S., E. BOZ, G. GOPINATH, F. ROCH, AND F. UNSAL (2020): "A conceptual model for the integrated policy framework," .

BENGUI, J. (2014): "Macro-prudential policy coordination," Mimeo, University of Montreal.

BENGUI, J., AND J. BIANCHI (2018): "Macroprudential policy with leakages," Discussion paper, NBER Working Paper No.25048.

BENIGNO, G., H. CHEN, C. OTROK, A. REBUCCI, AND E. R. YOUNG (2013): "Financial crises and macro-prudential policies," *Journal of International Economics*, 89, 453–470.

——— (2016): "Optimal capital controls and real exchange rate policies: A pecuniary externality perspective," *Journal of Monetary Economics*, 84, 147–165.

——— (2019): "Optimal Policy for Macro-Financial Stability," Federal Reserve Bank of New York Staff Reports, no. 899.

BIANCHI, J. (2011): "Overborrowing and Systemic Externalities in the Business Cycle," *American Economic Review*, 101, 3400–3426.

——— (2016): "Efficient bailouts?," *American Economic Review*, 106(12), 3607–59.

BIANCHI, J., E. BOZ, AND E. G. MENDOZA (2012): "Macro-Prudential Policy in a Fisherian Model of Financial Innovation," NBER Working Paper 18036.

BIANCHI, J., AND L. COULIBALY (2021): "Liquidity Traps, Prudential Policies, and International Spillovers," Mimeo, Federal Reserve Bank of Minneapolis.

——— (2022): "A theory of fear of floating," Mimeo, Federal Reserve Bank of Minneapolis.

Bianchi, J., J. C. Hatchondo, and L. Martinez (2018): "International reserves and rollover risk," *American Economic Review*, 108(9), 2629–70.

Bianchi, J., and E. G. Mendoza (2018): "Optimal time-consistent macroprudential policy," *Journal of Political Economy*, 126(2), 588–634.

——— (2020): "A fisherian approach to financial crises: Lessons from the sudden stops literature," *Review of Economic Dynamics*, 37, S254–S283.

Bianchi, J., and J. Mondragon (2022): "Monetary independence and rollover crises," .

Bianchi, J., P. Ottonello, and I. Presno (2019): "Fiscal stimulus under sovereign risk," NBER Working Paper No. 26307.

Bianchi, J., and C. Sosa-Padilla (2020): "Reserve Accumulation, Macroeconomic Stabilization and Sovereign Risk," Mimeo, Federal Reserve Bank of Minneapolis.

Blanchard, O. (2021): "Currency wars, coordination, and capital controls," in *The Asian monetary policy forum: Insights for Central Banking*, pp. 134–157. World Scientific.

Blanchard, O., G. Adler, and I. de Carvalho Filho (2015): "Can foreign exchange intervention stem exchange rate pressures from global capital flow shocks?," Discussion paper, National Bureau of Economic Research.

Bocola, L., and G. Lorenzoni (2020): "Financial crises, dollarization, and lending of last resort in open economies," *American Economic Review*, 110(8), 2524–57.

Broner, F., T. Didier, A. Erce, and S. L. Schmukler (2013): "Gross capital flows: Dynamics and crises," *Journal of Monetary Economics*, 60(1), 113–133.

Bussiere, M., G. Cheng, M. Chinn, and N. Lisack (2013): "Capital Controls and Foreign Reserve Accumulation: Substitutes or Complements in the Global Financial Crisis?," Mimeo, Bank of France.

Caballero, R. J., and A. Krishnamurthy (2003): "Excessive Dollar Debt: Financial Development and Underinsurance," *The Journal of Finance*.

Caballero, R. J., and G. Lorenzoni (2014): "Persistent Appreciations and Overshooting: A Normative Analysis," *IMF Economic Review*, 62(1), 1–47.

Caballero, R. J., and A. Simsek (2020): "A model of fickle capital flows and retrenchment," *Journal of Political Economy*, 128(6), 2288–2328.

CALVO, G. A. (1991): "The perils of sterilization," *Staff Papers*, 38(4), 921–926.

CALVO, G. A., AND C. M. REINHART (2002): "Fear of floating," *The Quarterly journal of economics*, 117(2), 379–408.

CAVALLINO, P. (2019): "Capital flows and foreign exchange intervention," *American Economic Journal: Macroeconomics*, 11(2), 127–70.

CESPEDES, L. F., R. CHANG, AND A. VELASCO (2004): "Balance Sheets and Exchange Rate Policy," *American Economic Review*, 94(4), 1183–1193.

CHI, C.-C., S. SCHMITT-GROHÉ, AND M. URIBE (2021): "Optimal Bank Reserve Remuneration and Capital Control Policy," Discussion paper, NBER Working Paper No. 29473.

CHINN, M. D., AND H. ITO (2006): "What matters for financial development? Capital controls, institutions, and interactions," *Journal of Development Economics*, 81, 163–192.

——— (2008): "A New Measure of Financial Openness," *Journal of Comparative Policy Analysis*.

CHRISTIANO, L. J., C. GUST, AND J. ROLDOS (2004): "Monetary policy in a financial crisis," *Journal of Economic theory*, 119(1), 64–103.

CLAYTON, C., AND A. SCHAAB (2020): "Multinational Banks and Financial Stability," *Available at SSRN 3512148*.

COOK, D. (2004): "Monetary policy in emerging markets: Can liability dollarization explain contractionary devaluations?," *Journal of Monetary Economics*, 51(6), 1155–1181.

CORSETTI, G., K. KUESTER, A. MEIER, AND G. J. MÜLLER (2013): "Sovereign risk, fiscal policy, and macroeconomic stability," *The Economic Journal*, 123(566), F99–F132.

——— (2014): "Sovereign risk and belief-driven fluctuations in the euro area," *Journal of Monetary Economics*, 61, 53–73.

CORSETTI, G., P. PESENTI, N. ROUBINI, AND C. TILLE (2000): "Competitive devaluations: toward a welfare-based approach," *Journal of International Economics*, 51(1), 217–241.

