The Composition of Capital Inflows and Optimal Monetary Policy in Sudden-Stop Economies

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Abstract

Accounting for different types of capital flows, this paper studies whether monetary policy in emerging market economies should be prudential—i.e., deviate from price stability to induce agents to borrow less and hold more insurance during tranquil times. I develop a New Keynesian open economy model in which agents can trade a variety of international assets subject to a collateral constraint. I derive a set of theoretical results, then calibrate the model and conduct a quantitative analysis. I find that there is no scope for prudential monetary policy if either (1) the government can regulate both the level and composition of capital inflows or (2) commitment is not possible and the government can only regulate the volume but not the composition of flows. Otherwise, monetary policy should be prudential, though it is less effective than capital controls, especially without commitment. Compared with single bond setups, having multiple securities further reduces monetary policy's capability to act in a prudential manner. These results suggest that macroprudential instruments that target both the level and composition of capital inflows are an essential part of an optimal policy mix. When capital controls are not available, committing to a simple inflation targeting rule delivers higher welfare than discretionary prudential monetary policy.

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1 Introduction

Cross-border capital flows generate substantial benefits for emerging market economies (EMEs) by facilitating more efficient consumption smoothing and risk sharing. However, capital flow surges and their subsequent reversals might undermine domestic financial stability (Forbes and Warnock 2021). Sudden stops of capital inflows are associated with financial crises in EMEs.[1] Further, these crises are preceded by large capital inflows, particularly in the form of debt flows (Reinhart and Rogoff 2011; Schularick and Taylor 2012). Therefore, how to mitigate the adverse impacts of capital flows is at the core of policy debates.[2] This paper investigates the role of monetary policy in managing capital flows by asking the following questions: Should monetary policy in EMEs depart from its traditional role of price stabilization to target *the volume and composition* of capital flows—that is, be prudential? If so, how effective is prudential monetary policy for reducing the likelihood and severity of financial crises? How do various policy regimes compare in terms of welfare, accounting for both normal and crisis times?

I answer these questions within the framework of a two-sector (tradable and nontradable) small open economy New Keynesian model, in which agents trade a variety of international securities. Domestic agents are subject to an occasionally binding collateral constraint as in Mendoza (2002, 2010), which captures surges and reversals of capital flows in EMEs. Also, some forms of flows are more cyclical than others, making them riskier. The value of collateral depends on the exchange rate; thus, the policymaker can influence borrowing capacity by manipulating the exchange rate. Along with monetary policy, the policymaker might have access to capital controls and reserve accumulation as policy instruments. I theoretically characterize the optimal monetary policy in this environment. Then I calibrate the model and conduct a numerical analysis to quantify the differences between alternative policy regimes.

The findings can be summarized as follows. In general, monetary policy is prudential and deviates from macroeconomic stabilization—i.e., stabilizing prices and closing the output gap—during tranquil times. In only two scenarios is monetary policy not prudential and focuses exclusively on macroeconomic stabilization: first, with distinct capital controls that alter both the volume and the composition of capital inflows; second, with uniform capital controls that only target the level but not the composition of flows under discretion. However, prudential monetary policy alone is less successful than capital controls in reducing the frequency and intensity of sudden stops, especially in the absence of commitment. Commitment is crucial; even sticking to a simple inflation targeting rule (which doesn't include leaning against the wind) delivers higher welfare than prudential monetary policy under discretion. Furthermore, allowing multiple securities as opposed to a single bond in the international asset markets further weakens the effectiveness of prudential monetary policy.

To better understand the intuition behind these results, consider the underlying inefficiencies and how their interactions create policy tradeoffs. First, the nominal rigidities are sources of aggregate demand

[1] See Bianchi and Mendoza (2020) who also identify 36 sudden stops in EMEs between 1979 and 2016.

[2] See, for instance, the recent institutional view of the International Money Fund on capital flow management, IMF (2022).

externalities and lead to inflation and an output gap when monetary policy cannot adjust (Korinek and Simsek 2016; Farhi and Werning 2016; Schmitt-Grohé and Uribe 2016). Second, the presence of a collateral constraint that depends on exchange rates generates pecuniary externalities (Korinek 2010; Bianchi 2011). When the constraint binds, a currency depreciation reduces the borrowing capacity of domestic agents, and therefore leads to capital outflows from the domestic economy. The fall in net capital inflows further depreciates the exchange rate and reduces borrowing capacity even more. This is a manifestation of amplification through the Fisherian debt deflation mechanism. Importantly, lower wealth in bad states exacerbates this negative feedback loop. Because individual agents take the exchange rate as given, they do not internalize how their financial decisions (both the total and composition of liabilities) in good states are contributors to contractionary depreciations in bad states. As a result, private agents overborrow *and* underinsure. All in all, there are four inefficiencies in the model—inflation, output, overborrowing, and underinsurance—that require conflicting monetary policy stances in normal times. Thus, although monetary policy is not constrained (by, e.g., the zero lower bound or by a fixed exchange rate regime), it cannot achieve all of the objectives and must strike a balance between them.

In normal times, absent capital controls, monetary policy must compromise between macroeconomic stabilization and leaning against the wind to mitigate overborrowing and underinsurance. Prudential monetary policy consists of two actions. First, by shifting demand between tradable and nontradable sectors, monetary policy can influence the demand for tradable goods and therefore the total borrowing of domestic agents. Since this does not require any commitment, it is available to policymakers under both discretion and commitment. However, this action can only impact the total level of borrowing but not the composition directly. In fact, as total borrowing decreases, the probability and severity of financial crises decrease as well. As a result, agents increase their exposure and have less insurance, since insurance is costly. In this way, private agents can undo the benefits of the first form of prudential monetary policy. The second type of prudential action involves a future threat of a more depreciated currency, and thus a more severe financial crisis. An expectation of a more severe and frequent crisis induces agents to limit their exposure by reducing total borrowing and increasing insurance. Since this policy is not, by definition, available to monetary policy under discretion, it cannot directly target underinsurance. To recap, absent capital controls, monetary policy under commitment aims for price stabilization, closing the output gap, addressing overborrowing, and addressing underinsurance; discretionary monetary policy has the same objectives, except for addressing underinsurance.

The existence of capital controls modifies the role of monetary policy. Under distinct capital controls, monetary policy focuses exclusively on macroeconomic stabilization. This is because capital controls can eliminate the financial inefficiencies that result from the pecuniary externalities without directly interacting with inflation and the output gap. Importantly, in this environment, there is a "divine coincidence", so monetary policy can simultaneously close the output gap and stabilize prices. As a result, under distinct capital controls, all of the inefficiencies are addressed in normal times. When only uniform capital controls are available, they restrict the volume of capital inflows and address overborrowing. The remaining financial inefficiency, underinsurance, can only be addressed by monetary policy under commitment. Notably, all the prudential actions, whether they are conducted by macroprudential tools or monetary policy, are in place only if there is a nonzero possibility of a binding constraint in the next period. When total liabilities are low enough, the possibility of a future financial crisis is zero. This means that the negative feedback between the exchange rate and the borrowing limit doesn't exist; thus, there is no financial inefficiency and no scope for prudential action.

Furthermore, during a financial crisis, monetary policy limits currency depreciation to prevent borrowing capacity from collapsing too much. This is a form of "fear of floating" (Calvo and Reinhart 2002). However, containing the exchange rate depreciation leads to expenditure switching from nontradables to tradables, and therefore underproduction and deflation in the nontradable sector. Thus, in a financial crisis, monetary policy sacrifices macroeconomic stabilization in favor of easing the borrowing constraint (Ottonello 2021). This tradeoff between macroeconomic stabilization and increasing capital inflows in bad states is present regardless of the commitment power or existence of capital controls.[3]

To summarize, the extent to which optimal monetary policy leans against the wind depends on commitment power, the nature of additional policy instruments, whether there is a financial crisis in the current period, and whether there is a possibility of a financial crisis in future. Note that without the borrowing constraint, the incentive to increase capital inflows during crisis times, as well as the financial inefficiencies of overborrowing and underinsurance, would disappear. That would leave macroeconomic stabilization as the sole responsibility of monetary policy in all circumstances.

Next, I calibrate the model and use a global solution technique[4] to solve it under optimal time consistent policies as well as under commitment with strict inflation targeting. In the quantitative model, I divide capital flows into debt and equity flows (Meng and van Wincoop 2020). The literature shows that equity inflows provide more insurance in a sudden stop for domestic agents (see, e.g., Forbes and Warnock 2012b). From the international investors' point of view, equity is riskier, and thus they demand a premium over debt. So, for the domestic economy, financing current account deficits via debt flows is cheaper but riskier. Due to the pecuniary externalities, private agents choose to carry an excessive level of liabilities with an excessive proportion of debt into the future.

The numerical analysis demonstrates the relative ineffectiveness of prudential monetary policy in reducing the frequency and intensity of sudden stops. Of the discretionary policy regimes I consider, the economy under prudential monetary policy has the highest crisis probability, followed by the uniform capital control regime. Distinct capital controls yields the lowest crisis probability. Further, in a crisis, the drop in both total consumption and nontradables production, as well as current account reversal are the highest under prudential monetary policy, which is followed by uniform and then distinct capital controls regimes. Notably, the policymaker allows a higher level of capital inflows under distinct than

[3]However, having commitment power and/or capital controls alleviates this tradeoff as shown below.

[4]Specifically, by including portfolio choice and optimal monetary policy, I extend the endogenous grid points with the endogenous borrowing limits procedure described in Jeanne and Korinek (2019), which builds on Carroll (2006).

under uniform capital controls. This is because the inefficiency comes from the amplification that occurs only in bad states. To the extent that wealth in bad states is not too low, having a high level of liabilities in good states does not create inefficiencies per se. This is indeed the case; the frequency and severity of financial crises are lower with distinct than uniform capital controls. The ineffectiveness of prudential monetary policy for improving financial stability leads to the lowest welfare compared with distinct or uniform capital controls.