COSTINOT, A., G. LORENZONI, AND I. WERNING (2014): "A Theory of Capital Controls as Dynamic Terms-of-Trade Manipulation," *Journal of Political Economy*, 122(1), 77–128.

COULIBALY, L. (2021): "Monetary policy in sudden stop-prone economies," Mimeo, Wisconsin.

DAVIS, J. S., M. B. DEVEREUX, AND C. YU (2020): "Sudden Stops and Optimal Foreign Exchange Intervention," Discussion paper, National Bureau of Economic Research.

DEVEREUX, M. B., AND J. YETMAN (2014): "Globalisation, pass-through and the optimal policy response to exchange rates," *Journal of International Money and Finance*, 49, 104–128.

DIAZ-ALEJANDRO, C. (1985): "Good-bye financial repression, hello financial crash," *Journal of development Economics*, 19(1-2), 1–24.

DU, W., AND J. SCHREGER (2021): "CIP Deviations, the Dollar, and Frictions in International Capital Markets," in *Forthcoming, Handbook of International Economics, Volume V, edited by Gita Gopinath, Elhanan Helpman and Kenneth Rogoff, North Holland.* Elsevier.

EICHENGREEN, B., AND A. ROSE (2014): "Capital Controls in the 21st Century," *Journal of International M*, 48, 1–16.

ERTEN, B., A. KORINEK, AND J. A. OCAMPO (2021): "Capital Controls: Theory and Evidence," *Journal of Economic Literature*.

FABIANI, A., M. LÓPEZ, J.-L. PEYDRÓ, AND P. E. SOTO (2018a): "Capital Controls, Corporate Debt and Real Effects," *Barcelona Graduate School of Economics*.

——— (2018b): "Controls, Domestic Macroprudential Policy and the Bank Lending Channel of Monetary Policy," *Barcelona Graduate School of Economics*.

FANELLI, S., AND L. STRAUB (2021): "Foreign Exchange Interventions and Exchange Rate Management," Forthcoming, Review of Economic Studies.

FARHI, E., AND I. WERNING (2016): "Theory of Macroprudential Policies in the Presence of Nominal Rigidities," *Econometrica*, 84(5), 1645–1704.

FARHI, E., AND I. WERNING (2017): "Fiscal Unions," *American Economic Review*, 107(12), 3788–3834.

FERNANDEZ, A., M. W. KLEIN, A. REBUCCI, M. SCHINDLER, AND M. URIBE (2015): "Capital Control Measures: A New Dataset," NBER Working Paper 20970.

FERNANDEZ, A., A. REBUCCI, AND M. URIBE (2015): "Are capital controls countercyclical?," *Journal of Monetary Economics*, 76, 1–14.

FLEMMING, J., J.-P. L'HUILLIER, AND F. PIGUILLEM (2019): "Macro-prudential taxation in good times," *Journal of International Economics*, 121, 103251.

FORBES, K., M. FRATZSCHER, T. KOSTKA, AND R. STRAUB (2016): "Bubble thy neighbour: Portfolio effects and externalities from capital controls," *Journal of International Economics*, 99, 85–104.

FORBES, K., M. FRATZSCHER, AND R. STRAUB (2015): "Capital-flow management measures:What are they good for?," *Journal of International Economics*, 96, S76–S97.

FORBES, K. J. (2007): "One cost of the Chilean capital controls: Increased financial constraints for smaller traded firms," *Journal of International Economics*.

FORNARO, L., AND F. ROMEI (2019): "The Paradox of Global Thrift," *American Economic Review*, 109(11), 3745–3779.

FRATZSCHER, M., O. GLOEDE, L. MENKHOFF, L. SARNO, AND T. STÖHR (2019): "When is foreign exchange intervention effective? Evidence from 33 countries," *American Economic Journal: Macroeconomics*, 11(1), 132–56.

GABAIX, X., AND M. MAGGIORI (2015): "International Liquidity and Exchange Rate Dynamics," *Quarterly Journal of Economics*, 130(3), 1369–1420.

GHOSH, A. R., AND M. S. QURESHI (2016): "What's in a name? That which we call capital controls," .

GOPINATH, G., AND O. ITSKHOKI (2021): "Dominant Currency Paradigm," Forthcoming, Handbook of International Economics, Volume V, edited by Gita Gopinath, Elhanan Helpman and Kenneth Rogoff, North Holland.

ILZETZKI, E., C. M. REINHART, AND K. S. ROGOFF (2019): "Exchange arrangements entering the twenty-first century: Which anchor will hold?," *The Quarterly Journal of Economics*, 134(2), 599–646.

IMF (2020): "Toward an integrated policy framework," IMF Policy Paper.

ITSKHOKI, O., AND D. MUKHIN (2020): "Exchange rate disconnect in general equilibrium," Discussion paper, National Bureau of Economic Research.

JEANNE, O., AND A. KORINEK (2019): "Managing credit booms and busts: A Pigouvian taxation approach," *Journal of Monetary Economics*, 107, 2–17.

Jeanne, O., and A. K. Rose (2002): "Noise trading and exchange rate regimes," *The Quarterly Journal of Economics*, 117(2), 537–569.

Jin, H., and H. Shen (2020): "Foreign asset accumulation among emerging market economies: A case for coordination," *Review of Economic Dynamics*, 35, 54–73.

Kalemli-Özcan, e. (2019): "US monetary policy and international risk spillovers," Discussion paper, National Bureau of Economic Research.

Kalemli-Özcan, S., and L. Varela (2021): "Five Facts about the UIP Premium," National Bureau of Economic Research, working paper no. 28923.

Kara, G. I. (2016): "Systemic risk, international regulation, and the limits of coordination," *Journal of International Economics*, 99, 192–222.

Keller, L. (2018): "Prudential capital controls and risk misallocation: bank lending channel," *Unpublished mimeo. Kellogg School of Management, Northwestern University*.

Kim, Y. J., and J. Zhang (2020): "International Capital Flows: Private Versus Public Flows in Developing and Developed Countries," Mimeo, Chicago Fed.

Kletzer, K., and M. M. Spiegel (2004): "Sterilization Costs and Exchange Rate Targeting," *Journal of International Money and Finance*, 23(6), 897–915.