Given that time consistent monetary policy is ineffective for prudential actions, is there any benefit in deviating from a strict inflation targeting regime when capital controls are not available? The inflation targeting regime focuses exclusively on stabilizing prices, *even in a financial crisis*. Since this means that monetary policy does not increase borrowing capacity under inflation targeting, crises are more severe than under prudential monetary policy. However, because private agents know this, they decrease their exposure by borrowing less in total and issuing proportionally more equity in normal times. The result is less frequent but more severe crises. Overall, committing to inflation targeting yields greater welfare than discretionary monetary policy with a prudential component. This shows the importance of commitment.

One reason for discretionary monetary policy's relative ineffectiveness in prudential actions is that when it reduces total liabilities, the frequency and severity of crises also decrease—and as a result, private agents shift their portfolios toward cheaper but riskier securities. This weakens the prudential benefits of having less liabilities and reduces the marginal benefit of having prudential monetary policy. Therefore, monetary policy places less weight on prudential actions. How important is this channel quantitatively? I create a synthetic security whose weights are the same as the equilibrium of the economy under both debt and equity. This ensures that the combined security has the same risk and return profiles as the portfolio chosen in the original equilibrium, while at the same time it allows the volume of flows to change without impacting the composition. As a result, in this case, discretionary prudential monetary policy reduces total borrowing more than it does under multiple securities. Consequently, financial crises are less frequent and less severe. The experiment suggests that models with a single borrowing instrument present in the literature overstate the effectiveness of prudential monetary policy.

These analyses reveal that an essential part of an optimal policy mix is capital controls that target both the total volume and composition of capital inflows. First, they are more effective for addressing financial inefficiencies than prudential monetary policies. Second, they alleviate the tradeoffs that monetary policy faces, and therefore monetary policy more effectively focuses on its traditional macroeconomic stabilization role. Finally, capital controls help insulate the domestic economy from external financial shocks. In normal times, distinct capital controls can be adjusted accordingly to neutralize the impacts of foreign shocks to capital inflows. In a crisis, since capital controls reduce the strength of financial crises, they also dampen the transmission of financial shocks through credit constraints. These results are in line with Rey (2015) who argues that even without any restriction on the exchange rates, global financial conditions constrain domestic monetary policy under unrestrained capital flows.

This paper contributes to a growing literature on optimal monetary and macroprudential policy mix in financially constrained economies[5] (see, e.g., Fornaro (2015); Ottonello (2021); Adrian et al. (2020); Basu et al. (2020); Benigno et al. (2013, 2016, 2019); Schmitt-Grohé and Uribe (2021), Bianchi and Coulibaly (2022)). Within this strand of literature, this paper is closely related to Devereux et al. (2019) and Coulibaly (2022). The borrowing constraint in Devereux et al. (2019) features the expected future value of collateral. Therefore, in contrast to this paper, neither monetary policy nor capital controls are prudential in their setup. In my model, borrowing capacity depends on current prices and monetary policy is prudential if the necessary capital controls are not available. Coulibaly (2022) argues that the relative strength of intra- and intertemporal substitutions explains procyclical monetary policies in EMEs. All of these papers consider homogeneous capital flows by assuming a single bond. By contrast, I focus on the effectiveness of prudential monetary policy in a setup with multiple nonuniform capital inflows and a nontrivial liability choice. Having multiple forms of capital inflows yields new insights into both financial crisis dynamics and optimal policy design in financially fragile economies.

This paper is also related to the financial crisis literature that features pecuniary externalities; for example, Korinek (2010); Bianchi (2011); Bianchi and Mendoza (2018); and Jeanne and Korinek (2019). The papers Erten et al. (2021) and Rebucci and Ma (2020) extensively review the literature on the source and implications of pecuniary externalities. The current paper departs from this literature by studying crisis dynamics under the interaction between financial and nominal frictions.

Finally, this paper also relates to the literature that investigates the role of external capital structures on financial stability. Korinek (2018) shows in a real model that the externalities generated by capital inflows in EMEs depend on the payoff profiles of these flows. By contrast, in this paper I consider interactions between nominal and financial frictions as well as optimal monetary policy design in an economy facing different forms of capital inflows. Liu et al. (2021) studies the role of having local currency in sudden stop dynamics, while Ma and Wei (2020) argues that financing current account deficits with more equity and less debt reduces financial risks. Empirical studies, such as Forbes and Warnock (2012a), Catão and Milesi-Ferretti (2014), document the importance of the liability structure of a country for financial stability. This paper complements those studies by focusing on the prudential role of monetary policy, which is not addressed by those papers.

2 Baseline Environment

Consider an infinite-horizon small open economy model with a tradable and a nontradable sector. The economy is subject to occasional sudden stops of capital inflows. Time is discrete and indexed by t. In each period, the economy is endowed with a stochastic tradable endowment Y_t^T while nontradable goods Y_t^N must be produced within the country. Households have access to international financial markets. In the baseline model, I assume that domestic agents have access to the full set of state contingent Arrow

[5] For earlier contributions to optimal contractionary monetary policy in a crisis, see, e.g., Caballero and Krishnamurthy (2003); Christiano et al. (2004); Caballero and Krishnamurthy (2004); and Braggion et al. (2009).

securities. In Appendix B, I show that the main results do not depend on this assumption. Specifically, the financial inefficiencies of overborrowing and underinsurance exist, and the policy responses are the same under financial markets with both complete Arrow securities and composite securities, such as bonds. Domestic agents are subject to a borrowing limit that depends on the price of tradables relative to nontradables. The exogenous shocks are the ones to the tradable goods endowment and to the pricing kernel of international investors.

2.1 Households

A representative household has preferences over tradable goods C_t^T, non tradable goods C_t^N, and labor L_t:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t) \tag{1}$$

where $\mathbb{E}_0$ denotes the conditional expectations operator and $\beta < 1$ is a discount factor. The utility function $U(.)$ is such that labor is separable from both consumption goods[6] and satisfies the standard regularity conditions. In the quantitative analysis section below, there will be more restrictions on the preferences.

Nontradable goods are produced and consumed domestically. Households are exogenously endowed with stochastic tradable goods Y_t^T in each period. The tradable good is homogeneous and can be traded internationally at price P_t^* without any friction. As a result, in each period, the small open economy has a net export of $Y_t^T - C_t^T$ expressed in the foreign currency. Assuming that the law of one price holds, the price of the tradable good in Home currency is

$$P_T^T = \mathscr{E}_t P_t^*$$

where $\mathscr{E}_t$ is the nominal exchange rate between home and foreign currency denoting the value of one unit of foreign currency in units of local currency. A depreciation in home currency corresponds to an increase in $\mathscr{E}_t$. Also, without loss of generality, I assume that the international price of the tradable good is one in every period: $P_t^* = 1$, $\forall t$.

Households trade securities with large international investors. As an implication of the small open economy assumption, payoff profiles of international securities expressed in the foreign currency are determined by the international investors' pricing kernel, and therefore they are exogenous to the domestic economy. Let B_{t+1}^s denote the security holdings of households for state $s \in S$ at time $t+1$ that is acquired at time t. $B_{t+1}^s > 0$ denotes domestic agents' savings, whereas $B_{t+1}^s < 0$ denotes their borrowings from the international investors using the security s.

In each state of the world, households are subject to the following sequence of flow budget constraints

[6] This assumption greatly simplifies the notation without directly impacting the qualitative findings below.

expressed in local currency:

$$P_t^N C_t^N + P_t^T C_t^T + \mathscr{E}_t \mathbb{E}_t \left[M_{t+1}^s B_{t+1}^s \right] = W_t L_t + P_t^T Y_t^T + \mathscr{E}_t B_t + \Pi_t + T_t, \tag{2}$$

where P_t^N is price of nontradable goods; M_{t+1}^s is the pricing kernel of international investors in state s at time $t+1$; W_t is wage from supplying one unit of labor to production of nontradable goods; Π_t is profit resulted from the ownership of the domestic firms; T_t is lump-sum tax or transfers levied by the government. The total wealth that the agent carry to the next period is given by the term $\mathscr{E}_t \mathbb{E}_t \left[M_{t+1}^s B_{t+1}^s \right]$. Note that all variables are indexed not only time but also state. However, to ease the notation, I will only explicitly denote states of $t+1$ variables, as in B_{t+1}^s and M_{t+1}^s.

Additionally, domestic households face a borrowing constraint that limits their total external liabilities in the form of

$$-\mathscr{E}_t \mathbb{E}_t \left[M_{t+1}^s B_{t+1}^s \right] \leq \kappa (P_t^T Y_t^T + P_t^N) \tag{3}$$

This borrowing constraint captures the idea that the level of total borrowing in the small open economy positively depends on the realization of tradable endowment, nontradable goods price, and the value of local currency against the foreign currency. Because $P_t^T = \mathscr{E}_t P_t^*$, holding everything else constant, a depreciation of the local currency reduces the borrowing limit expressed in tradable goods.[7] Even though the exact specification might differ, this class of borrowing constraints for small open economies is the backbone of sudden stop dynamics and, therefore they are used extensively in the literature.[8]

Given this environment, the representative household's problem is to choose consumption of tradable and nontradable goods, labor, and asset holdings to maximize the expected discounted utility (1) subject to the budget constraint (2), and the borrowing constraint (3). The resulting optimality conditions are

$$U_{T,t} = p_t U_{N,t}, \tag{4}$$

$$-\frac{U_{L,t}}{U_{N,t}} = \frac{W_t}{P_t^N}, \tag{5}$$

$$U_{T,t} = \beta U_{T,t+1}^s R_{t+1}^s + \mu_t, \qquad \forall s \in S, \tag{6}$$

where $p_t \equiv P_t^T / P_t^N$ is the price of the tradable good relative to the nontradable good. Following the convention, I interpret this relative price as the inverse of the real exchange rate. U_T, U_N, U_L are marginal utilities of tradable goods consumption, nontradable goods consumption and labor, respectively; $R_{t+1}^s \equiv 1/M_{t+1}^s$ is the return on the security B_{t+1}^s, and $\mu_t / \mathscr{E}_t$ is the lagrange multiplier on the borrowing

[7] To see this more clearly, rewrite the constraint as $-\mathbb{E}_t \left[M_{t+1}^s B_{t+1}^s \right] \leq \kappa (Y_t^T + P_t^N / \mathscr{E}_t)$.