Korinek, A. (2016): "Currency Wars Or Efficient Spillovers? A General Theory of International Policy Cooperation," NBER Working Paper 23004.

——— (2018): "Regulating capital flows to emerging markets: An externality view," *Journal of International Economics*, 111, 61–80.

Korinek, A., and A. Simsek (2016): "Liquidity Trap and Excessive Leverage," *American Economic Review*, 106(3), 699–738.

Krugman, P. (1999): "Balance Sheets, the Transfer Problem, and Financial Crises," *International Tax and Public Finance*, 6, 459–472.

Laibson, D., and J. Mollerstrom (2010): "Capital Flows, Consumption Booms and Asset Bubbles: A Behavioural Alternative to the Savings Glut Hypothesis," *Economic Journal*, 120(544), 354–374.

Lane, P. R. (2001): "The New Open Economy Macroeconomics: A Survey," *Journal of International Economics*, 54(2), 235–266.

LIAN, C., AND Y. MA (2021): "Anatomy of corporate borrowing constraints," *The Quarterly Journal of Economics*, 136(1), 229–291.

LORENZONI, G. (2008): "Inefficient Credit Booms," *The Review of Economic Studies*, 75(3), 809–833.

MAGGIORI, M. (2021): "International Macroeconomics With Imperfect Financial Markets," Forthcoming, Handbook of International Economics, Volume V, edited by Gita Gopinath, Elhanan Helpman and Kenneth Rogoff, North Holland.

MAGUD, N. E., C. M. REINHART, AND K. S. ROGOFF (2011): "Capital Controls: Myth and Reality - A Portfolio Balance Approach," NBER Working Paper 16805.

MCKINNON, R. I., AND H. PILL (1999): "Exchange-rate regimes for emerging markets: moral hazard and international overborrowing," *Oxford review of economic policy*, 15(3), 19–38.

MENDOZA, E. G. (2002): "Credit, prices, and crashes: Business cycles with a sudden stop," in *Preventing currency crises in emerging markets*, pp. 335–392. University of Chicago Press.

MENDOZA, E. G., V. QUADRINI, AND J.-V. RIOS-RULL (2009): "Financial integration, financial development, and global imbalances," *Journal of Political economy*, 117(3), 371–416.

MIRANDA-AGRIPPINO, S., AND H. REY (2021): "The global financial cycle," Forthcoming, Handbook of International Economics, Volume V, edited by Gita Gopinath, Elhanan Helpman and Kenneth Rogoff, North Holland.

NA, S., S. SCHMITT-GROHÉ, M. URIBE, AND V. YUE (2018): "The twin Ds: Optimal default and devaluation," *American Economic Review*, 108(7), 1773–1819.

OBSTFELD, M., AND K. S. ROGOFF (1996): *Foundations of international macroeconomics*, vol. 30. MIT press Cambridge, MA.

OBSTFELD, M., J. C. SHAMBAUGH, AND A. M. TAYLOR (2010): "Financial stability, the trilemma, and international reserves," *American Economic Journal: Macroeconomics*, 2(2), 57–94.

OSTRY, J. D., A. R. GHOSH, K. HABERMEIER, M. CHAMON, M. S. QURESHI, AND D. B. REINHARDT (2010): "Capital Inflows: The Role of Controls," IMF Staff Position Note 10/04.

OTTONELLO, P. (2021): "Optimal exchange rate policy under collateral constraints and wage rigidity," Forthcoming, Journal of International Economics.

OTTONELLO, P., D. J. PEREZ, AND P. VARRASO (2021): "Are Collateral-Constraint Models Ready for Macroprudential Policy Design?," NBER Working Paper No. 29204.

REBUCCI, A., AND C. MA (2019): "Capital Controls: A Survey of the New Literature," NBER Working Paper 26558.

REY, H. (2015): "Dilemma not trilemma: the global financial cycle and monetary policy independence," Discussion paper, National Bureau of Economic Research.

SAMANO, A. (2021): "International Reserves and Central Bank Independence," Mimeo, University of Minnesota.

SCHINDLER, M. (2009): "Measuring Financial Integration: A New Data Set," *IMF Staff Papers*, 56(1).

SCHMITT-GROHÉ, S., AND M. URIBE (2003): "Closing small open economy models," *Journal of international Economics*, 61(1), 163–185.

SCHMITT-GROHE, S., AND M. URIBE (2016): "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment," *Journal of Political Economy*, 124(5).

SCHMITT-GROHÉ, S., AND M. URIBE (2016): "Multiple equilibria in open economy models with collateral constraints: Overborrowing revisited," Forthcoming, Review of Economic Studies.

SEOANE, H. D., AND E. YURDAGUL (2019): "Trend shocks and sudden stops," *Journal of International Economics*, 121, 103252.

TAKÁTS, E., AND J. TEMESVARY (2021): "How does the interaction of macroprudential and monetary policies affect cross-border bank lending?," *Journal of International Economics*, 132, 103521.

TILLE, C. (2001): "The role of consumption substitutability in the international transmission of monetary shocks," *Journal of International Economics*, 53(2), 421–444.

VEGH, C. A., L. MORANO, D. FRIEDHEIM, AND D. ROJAS (2017): *Between a Rock and a Hard Place : The Monetary Policy Dilemma in Latin America and the Caribbean*, LAC Semiannual Report. World Bank.

ZEEV, N. B. (2017): "Capital controls as shock absorbers," *Journal of International Economics*, 109, 43–67.

Appendix to "The Prudential Use of Capital Controls and Foreign Currency Reserves"

A Proofs

A.1 Proof of Proposition 1

Let us first prove the following lemma:

Lemma A.1. *Assume that $\sigma = \rho$. If $a_t^* - b_t^* < 0$, we have $b_{t+1}^* > 0$.*

Proof. Suppose $a_{t+1}^* > 0, b_{t+1}^* = 0$. Then

$$U_T(y^T) < U_T\left(y^T + a_t^* - b_t^* - \frac{a_{t+1}^*}{1+i_t^*}\right) \leq U_T(y^T + (1-\beta)a_{t+1}^*) < U_T(y^T)$$

The first inequality follows from $a_t^* - b_t^* - \frac{a_{t+1}^*}{1+i_t^*} \leq 0$ and the equality follows from the Euler equation (2) and $\beta(1+i_t^*) \leq 1$. We then reach a contradiction. □

We now turn to the proof of the proposition. We divide the proof in three parts. The first part shows that the consumption of the tradable good is increasing in ω_t. The second part shows that given the value of $\underline{w}$, full-employment $n_t = \bar{n}$ is not feasible while keeping the nominal exchange rate peg $e_t = \bar{e}$ for any $\omega_t < \infty$. Finally, the last part shows that for sufficiently large fear-of-floating costs, the optimal policy features unemployment $n_t < \bar{n}$ and some depreciation $e_t > \bar{e}$.

i)

Proof. We want to show now that the real interest $\hat{i}_t^*$ is strictly decreasing in ω_t. From Lemma A.1, we have that households are net borrowers. We then have that optimality is determined by

$$U_T(c_t^T) = \beta(1+\hat{i}_t^*)U_T(y^T - (1-\beta)(c_t^T - y^T + b_t^*)(1+\hat{i}_t^*)) \tag{21}$$

Replacing $\hat{i}_t^* = \frac{b_{t+1}^*/(1+\hat{i}_t^*)}{\omega_t} + i_t^*$ from (1), and $c_t^T - y^T + b_t^* = b_{t+1}^*/(1+\hat{i}^*)$ in (21), we obtain

$$U_T(c_t^T) = \beta(1+\hat{i}_t^*)U_T(y^T - (1-\beta)(c_t^T - y^T + b_t^*)\left(1 + \frac{c_t^T - y^T + b_t^*}{\omega_t} + i_t^*\right) \tag{22}$$

Define

$$\Gamma(c_t^T, \omega_t) = U_T(c_t^T) - \beta(1+\hat{i}_t^*)U_T\left(y^T - (1-\beta)(c_t^T - y^T + b_t^*)\left(1 + \frac{c_t^T - y^T + b_t^*}{\omega_t} + i_t^*\right)\right)$$

Totally differentiating (22), we obtain

$$\frac{dc_t^T}{d\omega_t} = -\frac{\frac{d\Gamma}{d\omega_t}}{\frac{d\Gamma}{dc_t^T}} \tag{23}$$

Notice that

$$\frac{d\Gamma}{d\omega_t} = -\beta(1+\hat{i}_t^*)U_{TT}(c_t^T)\left((1-\beta)(c_t^T - y^T + b_t^*)^2\right)\frac{1}{\omega_t^2} > 0$$

where the inequality follows $U_{TT} < 0$.

In addition,

$$\frac{d\Gamma}{dc_t^T} = U_{TT}(c_t^T) + \beta(1+\hat{i}_t^*)U_{TT}(c_t^T)(1-\beta)\left[\left(1 + \frac{c_t^T - y^T + b_t^*}{\omega_t} + i_t^*\right) + \frac{1}{\omega_t}(c_t^T - y^T + b_t^*)\right] < 0$$

where the inequality follows from $U_{TT} < 0$ and $c_t^T - y^T + b_t^* > 0$ from Lemma A.1.

It thus follows from (23) that $\frac{dc_t^T}{d\omega_t} > 0$ as we wanted to show.

ii) We next want to show next the government cannot achieve an allocation with $n_t = \bar{n}$ and $e_t = \bar{e}$ for any $\omega_t \in (0, \infty)$.

Notice that if $e_t = \bar{e}$, we have unemployment if

$$c_t^T < \frac{\phi}{1-\phi}\left(\frac{\underline{w}}{\bar{e}}\right)^{\frac{1}{\rho}}\bar{n} \tag{24}$$

From the consumers' first-order condition, and the country's budget constraint

$$U_T\left(c_t^T\right) = \beta\left(1+\hat{i}_t^*\right)U_T\left(y^T - (1+\hat{i}_t^*)(1-\beta)\left(c_t^T - y_t^T - a_t^* + b_t^*\right)\right). \tag{25}$$

Totally differentiating (25), we obtain

$$\frac{dc_t^T}{d\hat{i}_t^*} = -\frac{-\beta U_T\left(c_{t+1}^T\right) - \beta\left(1+\hat{i}_t^*\right)^2(1-\beta)\left(c_t^T - y_t^T - a_t^* + b_t^*\right)U_{TT}\left(c_{t+1}^T\right)}{U_{TT}\left(c_t^T\right) + \beta\left(1+\hat{i}_t^*\right)^2(1-\beta)U_{TT}\left(c_{t+1}^T\right)} < 0$$

where the inequality follows from $U_{TT} < 0$ and $c_t^T - y_t^T - a_t^* + b_t^* > 0$ from Lemma A.1. Moreover, since $\frac{d\hat{i}_t^*}{d\omega_t} < 0$, it follows that $\frac{dc_t^T}{d\omega_t} > 0$ and that $c_t^T < y_t^T + (a_t^* - b_t^*)(1-\beta)$ for any $\omega_t < \infty$. Using (24) and that $\underline{w} \geq \left[\left(\frac{y_t^T + (a_t^* - b_t^*)(1-\beta)}{\bar{n}}\right)\left(\frac{1-\phi}{\phi}\right)\right]^\rho \bar{e}$, it then follows that for any $\omega_t < \infty$, an economy cannot be at full employment while having $e_t = \bar{e}$.

iii) Finally, we demonstrate that if the fear of floating is strong enough, the economy experiences unemployment. Let e_t^{full} denote the exchange rate that achieves full employment given a consumption level of tradables c_t^T and a nominal rigidity $\underline{w}$.

$$e_t^{full} \equiv \left(\frac{\phi}{1-\phi}\frac{\bar{n}}{c_t^T}\right)^\rho \underline{w}$$

We show next that if $\rho\Psi'(e_t^{full})e_t^{full} > U_N(\bar{n})\bar{n}$, the economy features unemployment $n_t < \bar{n}$. To determine the optimal exchange rate, we use that, under separable preferences, the problem of setting monetary policy at time t is static and can be expressed as

$$\max_{c_t^N, e_t} U\left(c_t^N\right) - \Psi\left(e_t\right) \tag{26}$$

subject to

$$\frac{c_t^N}{c_t^T} = \frac{1-\phi}{\phi}\left(\frac{\underline{w}}{e_t}\right)^{-\frac{1}{\rho}}$$

$$\bar{n} - c_t^N \geq 0$$

where $c_t^T = y^T + (a_t^* - b_t^*) + \frac{b_{t+1}^*}{1+\hat{i}_t^*}$ and $(b_{t+1}^*, \hat{i}_t^*)$ are the outcome of market clearing in the international loan market.