[8] See, for example, Basu et al. (2020), Farhi and Werning (2016), Bianchi (2011). In Farhi and Werning (2016) and Basu et al. (2020) borrowing limit depends only on the domestic currency price, and not the production level or endowment. Further, Korinek (2018) provides an analytic description of how this constraint can be micro-founded in the presence of a moral hazard problem.

constraint. Equations (4) and (5) are intratemporal optimality conditions: (4) relates relative demand between nontradable and tradable goods to their relative price, while (5) is the condition for optimal labor supply. (6) gives the usual intertemporal Euler equation with a wedge μ_t which is positive when the borrowing constraint binds, and zero otherwise.

The condition for optimal portfolio allocation between any two states s and s' is given by the following expression, which can be obtained by writing Euler equations with respect to both states:

$$U^s_{T,t+1} R^s_{t+1} = U^{s'}_{T,t+1} R^{s'}_{t+1} \tag{7}$$

This expression reveals that the extent of insurance across different states of the world depends on the relative cost (or return if households save) of the associated securities. If there is no difference in cost, that is, if international investors are risk neutral, and therefore $M^{s'}_{t+1} = M^s_{t+1}$, domestic households have perfect insurance between the two states, i.e., $U^s_{t+1} = U^{s'}_{t+1}$.

2.2 Firms

To introduce price stickiness in the nontradable sector, I assume that production of final nontradable goods Y^N_t requires nontradable intermediate goods that are produced by monopolistically competitive firms. The final nontradable good Y^N_t is produced by competitive firms according to the following technology

$$Y^N_t = \left(\int_0^1 Y^{N\,\frac{\varepsilon-1}{\varepsilon}}_{j,t} \, dj \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where $\varepsilon > 1$ is the elasticity of substitution between varieties. Each intermediate variety $Y^N_{j,t}$ is produced by a monopolistically competitive firm j which faces the economy-wide productivity A and uses labor as the only input: $Y^N_{j,t} = AL_{j,t}$. The government provides a wage subsidy ϕ^n to each firm j to remove the inefficiency resulted by the imperfect competition. As a result, each firm has the same marginal cost expressed in nontradable goods: $MC_t = \frac{W_t}{AP^N_t}(1-\phi^n)$.

The intermediate goods producers can adjust their prices in each period but are subject to a convex price-adjustment cost in terms of final nontradable goods as in Rotemberg (1982):

$$\frac{\varphi}{2} \left(\frac{P^N_{j,t}}{P^N_{j,t-1}} - 1 \right)^2$$

In a symmetric equilibrium, this formulation yields the following version of the New Keynesian Philips curve:

$$\varphi \pi_t (1+\pi_t) = \varepsilon \left(MC_t - \frac{\varepsilon - 1}{\varepsilon} \right) + \frac{\varphi}{Y^N_t} \mathbb{E}_t \left[\Theta_{t,t+1} Y^N_{t+1} \pi_{t+1} (1+\pi_{t+1}) \right] \tag{8}$$

where $\pi_t \equiv \frac{P_t^N}{P_{t-1}^N} - 1$ is the inflation rate of nontradable goods and $\Theta_{t,t+1} \equiv \frac{\beta U_{N,t+1}}{U_{N,t}}$ is households' stochastic discount factor between t and $t+1$. Firms' profit is equal to revenue minus wage and price adjustment costs:

$$\Pi_t = P_t^N Y_t^N \left(1 - \frac{\varphi}{2}\pi_t^2\right) - W_t \left(1 - \phi^n\right) L_t$$

2.3 Government

The government in the small open economy is an entity that sets monetary policy, macroprudential policies, and the wage subsidy. The monetary policy instrument is the value of the local currency, i.e. the exchange rate between the home and foreign currency. Note that the usual interpretation of monetary policy of setting the domestic interest rate path would be isomorphic to choosing the exchange rate between the home and foreign currency, given exchange rate expectations and foreign interest rates. For this, one can assume that there is a zero net supply home currency bonds which can only be traded domestically. Moreover, since for a given nontradable price level P_t^N the policymaker can choose P_t^T, I interpret Home's monetary policy as choosing price of tradable goods relative to nontradable goods p_t.

I examine optimal monetary policy based on (1) the availability of additional prudential instruments that can directly regulate the household's portfolio holdings and (2) whether the policy maker has the commitment power. For the additional macroprudential instruments, I consider capital control taxes in the baseline model. I investigate whether monetary policy should lean against the wind and be prudential under three different assumptions about the nature of capital controls. The first one is distinct capital controls, where the policymaker can impose a differential capital control tax on each security. I show in Appendix C that employing these kinds of capital controls yields the same allocations as accumulating international reserves. In this sense, capital controls and reserve accumulation are equivalent to each other in the current setup. Then I consider uniform capital controls, in which the policymaker cannot distinguish between capital control taxes among various securities but rather imposes a uniform tax for all types of securities. The final case is when capital controls are not available to the policymaker. The government runs a balanced budget regardless of the type of policy instruments. This means that the lump sum transfers or taxes T_t include the wage subsidy as well as the revenue from macroprudential policies when they are in place.

2.4 Equilibrium

In an equilibrium, nontradable good consumption is equal to nontradable production net of price adjustment cost

$$C_t^N = Y_t^N \left(1 - \frac{\varphi}{2}\pi_t^2\right) \tag{9}$$

The resource constraint for tradable goods derives from substituting firms' profits, the government budget identity and the market clearing condition for nontradable goods into the household budget constraint:

$$C_t^T = Y_t^T + B_t - \mathbb{E}_t \left[M_{t+1}^s B_{t+1}^s \right] \tag{10}$$

Definition 1 *(Competitive Equilibrium) A competitive equilibrium for this economy consists of allocations* $\{C_t^T, C_t^N, L_t, \{B_{t+1}^s\}_{s \in S}\}$ *and prices* $\{P_t^N, W_t\}$ *such that taking as given the monetary policy* $\{p_t\}$*, macroprudential policies, wage subsidy and prices, households maximize their lifetime utility (1) subject to their budget constraint (2) and borrowing constraint (3); firms maximize profits; markets for labor, tradable and nontradable goods clear.*

In line with the optimal policy literature, I take the primal approach by substituting away the policy instruments using the associated equilibrium conditions. This yields the following implementability result:

Lemma 1 *An allocation* $\{C_t^T, C_t^N, L_t, \{B_t^s\}_{s \in S}\}$ *and prices* $\{\pi_t, p_t\}$ *form part of an equilibrium if and only if the conditions (3), (4), (8), (9), and (10) are satisfied.*

Note that the implementability result is obtained by assuming that the government has access to tools that can target both the level and composition of security holdings of households. Without these tools, the relevant household optimality conditions become additional implementability constraints for the policymaker, as shown below.

3 Optimal Policy Analysis

In this section, I analyze optimal policy design and whether monetary policy has a prudential role. First, I discuss the externalities and inefficiencies that shape the optimal policy actions. Then, I characterize the optimal monetary policy under commitment and discretion. In each case, I investigate how the tradeoffs that monetary policy faces depend on the availability and nature of additional prudential instruments. In what follows, I assume that the wage subsidy is only used to eliminate the inefficiency resulting from imperfect competition in the production of intermediate nontradable goods. This means that the subsidy is time invariant and set to the inverse of the elasticity of substitution between varieties, $\phi^n = 1/\varepsilon$. Setting an optimal wage subsidy in each period would give another optimality condition and provides little or no realism for the optimal policy design.

3.1 Frictions, Externalities and Inefficiencies

Next, I will discuss nominal and financial frictions in this economy and how they create inefficiencies.

Nominal Frictions and Aggregate Demand Externalities

The first friction is nominal rigidity, that is, costly price adjustments in the nontradable sector. Because resetting prices is costly, after the realization of a shock, the prices of nontradables do not adjust as they would under flexible prices. This leads to either over- or under-production of nontradable goods compared to the production under flexible price level, hence an output gap. Also, any price change reduces the amount of nontradable goods available for consumption, thereby inducing welfare losses. Households do not take into account the impacts of their demand on the price adjustments. Therefore, there are aggregate demand externalities. These externalities are associated with two inefficiencies: inflation and output gaps.

To ease the notation, instead of using the standard output gap concept in the New Keynesian literature, following Farhi and Werning (2016), I will analyze optimal policies using a closely related equilibrium object, the labor wedge, which indicates the wedge between social marginal cost and benefit of transforming labor into nontradable goods:

$$\tau_t = 1 + \frac{1}{A} \frac{U_{L,t}}{U_{N,t}}.$$

The labor wedge is proportional to the output gap and is zero in the flexible price allocations. A positive wedge indicates an output that is below its efficient level (or a recession). As will be shown below, when the borrowing constraint is binding, monetary policy increases the borrowing capacity of the economy, which requires having an exchange rate not depreciated enough to close the output gap. This results in a positive labor wedge in a financial crisis.

Financial Frictions and Pecuniary Externalities

The second friction is due to the existence of the borrowing constraint that depends on the relative price of tradable goods. As the literature shows, this friction leads to pecuniary externalities because private agents do not internalize how their portfolio decisions impact the relative price of tradables through the absorption of tradable goods. In the states in which the borrowing is constrained, lower absorption of tradables due to lower wealth depreciates the real exchange rate (or equivalently, raises the price of tradables relative to nontradables) in an equilibrium. A depreciation in the real exchange rate makes the borrowing constraint even more stringent and further reduces the tradable goods consumption. This is a version of financial amplification through Fisherian debt deflation: A binding borrowing constraint leads to a reduction in net capital inflows, which results in falling in real exchange rates and adverse balance sheet effects through a tighter borrowing constraint; thus leads to even more reduction in net capital inflows. Because this mechanism operates through relative prices, which is an equilibrium object, private agents do not consider how their actions contribute to it, and they accumulate too little wealth in tranquil times.

Remark 1 *Private agents' security holdings in decentralized equilibrium is generally inefficient and it exhibits inefficiencies in*

(i) total volume: the level of total borrowing is excessive, i.e., private agents overborrow,

(ii) composition: portfolio allocation is not socially desirable, i.e., private agents underinsure.

To better understand how pecuniary externalities lead to portfolio inefficiencies in the current setup, suppose that prices are fully rigid[9] at $P_t^N = 1$ for all t and policymaker has access to a distinct capital controls tax for each security. Then the policymaker's problem becomes maximizing households' life time utility (1) subject to the implementability constraints (3), (6), (9), (10). Also, suppose that there is no financial crisis in the current period. Under these conditions, the Euler equations of the policymaker becomes:

$$U_{T,t} = \beta U_{T,t+1}^s \left(1 + \mu_{t+1}^{*,s} \Phi_{t+1}^s\right) R_{t+1}^s, \qquad \forall s \in S \tag{11}$$

where $\mu_{t+1}^{*,s}$ is the policymaker's lagrange multiplier on the borrowing constraint at time $t+1$ in state s, and $\Phi_{t+1}^s \equiv \frac{\kappa(U_{NT,t+1}^s - U_{TT,t+1}^s)}{U_{T,t+1}^{s2} p_{t+1}^s} > 0$. Weighting these state dependent Euler equations with their associated probabilities and summing across states yields:

$$U_{T,t} = \beta \mathbb{E}_t \left[U_{T,t+1}^s \left(1 + \mu_{t+1}^{*,s} \Phi_{t+1}^s\right) R_{t+1}^s\right]. \tag{12}$$

Similarly, applying the same steps to the households' Euler equations 6, we have

$$U_{T,t} = \beta \mathbb{E}_t \left[U_{T,t+1}^s R_{t+1}^s\right]. \tag{13}$$

Because of the assumptions that the constraint is not currently binding and the nontradable good price is rigid, the marginal benefit of an additional unit of borrowing, given by the left hand side of the equations, are the same for households and the policymaker. However, private and social marginal cost of an additional unit of borrowing (the right hand side of the equations) are different, if there is a nonzero possibility of a binding borrowing constraint in some states $\mu_{t+1}^{*,s} \neq 0$. A higher level of debt, first, directly reduces tradable good in the next period. Second, there is an indirect channel. In the states in which the constraint is binding, this reduction in the absorption of tradable goods further decreases the relative price of tradables and makes the constraint even tighter as explained above, which reduces tradable goods consumption even more. The planner takes into account these secondary general equilibrium impacts of borrowing, summarized by the term $U_{T,t+1}\mu_{t+1}^* \Phi_{t+1}$, while private agents do not. For private agents, the marginal value of the next period tradable consumption is $U_{T,t+1}$, while for the government it is $U_{T,t+1}\left(1 + \mu_{t+1}^* \Phi_{t+1}\right)$. Consequently, private debt accumulation is inefficiently high, that is, households overborrow.

[9]This means resetting price is "too costly" i.e., $\varphi \to \infty$.

In addition to overborrowing (inefficient wealth distribution across time), households' security holdings suffer from underinsurance (inefficient wealth distribution across states) due to the existence of pecuniary externalities. Comparing private agents' and the planner's optimality conditions for portfolio allocation between a crisis state sc and a non-crisis state sn at $t+1$ is illustrative for this point:

$$U_{t+1}^{sn} R_{t+1}^{sn} = U_{t+1}^{sc} R_{t+1}^{sc} \tag{14}$$

$$U_{t+1}^{sn} R_{t+1}^{sn} = U_{t+1}^{sc} \left(1 + \mu_{t+1}^{*,sc} \Phi_{t+1}^{sc}\right) R_{t+1}^{sc}. \tag{15}$$

Equation (14) is obtained from the households' optimality condition (7), and equation (15) is the policymaker's optimality condition for the portfolio shares under the fully rigid nontradable goods price assumption. Whether there is a binding constraint or not, households value the tradable goods consumption by its direct effect U_T. Thus, at the optimum, they allocate their portfolio such that the marginal benefits of tradable consumption is equal to the relative cost of securities. The policymaker also makes this marginal cost-benefit tradeoff. However, in crisis states the value of an additional unit of consumption is not just U_T but also $U_T(1+\mu^*\Phi)$ due to the secondary general equilibrium effects as explained before. That's why although the marginal cost of allocating wealth from the non-crisis state sn to the crisis state sc (the left hand side) is the same for both private agents and the policymaker, marginal benefit (the right hand side) is different. As a result, private agents misallocate their portfolios and take excessive risks. This is the underinsurance problem.

Importantly, having the full set of Arrow securities clearly shows that overborrowing in and itself, is not the main problem but underinsurance is. This is because low level of wealth is a source of inefficiency in bad states but not in good states. However, consumption smoothing across states induces private agents to have a higher level of borrowing than the policymaker in good states as well. With arbitrary composite securities (such as bonds or equities) one cannot distribute wealth across states however one wishes, thus overborrowing and underinsurance is more tightly connected.

The relationship between the volume and composition of debt securities. In this environment, under some mild assumptions, if the total level of borrowing exogenously increases, private agents also reallocate their portfolio to increase their wealth in bad states. This is because as their total liabilities increase, the consumption risk in a crisis also increase. Therefore, private agents want to contain their exposure by having more insurance. As the quantitative analysis shows, this has important policy implications. The following example illustrates this point.

Example. Suppose that there are only two states of the world, crisis and noncrisis, with probabilities pr_c and pr_n. Private agents allocate their exogenously given debt B at time 0 between crisis period securities b_c and noncrisis period securities b_n so that $b_c + b_n = B$. In the crisis period they pay back $b_c r_c$ while in the noncrisis period they pay back $b_n r_n$ to international investors. Domestic agents' exogenous endowment is Y_s with $s \in \{c,n\}$ and $Y_n > Y_c$. As a result, the agents' problem becomes

$$\max \quad \sum_{s\in\{c,n\}} pr_s U(C_s)$$
$$\text{s.t.} \quad C_s = Y_s - b_s r_s$$

An optimal portfolio allocation then has to satisfy a version of the condition (7):

$$\frac{pr_c U_C(c)}{pr_n U_C(n)} = \frac{r_n}{r_c}.$$

where $U_C(s)$ is marginal utility of consumption in state s. Assuming homothetic preferences, this implies $C_n = g(\frac{pr_n r_n}{pr_c r_c})C_c$ for some increasing function g. Then, it is easy to show that $\frac{\partial(b_n/b_c)}{\partial B} > 0 \iff g(\frac{pr_n r_n}{pr_c r_c}) > \frac{Y_n}{Y_t}$, which means that an increase in the total liabilities is associated with more insurance. Furthermore, if we also assume that the probability of a crisis increasing with a higher level of debt[10] B, then one can also show in the above setup that there is an additional motivation for agents to shift their allocation from b_c to b_n. ■

To summarize, there are two relevant frictions in this setup, costly price adjustments and the borrowing constraint that depends on the exchange rates. These two frictions lead to aggregate demand and pecuniary externalities that are associated with four inefficiencies: labor wedge, inflation, overborrowing, and underinsurance. The policymaker takes into account these frictions when designing an optimal policy mix.

Also note that due to the modelling assumptions, other possible motives of monetary policy that are usually present in open economy setups do not exist here. Two such motives are manipulating terms of trade and "completing" financial markets by adjusting asset returns. Both terms of trade and asset returns are exogenous to the policymaker in this study. Therefore, they do not play any role in shaping the optimal policy.

3.2 Policy Instruments

The monetary policy instrument in this study is the nominal exchange rate, or equivalently, the local currency price of tradable goods. Due to staggering prices in the nontradable sector, by adjusting the exchange rate, monetary policy impacts the relative price of tradable and nontradable goods. Through this expenditure switching between the two sectors, the policymaker affects the demand for nontradables and manipulates inflation and the labor wedge.

For additional prudential instruments, I consider capital control taxes that the policymaker imposes on transactions in international securities. By adjusting these taxes, the policymaker distorts private in-

[10]This will, indeed, be the case in the quantitative analysis: A higher total level of debt increases the probability of a binding borrowing constraint in the future, holding everything else constant.

tertemporal and intratemporal financial decisions. This allows the policymaker to choose allocations without having to respect the relevant households Euler equations given by (6). These sets of Euler equations can be rewritten in the forms of (13) and (7) to study the implications of distinct and uniform capital control taxes. If the policymaker has access to the distinct capital control taxes that can be differentiated by forms of capital inflows, then both (13) and (7) are not a constraint for the policymaker.[11] When, instead, uniform taxes are available, so that the policymaker cannot directly adjust portfolio allocations, then although (13) is not a constraint, the policymaker has to respect the private equilibrium conditions (7). If no capital control tax is available, then both both (13) and (7) enter as constraints to Ramsey problems. I assume that the proceeds from capital control taxes are rebated to households so that the government always has a balanced budget.

Next, I will study how optimal policy mixes should be designed considering the inefficiencies outlined above.

3.3 Optimal Policies under Commitment

In this subsection, I will characterize optimal monetary policy with the premise that the policymaker is able to commit. Due to the existence of inefficiencies described above, the policymaker has three separate roles in this economy. The first is the standard role of macroeconomic stabilization, which involves stabilizing prices and closing the output gap. Second, in a financial crisis, i.e., when the borrowing constraint is binding, the policymaker aims to ease the credit conditions by increasing the value of collateral. Finally, in normal times, monetary policy leans against the wind to correct the financial inefficiencies that capital inflows create. This policy reduces the severity and frequency of financial crises. The next proposition explains how these roles interact with each other depending on the availability of additional prudential instruments.

Proposition 1 *Optimal monetary policy under commitment has the following properties:*

1. *without the financial friction (if the borrowing constraint is never binding), it achieves the perfect macro stabilization by eliminating inflation and closing labor wedge, i.e.,* $\pi_t = \tau_t = 0$.