Using ν_t to denote the Lagrange multiplier on the constraint $c_t^N \leq \bar{n}$ and replacing the equality in the objective, we obtain that the first-order condition with respect to e_t is

$$U_N(c_t^N) = \nu_t + \Psi'\left(e_t\right)\rho\frac{e_t}{c_t^N} \tag{27}$$

Suppose $c_t^N = \bar{n}$. Then, we must have $e_t \geq e_t^{full}$ and

$$0 > U_N(\bar{n}) - \Psi'\left(e_t^{full}\right)\rho\frac{e_t^{full}}{\bar{n}} = \nu_t \geq 0$$

We then reach a contradiction. It must be the case that $c_t^N < \bar{n}$, which implies $\nu_t = 0$.

Finally, to see that $e_t > \bar{e}$, notice first that $e_t \geq \bar{e}$. Otherwise, the government can reduce $\Psi(e)$ and increase c^N by raising e. Moreover, using that $c^N < \bar{n}$ implies $\nu_t = 0$. The result is then immediate from (27) and the fact that $\Psi' = 0$ for $e_t = \bar{e}$.

□

A.2 Proof of Proposition 2

Let us rewrite here the planner's problem

$$V\left(a_t^* - b_t^*, \omega_t\right) = \max_{c_t^T, c_{t+1}^T, c_t^N, e_t, \hat{i}_t^*} (1-\beta)\left(U\left(c_t^T, c_t^N\right) - \Psi\left(e_t\right)\right) + \beta U\left(c_{t+1}^T, \bar{n}\right),$$

subject to the constraints

$$\begin{aligned}
(1-\beta)\left(c_t^T - y_t^T - a_t^* + b_t^*\right) + \frac{1}{1+\hat{i}_t^*}\left(c_{t+1}^T - y^T\right) &\leq 0, \\
c_t^T - y_t^T - a_t^* + b_t^* &\leq \omega_t\left(\hat{i}_t^* - i_t^*\right), \\
e_t &\geq w_t\left(\frac{1-\phi}{\phi}\frac{c_t^T}{c_t^N}\right)^{-\rho}, \\
c_t^N \leq \bar{n}, \quad w_t &\geq \underline{w}.
\end{aligned}$$

If the constraint $c_t^N \leq \bar{n}$ is slack and $w_t = \underline{w}$ is binding, and if we use λ_t, μ_t, ν_t as Lagrange multipliers for the first three constraints, the first-order conditions are as follows:

$$c_t^T: \quad (1-\beta) U_T\left(c_t^T, c_t^N\right) - (1-\beta)\lambda_t - \mu_t + \nu_t \rho \frac{e_t}{c_t^T} = 0, \tag{28}$$

$$c_{t+1}^T: \quad \beta U_T\left(c_{t+1}^T, \bar{n}\right) - \frac{1}{1+\hat{i}_t^*}\lambda_t = 0, \tag{29}$$

$$c_t^N: \quad (1-\beta) U_N\left(c_t^T, c_t^N\right) - \nu_t \rho \frac{e_t}{c_t^N} = 0, \tag{30}$$

$$e_t: \quad -(1-\beta)\Psi'\left(e_t\right) + \nu_t = 0, \tag{31}$$

$$\hat{i}_t^*: \quad \lambda \frac{c_{t+1}^T - y^T}{\left(1+\hat{i}_t^*\right)^2} + \omega_t \mu_t = 0. \tag{32}$$

We get λ_t from (29):

$$\lambda_t = \beta\left(1+\hat{i}_t^*\right) U_T\left(c_{t+1}^T, \bar{n}\right). \tag{33}$$

From (32), we get μ_t

$$\mu_t = -\frac{\lambda_t}{\omega_t} \frac{c^T_{t+1} - y^T}{\left(1 + \hat{i}^*_t\right)^2}.$$

Substituting for λ_t and using that $c^T_{t+1} = y^T - (1-\beta)\, b^*_{t+1}$, we obtain

$$\mu_t = \frac{1}{\omega_t} \beta U_T \left(c^T_{t+1}, \bar{n}\right) \frac{(1-\beta)\, b^*_{t+1}}{1 + \hat{i}^*_t} \tag{34}$$

We get ν_t from the optimality condition for (30)

$$\nu_t = (1-\beta)\, U_N \left(c^T_t, c^N_t\right) \frac{1}{\rho} \frac{c^N_t}{e_t}. \tag{35}$$

Substituting the expressions above for λ_t, μ_t and ν_t in the optimality condition for c^T_t, (28), we get

$$U_T \left(c^T_t, c^N_t\right) = \left(1 + \hat{i}^*_t + \frac{1}{\omega_t} \frac{b^*_{t+1}}{1 + \hat{i}^*_t}\right) \beta U_T \left(c^T_{t+1}, \bar{n}\right) + U_N \left(c^T_t, c^N_t\right) \frac{c^N_t}{c^T_t},$$

which corresponds to (10). When the constraint $c^N_t = \bar{n}$ is binding and $w_t \geq \underline{w}$ is slack, similar steps yield[29]

$$U_T \left(c^T_t, c^N_t\right) = \left(1 + \hat{i}^*_t + \frac{1}{\omega_t} \frac{b^*_{t+1}}{1 + \hat{i}^*_t}\right) \beta U_T \left(c^T_{t+1}, \bar{n}\right).$$