2. *with the financial friction,*

   (a) *under distinct capital controls*

      i. *in normal times, it is able to fully stabilize the economy (*$\pi_t = \tau_t = 0$*) if the most recent crisis is sufficiently past,*

      ii. *in a financial crisis, it strikes a balance between macroeconomic stabilization and relaxing the borrowing constraint,*

[11] As an alternative to distinct capital controls, the policymaker might also accumulate reserves for prudential purposes, as in Arce et al. (2019). Appendix C shows the reserve accumulation case.

iii. it is not prudential,

(b) under uniform capital controls

i. in normal times, it deviates from macroeconomic stabilization to target private agents' portfolio allocations by promising a more severe crisis when the constraint binds,

ii. this macroprudential role only exists if there is a nonzero possibility of a financial crisis in the future,

iii. in a financial crisis, it aims for increasing capital inflows by relaxing the borrowing constraint,

(c) without capital controls

i. in normal times, it deviates from macro stabilization to target both level and composition of households' debt by (1) promising a more severe crisis when the constraint binds (2) increasing private marginal cost of borrowing,

ii. this macroprudential role only exists if there is a nonzero possibility of a financial crisis in the future,

iii. in a financial crisis, it aims for increasing capital inflows by relaxing the borrowing constraint.

Proof See Appendix A.1.

An immediate observation from these results is that in the event of a financial crisis, to alleviate the severity of the crisis, monetary policy increases domestic agents' borrowing capacity by increasing the value of collateral and relaxing the credit constraint, regardless of the capital controls. This requires appreciating the local currency to decrease the relative price of tradables. However, reducing the relative price of tradables induces an expenditure switch from nontradable goods to tradable goods, which leads to underproduction, deflation, and a recession in the nontradable sector. This tradeoff between easing financial conditions and ensuring macroeconomic stabilization is usually present in open economy models with financial frictions (see Farhi and Werning (2016), Ottonello (2021), Coulibaly (2022), among others). In reality, many EME central banks face a similar dilemma as monetary easing might stimulate demand but also it depreciates the currency and reduces capital inflows to the economy. To see this tension more clearly in this environment, suppose the nontradable goods price is extremely rigid at $P^N = 1$ and policymaker has access to the full set of prudential instruments. Then monetary policy can be characterized by the following simple expression

$$\underbrace{U_{N,t}^2 \tau_t (p_t)^2}_{\text{macro stabilization}} = \underbrace{\mu_t^* \kappa \left(U_{TN,t} - p_t U_{NN,t}\right)}_{\text{relaxing the borrowing constraint}}$$

which indicates that in a financial crisis ($\mu_t^* > 0$), monetary policy has to sacrifice macroeconomic stabilization ($\tau \neq 0$) in order to relax the borrowing constraint. Conversely, macroeconomic stabilization is only possible if the constraint is not binding.

Remark 2 *Inflation stabilization is generally not the optimal policy.*

Importantly, considering various types of capital inflows reveals that inflation stabilization is the optimal monetary policy in financially fragile economies only under rare circumstances. The first is the absence of the credit frictions (and therefore financial frictions), that is, when κ is sufficiently large. There is no financial crisis and no need to increase capital inflows[12] without an occasionally binding borrowing constraint. Moreover, as a consequence of the absence of the borrowing restriction, there is no pecuniary externality and thus, neither overborrowing nor underinsurance arises. This also eliminates the need for prudential action. As a result, monetary policy can focus entirely on stabilizing prices and closing the labor wedge.

Another case when perfect price stabilization is the optimal policy is when there is a full set of policy instruments that can target both the level and the composition of capital inflows *and* the last financial crisis has occurred a sufficiently long time ago. The prudential instruments considered in this study can perfectly eliminate the financial inefficiencies (overborrowing and underinsurance) without directly interfering with the non-financial inefficiencies of the labor wedge and inflation. Therefore, when they are in place, the only role left for monetary policy is macroeconomic stabilization. The requirement that the last crisis hit the economy sufficiently in the past is due to the commitment assumption. If there was a financial crisis that resulted in a deviation from macroeconomic stabilization recently, then convex price adjustment cost requires to adjust nontradable goods price through time, rather than in just one period. This is only possible under commitment. As a result, if there was a recent crisis, even with perfect instruments and without a financial crisis in this period, monetary policy still deviates from zero inflation to keep previous price adjustment promises.

A key feature of the current model that makes price stabilization to be optimal under aforementioned conditions is the possibility of simultaneously eliminating inflation and output gap; that is, the divine coincidence (Blanchard and Galí 2007) exists. In general, in open economy models, there is a tension between closing output gap and stabilizing prices, as explored by Corsetti et al. (2010). The absence of a compromise between inflation and labor wedge in the current setup is due to a combination of different factors. Importantly, here inflation and labor wedge are defined with respect to only nontradable sector which does not feature any other frictions. Also, terms of trade is exogenous because of the existence of homogeneous tradable goods with an exogenous price in foreign currency. Finally, there are no real or nominal frictions other than staggering nontradable goods prices and credit frictions.[13] Without these assumptions of the model, the divine coincidence would not exist.

[12] In fact, without a borrowing constraint that depends on exchange rate (or any other policy instrument) the policymaker is not able to directly adjust capital inflows other than through changing the demand for tradable goods.

[13] The existence of credit frictions worsens the trade off between output gap and consumer price inflation (CPI) but not between output and tradable good inflation. Here, CPI is not inherently a source of inefficiency.

Remark 3 *Absent from the relevant full set of capital controls, optimal monetary always policy has a prudential element.*

Without the full set of prudential instruments that can target the size and composition of households' borrowing, monetary policy has a prudential role to correct inefficiencies in private portfolios since they contribute to more frequent and severe financial crises. In order to examine how monetary policy reacts to portfolio inefficiencies, let us suppose that there is no financial crisis in the current period and that the nontradable good price is fully rigid at $P^N = 1$. Assuming that there are no other prudential instruments, monetary policy can be characterized by the following expression in a target form

$$\underbrace{U_{N,t}\tau_t}_{\text{macroeconomic stabilization}} = \underbrace{\lambda_{5,t-1}U_{TN,t}R_t}_{\text{addressing underinsurance}} \underbrace{+\lambda_{6,t}U_{TN,t} - \beta\lambda_{6,t-1}U_{TN,t}R_t}_{\text{addressing overborrowing}} \tag{16}$$

where λ_5 and λ_6 denote the policymaker's lagrange multipliers on the optimality condition for portfolio allocation (7) and the households' Euler equation (13) respectively. Note that to emphasize the monetary policy actions on addressing overborrowing and underinsurance, I break the households' financing decisions into two steps: deciding how much to save or borrow and allocating this sum across different states. In other words, I break the condition (6) into two separate conditions: (7) and (13).

The prudential actions of monetary policy are given on the right side of the above formulation. These actions involve adjusting the private benefits of tradable goods, U_T. All of the terms on the right hand side has U_{TN} in them, meaning that monetary policy uses expenditure switching between tradable and nontradables to improve financial stability. Depending on the degree of complementarity between tradables and nontradables, the policymaker either creates a boom or recession in the nontradable sector to adjust the private value of tradables U_T.

First, consider the case in which the policymaker has access to uniform capital control tax. Then the households' Euler equation (13) is not a constraint to the policymaker and the terms in the last bracket in the above expression drop. In this case, monetary policy tradeoffs between macroeconomic stabilization and keeping a promise from the last period. At time $t-1$, the policymaker promises that in the states of time t where the repayment cost is high (R^s_t is high), it will make marginal cost of not having additional insurance, U_T, also high. This requires to depart from macroeconomic stabilization (i.e., $\tau_t \neq 0$). Importantly, this promise is the only policy action available through which monetary policy can address underinsurance. For a given borrowing level, portfolio choice is a forward-looking optimization problem that involves future excess returns and consumption risk. The assumption that portfolio returns are exogenous to the policymaker leaves promising to increase the consumption risk in the future bad states as the only policy action to adjust portfolio weights.

If both the level of capital inflows as well as portfolio shares cannot be targeted by additional prudential instruments, monetary policy aims to reduce overall borrowing as well. Under commitment, this can be done through two policy actions. First, at time t, the policymaker increases the cost of borrowing by reducing private marginal value of tradables, $U_{T,t}$. Second, at time $t-1$, the policymaker increases the value of additional wealth at time t by promising an increase in the private marginal value of tradables $U_{T,t}$. However, once household borrowing decisions are already made at time $t-1$, this promise of increasing $U_{T,t}$ at time t is in contrast with the first action (decreasing $U_{T,t}$). This is a source of the time inconsistency problem.

What is the resulting monetary policy stance in a given state? Is it expansionary or contractionary policy in nontradable sector? This depends, first, on the combined impacts of the three action—one for targeting underinsurance and two for targeting overborrowing—explained above, that is, $\left(\lambda_{5,t-1}R_t - \beta\lambda_{6,t-1}R_t + \lambda_{6,t}\right)$. The sign of this expression reveals whether the policymaker wants to increase or decrease the private marginal utility of tradables, $U_{T,t}$. Second, whether this translates into creating a recession or a boom in the nontradables depends on the substitutability between tradables and nontradables, that is, on the sign of $U_{TN,t}$.

Remark 4 *Having additional prudential instruments help insulate the domestic economy from external shocks.*

The results also speak to the recent global financial cycle (GFC) literature that studies whether and how countries insulate themselves from the GFC (see, e.g., Rey 2015). The external shocks in this setup are the ones to the pricing kernel of international investors and, thus, to asset payoffs. If the economy is in a financial crisis, then any change in the debt repayment cost affects the domestic consumption of tradable goods and the exchange rates. Through these, asset price changes have a direct impact on the tightness of the collateral constraint, inflation, and labor wedge. Also, without distinct capital controls, external shocks translate into changes in inflation and labor wedge, even in normal times. Shocks to the cost of borrowing changes the monetary policy stance, as can be seen from (16). With a full set of instruments, on the other hand, monetary policy does not face a trade off between macroeconomic stabilization and financial stabilization, and any external shock can be absorbed through exchange rate movements which then lead to an adjustment of the relative price of tradables. In this case, the external shock does not have an impact on inflation and the labor wedge. In this sense, monetary policy is inward looking.