A.3 Proof of Proposition 3

The planner's maximization is

$$(1-\beta)\, U \left(c^T_{t-1}, \bar{n}\right) + \beta \mathbf{E}_{t-1} \left[V \left(a^*_t - b^*_t, \omega_t\right)\right], \tag{36}$$

subject to the constraints

$$\frac{1}{1 + i^*_{t-1}} a^*_t - \frac{1}{1 + \hat{i}^*_{t-1}} b^*_t + c^T_{t-1} = y^T_{t-1},$$

[29] In principle, it is also possible to have $c^N_t = \bar{n}$ binding and $w_t = \underline{w}$.

$$c_{t-1}^T - y_{t-1}^T = \omega_t \left(\hat{i}_t^* - i_t^*\right),$$

From (8), we have that differentiating with respect to $a_t^* - b_t^*$ and applying envelope the envelope condition yields

$$V_{a^*}\left(a_t^* - b_t^*, \omega_t\right) = (1-\beta)\,\lambda_t + \mu_t.$$

Rewrite the optimality condition for c_t^T, (28), as

$$(1-\beta)\,\lambda_t + \mu_t = (1-\beta)\,U_T\left(c_t^T, c_t^N\right) + \nu_t \rho \frac{e_t}{c_t^T}.$$

Combining the last two equations and substituting for ν_t from (35) in the case in which $c_t^N < \bar{n}$ gives

$$V_{a^*}\left(a_t^* - b_t^*, \omega_t\right) = (1-\beta)\left(U_T\left(c_t^T, c_t^N\right) + U_N\left(c_t^T, c_t^N\right)\frac{c_t^N}{c_t^T}\right). \tag{37}$$

In addition, taking first-order conditions in problem (36) we obtain that

$$c_{t-1}^T: \quad (1-\beta)U_T\left(c_{t-1}^T, \bar{n}\right) = \lambda_{t-1} + \mu_{t-1} \tag{38}$$

$$b_t^*: \quad \frac{\lambda_{t-1}}{1+i_{t-1}^*} = \beta \mathbf{E}_{t-1} V_{a^*}\left(a_t^* - b_t^*, \omega_t\right) \tag{39}$$

where the latter assumes that $b_t^* > 0$ at the optimum.

Combining (37), (38), (39)

$$U_T\left(c_{t-1}^T, \bar{n}\right) = \beta\left(1 + \hat{i}_t^* + \frac{1}{\omega_t}\frac{b_{t+1}^*}{1+\hat{i}_t^*}\right)\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right) + \iota_{n_t<\bar{n}} U_{N,t}\frac{c_t^N}{c_t^T}\right]. \tag{40}$$

A.4 Proof of Proposition 4

With a tax on debt, consumers' first order condition is given by

$$U_T\left(c_{t-1}^T, c_{t-1}^N\right) = \beta\left(1+\hat{i}_t^*\right)\frac{1}{1-\tau}\mathbf{E}_{t-1}\left[U_T\left(c_t^T, c_t^N\right)\right]. \tag{41}$$

Replacing the expression for the tax in (40) and using that $c_{t-1}^N = \bar{n}$ yields (13).

B Data Appendix

B.1 List of Countries in the Data Set

Advanced Economies: Australia, Austria, Belgium, Canada, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, New Zealand, Norway, Portugal, San Marino, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan, the United Kingdom, and ghe United States.
Emerging Economies: Belarus, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Ecuador, Egypt, Hungary, India, Indonesia, Lebanon, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Paraguay, Peru, the Philippines, Poland, Romania, Russia, Saudi Arabia, Serbia, South Africa, Thailand, Turkey, Ukraine, Uruguay, Venezuela, and Vietnam.
Low Income Countries: Bolivia, Burundi, Cameroon, the Central African Republic, Chad, the Comoros, Eritrea, Ethiopia, Ghana, Guinea, Guyana, Haiti, Honduras, Kenya, Liberia, Madagascar, Malawi, Mauritania, Mozambique, Nicaragua, Rwanda, Sierra Leone, Somalia, Sudan, Tanzania, Uganda, and Zambia.

B.2 Data Sources and Variable Definitions

- International Reserves (as percentage of GDP): We use data from the International Financial Statistics for reserves and data from the World Economic Outlook for GDP.
- Chinn-Ito Financial Openness Index: We use data from Chinn and Ito (2006) and updated data from `http://web.pdx.edu/~ito/Chinn-Ito_website.htm`

B.3 Exchange Rate Classification

We consider as fixed exchange rate regimes all countries coded with 1 and 2 in Ilzetzki, Reinhart, and Rogoff (2019) (IRR) and flexible exchange rate regimes all countries coded with 3, 4, and 5 in IRR. By 2018, the countries classified as fixed are Bulgaria, China, Costa Rica, Croatia, Ecuador, Egypt, Hungary, India, Lebanon, Morocco, Pakistan, Peru, Romania, Saudi Arabia, Serbia, and Vietnam. By 2018, the countries classified as floaters are Belarus, Brazil, Chile, Colombia, Indonesia, Malaysia, Mexico, Nigeria, Paraguay, the Philippines, Poland, Russia, South Africa, Thailand, Turkey, Ukraine, Uruguay, and Venezuela.