Remark 5 *The resulting allocation is (constrained) efficient only if distinct capital controls are in place and the last crisis has occurred a sufficiently long time ago.*

Because the policymaker cannot undo the frictions that stem from the existence of the borrowing constraint, the first-best allocations are unattainable in this setup. A closely relevant welfare metric used by the literature is constrained efficiency. Constrained efficient allocations are obtained by the policymaker who faces the same financial constraints as private agents but fully internalizes the impacts of their financial decisions on the equilibrium. Without a proper set of instruments that can fully target households' portfolio size and weights, the pecuniary externalities cannot be eliminated. Only with a full set of instruments and after a long period of tranquil times[14], the constrained efficient allocations in

[14] The long period of tranquil times assumption is necessary to completely eliminate the welfare reducing price adjustment.

which external liabilities do not feature overborrowing and underinsurance can be achieved. This means monetary policy cannot substitute for prudential policies, and these relevant additional prudential policies are welfare improving.

3.4 Optimal Policies under Discretion

What are the features of optimal time consistent policies in this environment? To answer this question, in line with the optimal time consistent policy literature (e.g. Klein et al. 2008), I investigate an equilibrium in which the current planner knows that the future planners will re-maximize in future periods, but knows that those maximizations also depend on today's financial decisions B^s_{t+1}. A Markov-perfect equilibrium is a fixed point in these policy actions. Using this equilibrium concept, the next proposition characterizes the time consistent monetary policy, depending on the nature of macroprudential tools.

Proposition 2 *Optimal time consistent monetary policy has the following properties*

1. *without the financial friction (if the borrowing constraint is never binding), it achieves perfect macro stabilization by eliminating inflation and closing labor wedge, i.e.,* $\pi_t = \tau_t = 0$.
2. *with the financial friction,*
   (a) *both under full instrument and under uniform macroprudential tax*
      i. *in normal times, it can fully stabilize the economy (*$\pi_t = \tau_t = 0$*)*
      ii. *in a financial crisis, it strikes a balance between macro stabilization and relaxing the borrowing constraint*
      iii. *it does not play any prudential role*
   (b) *without any other prudential instrument*
      i. *in normal times, it diverges from macro stabilization to target level of households' debt by increasing private marginal cost of borrowing*
      ii. *this macroprudential role exists only if there is a nonzero possibility of a financial crisis in the future*
      iii. *in a crisis, it aims for increasing capital inflows by relaxing the borrowing constraint*

Proof See Appendix A.2.

As in the commitment case, in a financial crisis, monetary policy under discretion has to compromise between macrostability and easier financial conditions (relaxing the borrowing constraint) regardless of the availability of prudential instruments. In normal times, the nature of the tradeoffs that the policymaker faces is different under discretion than under commitment.

Remark 6 *Discretionary monetary policy cannot directly target underinsurance.*

The last section shows that in normal times, absent from a full set of instruments that eliminates overborrowing and underinsurance, monetary policy wants to curtail financial inefficiencies in addition to macroeconomic stabilization. This tradeoff between financial stability (if left unaddressed by capital controls) and macroeconomic stabilization also exits under discretion. However, as the last subsection shows, threatening a more severe crisis is an essential tool of monetary policy for ensuring financial stability. As all future promises are futile under discretion, monetary policy is less potent to tackle the financial inefficiencies. As a result, monetary policy focuses more on macroeconomic stabilization, rendering it more inward-looking under discretion than commitment. Note that although discretionary monetary policy wants to target inefficiencies created by capital inflows if they are not addressed by the relevant capital controls, compared with the commitment case, it has fewer options to do so.

Specifically, without a future promise, monetary policy alone cannot directly address inefficient portfolio shares. This result is not surprising given that portfolio choice involves comparing future risk and returns of different assets and that monetary policy cannot impact them without a promise. One implication of this result is that discretionary monetary policies under both distinct capital controls and uniform capital controls face the same tradeoffs, since in both cases the only financial inefficiency that discretionary monetary policy can target (underinsurance) is already addressed by capital controls.

Remark 7 *Discretionary monetary policy faces less restrictive conditions for stabilizing inflation than under monetary policy commitment.*

In normal times, macroeconomic stabilization is the optimal discretionary policy, except for the case where there are no capital controls available to the policymaker. Consequently, for inflation targeting to be an optimal policy, it requires fewer conditions to be met than under monetary policy commitment. Note that the reasons why inflation stabilization is the optimal policy are different for the distinct capital control case and the uniform capital control case. In the former, all the financial inefficiencies are already addressed, so the only job left to monetary policy is to ensure macroeconomic stabilization. Under the uniform capital control tax case, although overborrowing is addressed, the underinsurance problem is still present, and monetary policy *would* address it if it had a way to do it (as in the commitment case). However, discretionary monetary policy lacks tools to address underinsurance, thus it focuses only on closing the output gap and eliminating inflation.

Remark 8 *Compared to single bond only setups, having multiple assets hinders the discretionary monetary policy's ability to address financial inefficiencies, as overborrowing and underinsurance are negatively related.*

Importantly, although discretionary monetary policy cannot directly address underinsurance, it can still target overborrowing when capital controls are not available to the policymaker. Through expenditure switching between tradable and nontradable sectors, monetary policy is able to alter the private cost of borrowing $U_{T,t}$ by adjusting $U_{TN,t}$. Therefore, the policymaker can reduce overborrowing to some extent, even without additional prudential instruments. However, as explained before, a lower level of borrowing reduces the probability of a financial crisis in the future, and thus the cost of underinsurance becomes lower. As a result, private agents have less incentive to make socially efficient portfolio choices if they accumulate lower debt, and in effect, undo at least some of the prudential gains of reducing the financial inefficiencies. This reduces the effectiveness of prudential actions of monetary policy. Therefore, the benefit of deviating from macroeconomic stabilization to reduce financial inefficiencies is lower than it would be if reducing overborrowing does not lead agents to increase the riskiness of their portfolio. As the marginal benefit is lower in this case, monetary policy gives more weight to macroeconomic stabilization. Indeed, in the quantitative analysis below, I show that discretionary monetary policy is more effective in prudential roles under a single bond setup than multiple security setup.

The result that time consistent monetary policy cannot directly address underinsurance together with the fact that overborrowing and underinsurance are negatively related to each other highlight the importance of well-crafted prudential tools. Monetary policy under discretion alone has much less ability to tackle financial inefficiencies. As the quantitative section shows, these inefficiencies are associated with large welfare losses if they are left unaddressed.

3.5 Summary of Policy Objectives

The previous two sections show that optimal monetary policy targets crucially hinge on the existence of other prudential instruments and commitment ability. Table 1 summarizes these findings. In every different configuration, monetary policy always has the traditional macroeconomic stabilization objective, namely stabilizing prices and closing the labor wedge. However, the financial stability role of monetary policy is contingent upon the state of the economy and the nature of policy tools. First, regardless of additional prudential instruments, if the economy is in financial crisis, monetary policy also relaxes the constraint by appreciating the currency. Second, if a financial inefficiency can be addressed by prudential policies such as capital controls or reserve accumulation, then monetary policy does not address it. Otherwise, monetary policy addresses both overborrowing and underinsurance under commitment but only the former under discretion.

Table 1: Monetary Policy Actions

	Full Instrument	Uniform Tax	No Other Instrument
Commitment	MS, (RB)	MS, (RB), AU	MS, (RB), AU, AO
Discretion	MS, (RB)	MS, (RB)	MS, (RB), AO

Note: This table summarizes the monetary policy actions depending on availability of other prudential instruments and commitment mechanism. MS: macro stabilization; RB: relaxing borrowing constraint; AU: addressing underinsurance; AO: addressing overborrowing.

4 Quantitative Model

In this section I show that the financial inefficiencies of overborrowing and underinsurance have quantitatively important impacts on severity and frequency of sudden stops, and hence on welfare. I also evaluate the welfare implications of alternative policy designs.

4.1 Preferences, Financial Markets and Policy Instruments

The household utility function in (1) takes the following form

$$U(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\varphi_L}}{1+\varphi_L}$$

Consumption good is a composite of nontradable C_t^N and tradable C_t^T consumption and given by

$$C_t(C_t^N, C_t^T) = \left[a^{\frac{1}{\eta}} \left(C_t^T\right)^{\frac{\eta-1}{\eta}} + (1-a)^{\frac{1}{\eta}} \left(C_t^N\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}},$$

where $\eta > 1$ is the intratemporal elasticity of substitution.

In the previous sections, I considered the full set of Arrow securities in the financial markets. Using these securities, one can create various forms of composite assets that are differentiated based on their risk and return profiles. In practice, capital flows are differentiated as equity flows and debt flows (Meng and van Wincoop 2020). Also, literature has documented that debt flows are usually cyclical and riskier for sudden stop prone economies, while equity flows are more benign (Korinek 2018, Forbes and Warnock 2012a, Razin et al. 1998). Based on this, in the quantitative model, I assume that there are two types of capital flows, debt and equity, with equity being safer for domestic agents. On the flip side, equity is riskier for international investors, so they require an equity premium to compensate for the risk.

Then, period budget constraint in local currency becomes

$$P_t^N C_t^N + P_t^T C_t^T + \mathscr{E}_t \left(B_{t+1}^d + q_{t+1}^e B_{t+1}^e \right) \leq W_t L_t + P_t^T Y_t^T + \mathscr{E}_t \left(B_t^d R_t^* + B_t^e R_t^e \right) + \Pi_t + T_t,$$

where B^d and B^e are bond and equity holdings of households, $q^e < 1$ is the price of equity. This price, and returns R^* and R^e are assumed to be set by the international investor's pricing kernel and are expressed in terms of tradable goods. As in the general model, these prices and returns expressed in tradable goods units are exogenous to the policymaker. I will assume that q^e and R^* are constant over time while R_t^e is stochastic in what follows. The borrowing constraint takes the following form

$$-\mathscr{E}_t \left(B_{t+1}^d + q^e B_{t+1}^e \right) \leq \kappa \left(P_t^T Y_t^T + P_t^N \right).$$

Table 2: Parameter values

Parameter	Description	Value	Source or Target
β	Subjective discount factor	0.91	Average NFA-GDP ratio = -29%
R^*	International interest rate	1.04	Bianchi (2011)
q^e	Price of equity	0.98	Equity to total liabilities = 48%
σ	Risk aversion	2	Standard value
φ_L	Inverse Frisch elasticity	1	Standard value
a	Weight on tradables	0.38	Benigno et al. (2013)
η	Elasticity of substitution	0.83	Mendoza (2005)
ε	Monopoly power	10	11% net markup
φ	Adjustment cost parameter	65	Three quarter of price stickiness
κ	Collateral coefficient	0.30	Frequency of crisis = 5.5 %
χ	Labor disutility coefficient	0.65	Mean labor = 1
A	TFP in non-tradable sector	1	Normalization

The rest of the model has the same structure as before. Appendix D provides private agents' optimality conditions and the government's problems.

4.2 Calibration

I calibrate the model to Argentina. Table 2 summarizes the parameter values and corresponding sources or targets. There are two categories of parameters. The first set of parameters are those whose values are fairly standard in the literature (Christiano et al. 2005, Mendoza 2005, Bianchi 2011, Devereux et al. 2019). These include international interest rate $R^* = 1.04$, risk aversion $\sigma = 2$, iverse Frish elasticity $\varphi_L = 1$, weight on tradables $a = 0.38$, elasticity of substitution $\nu = 0.83$, monopoly power $\varepsilon = 10$.

The second type of parameters are the ones used to match the moment of historical Argentinian data: $\beta = 0.91$ to have an average net foreign asset to GDP ratio of -29%; $\delta = 0.98$ to have an equity to total liabilities ratio of 48% (Lane and Milesi-Ferretti 2017); $\kappa = 0.304$ to have a frequency of sudden stop of 5.5%. The price adjustment parameter φ is chosen to have a three quarter of price stickiness (Faia and Monacelli 2008). I normalize mean labor and total factor productivity to one by choosing labor disutility coefficient $\chi = 0.65$ and $A = 1$.

The stochastic processes for endowment and equity returns are jointly assumed to have a bivariate first-order autoregressive process in log forms:

$$\begin{bmatrix} \ln\left(Y_t^T\right) \\ \ln\left(\frac{R_t^e}{\overline{R^e}}\right) \end{bmatrix} = \rho_s \begin{bmatrix} \ln\left(Y_{t-1}^T\right) \\ \ln\left(\frac{R_{t-1}^e}{\overline{R^e}}\right) \end{bmatrix} + \begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^R \end{bmatrix}$$

with

$$\left[\varepsilon_t^Y, \varepsilon_t^R\right] \sim \text{ i.i.d. } N\left(0, \begin{bmatrix} \sigma_Y^2 & \sigma_{Y,R^e}^2 \\ \sigma_{Y,R^e}^2 & \sigma_{R^e}^2 \end{bmatrix}\right).$$

For the tradable income data, I use the sectoral outputs from manufacturing, agriculture and total natural sources provided by the World Development Indicators (Bianchi 2011). I calculate the return on equity using the data on the Argentina Stock Market (MERVAL) index (Korinek 2018). Then I obtain the following parameter estimates:

$$\hat{\rho}_s = \begin{bmatrix} 0.726 & 0.092 \\ 0.184 & 0.097 \end{bmatrix}, \quad \hat{\Sigma}_\varepsilon = \begin{bmatrix} 0.0034 & 0.0152 \\ 0.0152 & 0.0561 \end{bmatrix}.$$

Then, based on Tauchen and Hussey (1991), I discretize this continuous process for the tradable endowment and equity returns. In what follows, following the literature, sudden stops are defined as an event in which the borrowing constraint becomes binding and current account reversal is more than one standard deviation.

4.3 Solution Method

In order to solve the model, I use a version of the endogenous grid points method proposed by Carroll (2006). I extend the method to the case where the borrowing constraint is endogenous[15], there is a portfolio choice, and there is optimally set monetary policy. The method uses backwards time iteration on the relevant optimality conditions. To simplify the multidimensional nature of the problem, I follow Carroll (2011) and first solve the optimal portfolio weights using the next period's optimal choices (policy functions), then with them, reconstruct the relevant policy functions. Again, treating these new policy functions as the next period's optimal choices, I solve for the rest of today's choice variables and the endogenous state variable of total debt repayment. In the next step, I follow the same procedure by treating the policy functions as the optimum future choices. I repeat these steps until the policy functions in the consecutive periods converge.

[15] For a similar approach, see Jeanne and Korinek (2019).

5 Quantitative Analysis

This section presents the results from the quantitative analysis. First, I show the ineffectiveness of prudential discretionary monetary policy in reducing the likelihood and severity of financial crises. Then, I compare prudential discretionary monetary policy with the inflation targeting regime. Finally, I investigate the impacts of the capital inflows structure on the effectiveness of prudential monetary policy,

5.1 Ineffectiviness of Prudential Monetary Policy

5.1.1 Policy Functions

For a given negative one standard deviation shocks, Figure 1 depicts the policy functions that maps the external wealth at the beginning of the period[16] (B_tR_t) to endogenous variables, tradable consumption, total savings, equity share in total financing and inflation. In the graphs, the three lines correspond to different policy mixes based on the availability of capital controls. The solid blue line denotes the policy mix with distinct capital controls that can be distinguished for equity and debt flows. The dashed red line corresponds to the uniform capital controls case in which capital controls are the same for both types of flows; and the dashed-dotted line represents no capital controls. In each regime, monetary policy is assumed to be under discretion. Time consistent monetary policy is prudential only in the absence of capital controls. In the other two cases, monetary policy focuses on macroeconomic stabilization in normal times.

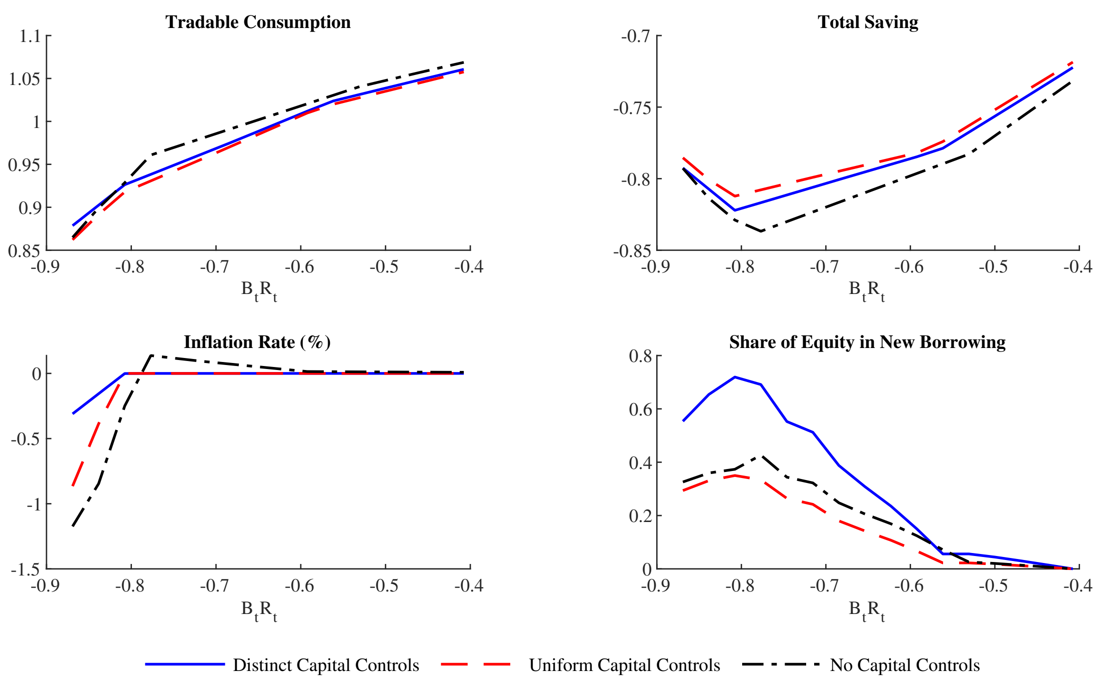
As is standard in sudden stop models, the decision rules are nonlinear. Further, the total saving and equity share policy mappings have kinks at the points where the borrowing constraint becomes binding. In the unconstrained region, total saving is increasing (or total financing from abroad is decreasing) in the total external wealth. Due to the existence of externalities, private agents tend to overborrow[17] without capital controls. Indeed, economy under no capital controls borrows the most. Remarkably, when the distinct taxes are available, the policymaker allows more borrowing than the uniform tax. This is because, the policymaker does not want to increase the next period wealth per se but to shift the wealth from bad states to good states and to change the composition of new financing. When this shift is possible, there is no need to reduce the total borrowing as much as in the uniform tax case. On the other hand, in the uniform tax case, the policymaker restricts the total borrowing sharply, since this is the only option to address financial inefficiencies. Tradable consumption follows the patterns of the total financing.

Equity shares are very small at first, then they increase with the total debt repayment in the unconstrained region. When there is no risk of a binding borrowing constraint in next period, the benefit of issuing equity is relatively low, so private agents prefer the cheaper option, issuing debt. As the risk of

[16]With a slight abuse of notation, I will refer B_tR_t as the total debt repayment, including both debt and equity outflows.

[17]Here overborrowing refers to carrying too little wealth to the next period by raising too much financing (both equity and debt) from abroad in the current period.

Figure 1: Policy Functions



Notes: B_tR_t denotes external wealth at the beginning of the period. This figure shows the policy functions under various policy mixes for negative one standard deviation shocks.

a binding borrowing constraint becomes positive, agents under all regimes issue more equity. As the solid blue line demonstrates, under the distinct capital controls case, the equity issuance is the largest. Although a higher equity share in liabilities provides more insurance by leading to higher wealth in bad states, private agents do not fully take advantage of it, thus underinsure. By imposing higher capital controls tax on bond issuance, the policymaker is able to induce agents to have a higher equity share. Further, the economy under no capital controls case has a larger proportion in equity than the one under uniform controls. As agents borrow more, they also want to use less risky instrument to contain overall riskiness of their total liabilities in the next period, $B_{t+1}R_{t+1}$.