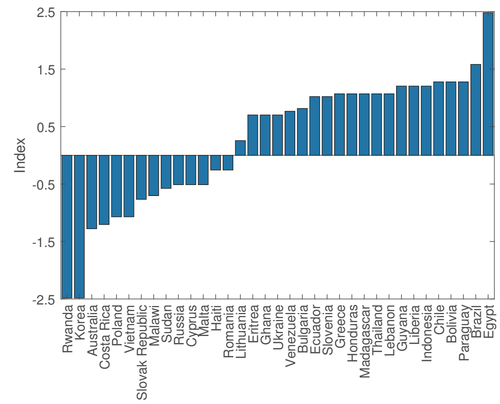
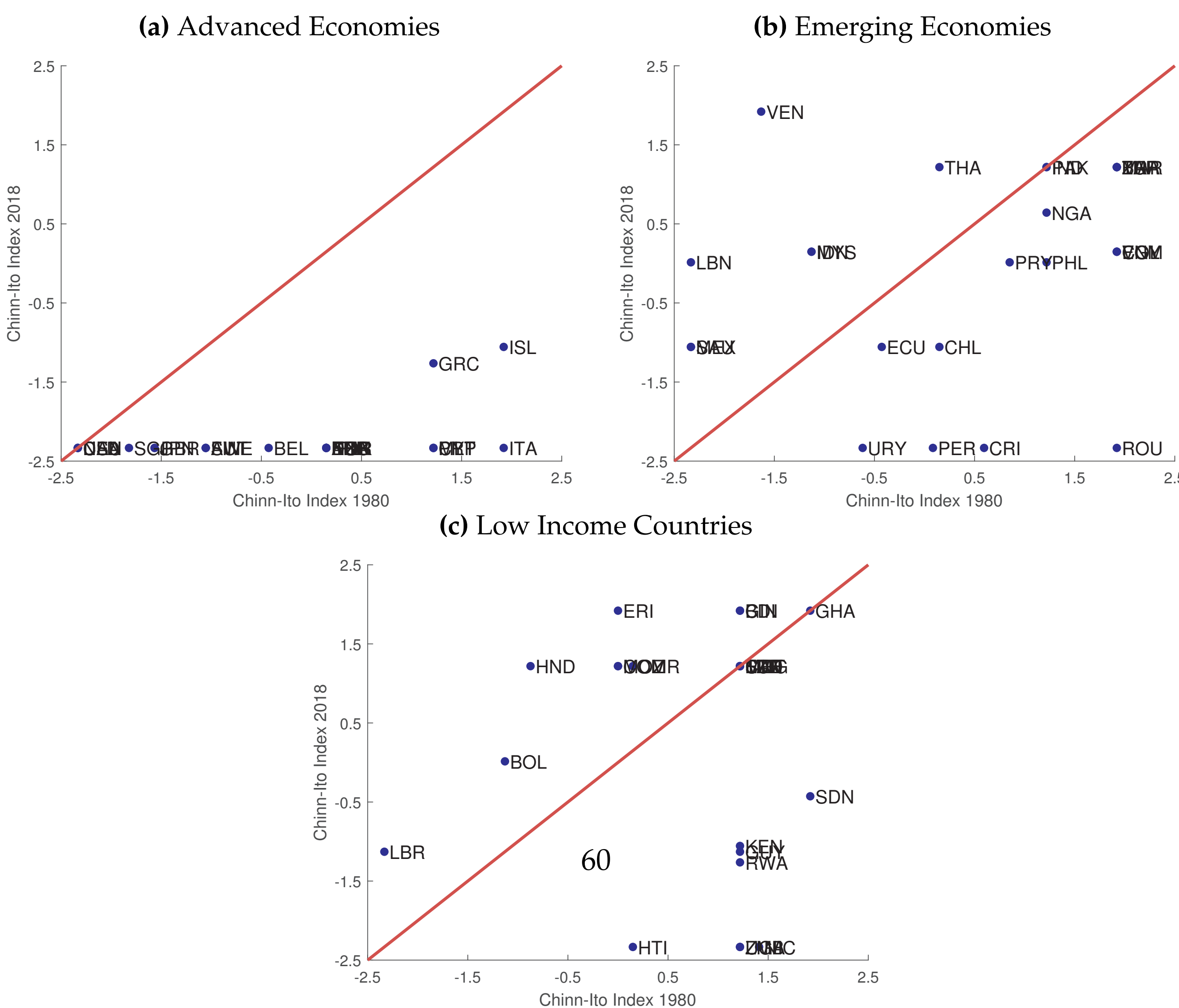


Figure 8: Change in Chinn-Ito Index 2018 vs 2006

Note: In some countries the Chinn-Ito index did notchangebetween 2006 and 2018. Examples include Austria, Belgium, Burundi, Cameroon, Canada, the Central African, Chad, China, Colombia, the Comoros, Denmark, Ethiopia, Finland, France, Germany, Iceland, India, Ireland, Italy, Japan, Kenya, Malaysia, Mexico, Morocco, the Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Peru, the Philippines, Portugal, Saudi Arabia, Sierra Leone, Singapore, South Africa, Spain, Sudan, Sweden, Tanzania, Turkey, Uganda, the United Kingdom, the United States, Uruguay, and Zambia.

B.4 Additional Figures



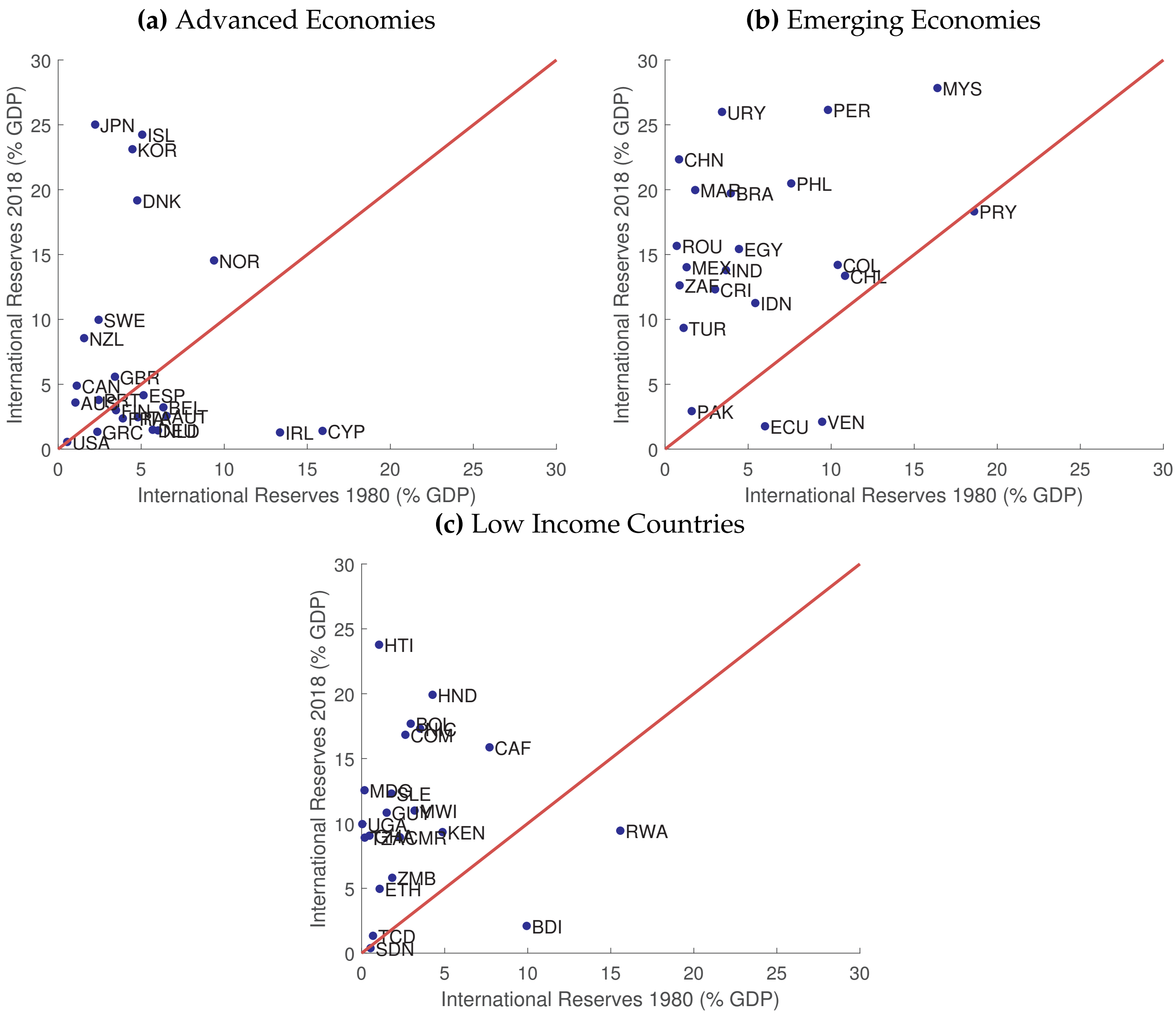


Figure 10: International Reserves: 1980 vs. 2018

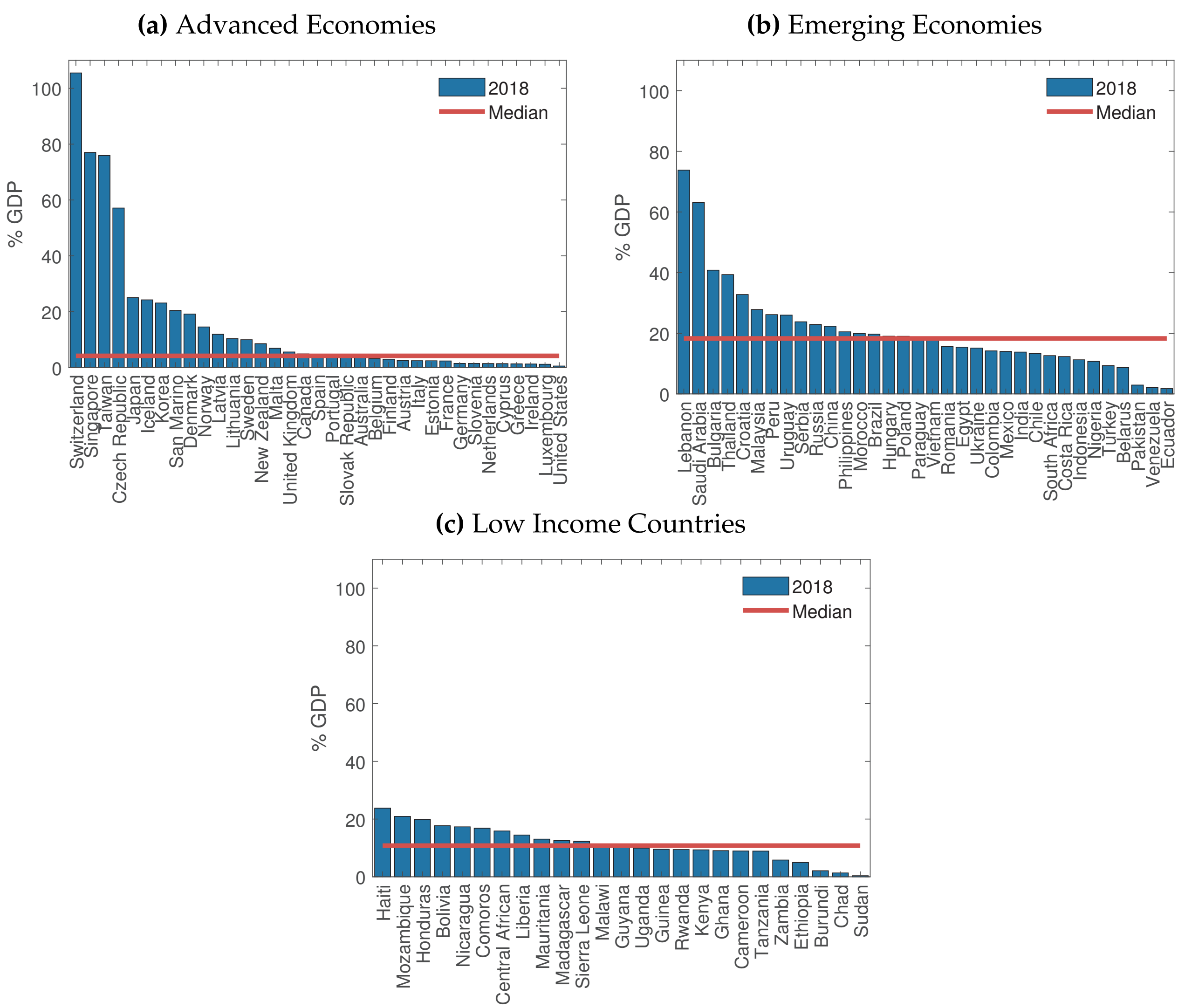


Figure 11: International Reserves by Group