Discretionary monetary policy focuses on macroeconomic stabilization if uniform or distinct capital control taxes are available in the unconstrained region. When the distinct taxes are available, all the financial inefficiencies are corrected by the capital controls, and monetary policy eliminates the costly price adjustments by stabilizing prices. If only uniform taxes are available, although overborrowing is addressed by the capital controls, underinsurance is not. However, discretionary monetary policy cannot address underinsurance because this requires a credible future promise. As a result, discretionary monetary policy again focuses on macroeconomic stabilization and does not play a prudential role—however, for different reasons than under distinct capital taxes. There is no need for monetary policy to be prudential in the distinct tax case, whereas there is a room to be prudential, but it discretionary monetary policy does not have tools for it, namely a credible threat.

If there is no additional prudential instruments, monetary policy deviates from price stabilisation to be prudential, and thus, there is a spike in the corresponding inflation decision rule in the unconstrained region. Monetary policy creates a boom in the nontradable sector, which then reduces the private value of tradable goods consumption (or increases cost of borrowing); and through this channel contains overborrowing to some extent. Because this entails welfare cost because of nonzero inflation and labor wedge, the policymaker does not fully eliminate overborrowing. Further, reducing total borrowing induces agents to have more risk since low level of total liabilities reduces the probability and severity of financial crises. Thus, in addition to inflation and the labor wedge, containing borrowing has another cost. As a result, capital controls are more effective and less welfare-costly than prudential monetary policy.

In the constrained region, consistent with the Fisherian debt deflation mechanism, as the total wealth decreases, consumption also decreases, and the real exchange rate appreciates, which then further tightens the borrowing constraint and reduces capital inflows (increases total savings). Because this mechanism works through a binding borrowing constraint, we observe a "v-shape" decision rule in total savings (or borrowing). As in the unconstrained region, equity shares follow borrowing patterns; as total borrowing decreases, so do equity shares of all policy regimes. When the borrowing constraint is binding, monetary policy faces a tradeoff: stabilizing prices and closing the output gap requires an expansionary monetary policy; however, relaxing the borrowing constraint requires a contractionary monetary policy to appreciate the currency and relax the constraint. The result is having deflation and a positive labor wedge (underproduction of nontradables). This trade-off is the most severe under a prudential monetary policy regime and the least severe under distinct capital controls. This translates into the highest drop in nontradable production and also in price under prudential monetary policy and the lowest in the distinct tax.

5.1.2 Crisis Dynamics

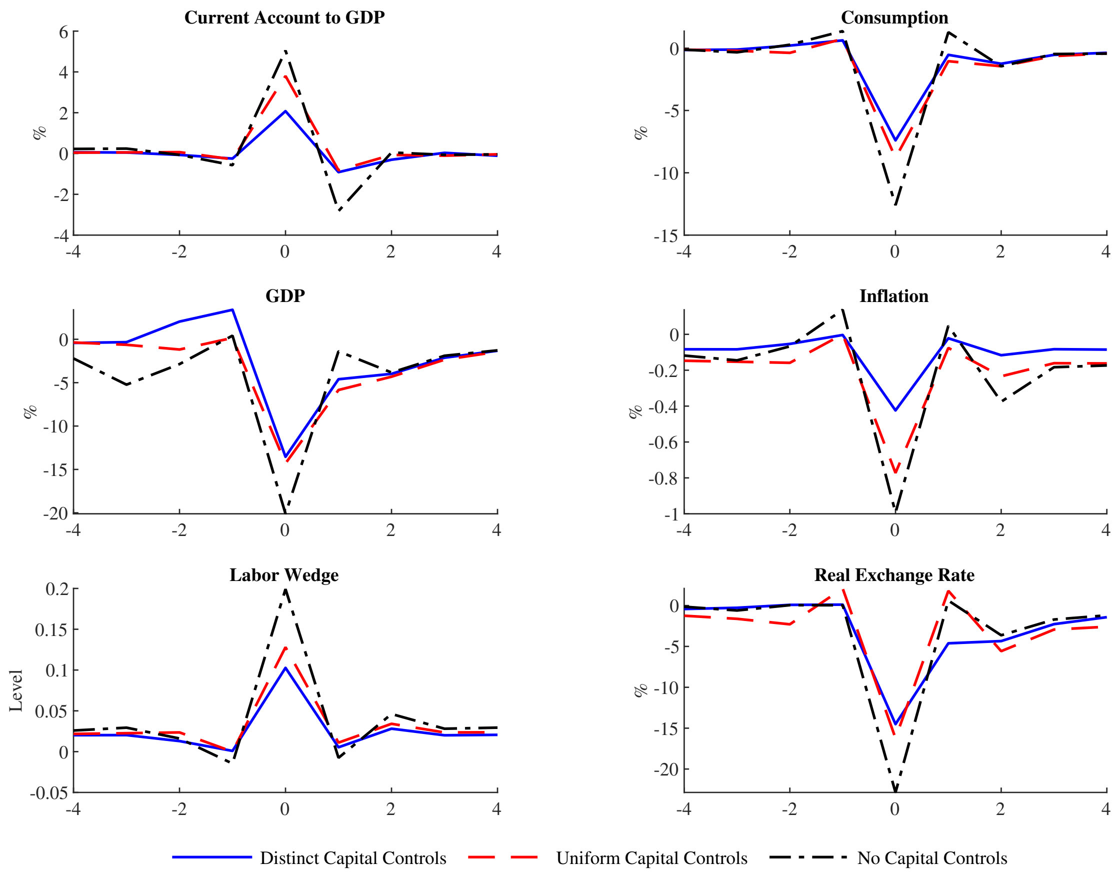
This section simulates the model and conducts an event window analysis to describe the sudden stop dynamics under different monetary and capital control mixes. A sudden stop is defined as a crisis in which borrowing constraint is binding and the current account is one standard deviation above its ergodic distribution. The model is simulated for 500,000 periods, using the same initial shocks and states for tradable endowment and equity returns for all different regimes. Then, based on the sudden stop definition, I identify crisis episodes and take the averages of the relevant variables around sudden stops. Figure 2 presents the results. The x-axes in the figure represent the timing such that time 0 denotes crisis periods and minus and plus numbers represent periods before and after the crisis. As before, the solid blue line, the dashed red line, and the dashed-dotted black line represent distinct capital controls, uniform capital controls, and prudential monetary policy regimes; and in all these regimes, monetary policy is optimally set under discretion.

The first observation from the figure is that sudden stops episodes are painful for the economy. In a sudden stop, current account largely reverses; consumption, production, inflation, real exchange rate sharply fall; labor wedge becomes positive, which represents underproduction of nontradable goods, i.e., recession. These results are consistent with the empirical sudden stop patterns of the corresponding variables in the data, for example, presented by Korinek et al. (2014) and Bianchi and Mendoza (2020).

Importantly, prudential monetary policy is inferior to capital controls in mitigating the severity of financial crises. In every panel of Figure 2, the economy in which monetary policy (rather than capital controls) plays a prudential role (dashed-dotted black line) suffers the most. Although monetary policy engineers the highest recession in the nontradable sector and the steepest drop in price level to ease the borrowing constraint, both the current account reversal and the consumption drops are still the highest in this case. This is because discretionary monetary policy is ineffective in playing a prudential role and resolving financial inefficiencies. As a result, agents enter into sudden stops with lower wealth and with a higher share of debt.

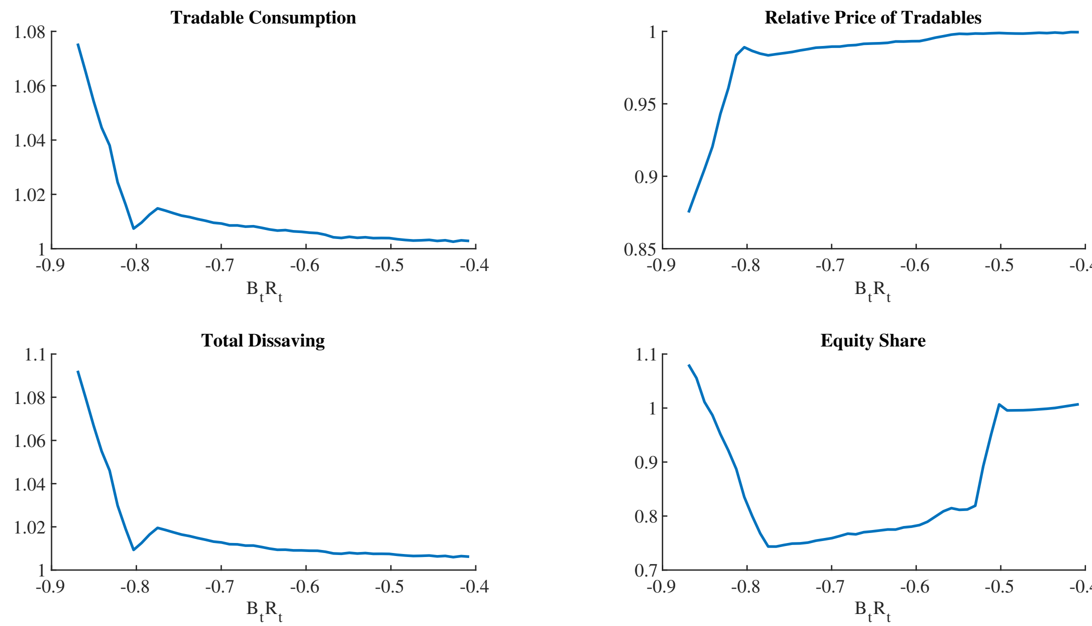
The figure also shows that the composition of liabilities is an important driver of the severity of financial crises, as the comparison of the solid blue line to the others reveals. Since the equity dividend payments decrease in a crisis, the value of existing liabilities also decreases in a sudden stop. Therefore, a higher share of equity in total liabilities makes financial crises less acute. Notably, even though total borrowing is greater in the distinct capital controls case than the uniform tax case, the crisis is less severe under the former. This indicates that for the strength of a financial crisis, not the level of total liabilities per se, but the composition of them matters.

Figure 2: Event Window Analysis



Notes: This graph shows the averages of variables around the sudden stop events. In the x-axes, 0 denotes the timing of sudden stops, while minus and plus numbers show the before and after crises.

Figure 3: Policy Function Ratios of Prudential Monetary Policy to Inflation Targeting



Notes: This graph shows the ratios of policy functions under prudential monetary policy to those under inflation targeting regime.

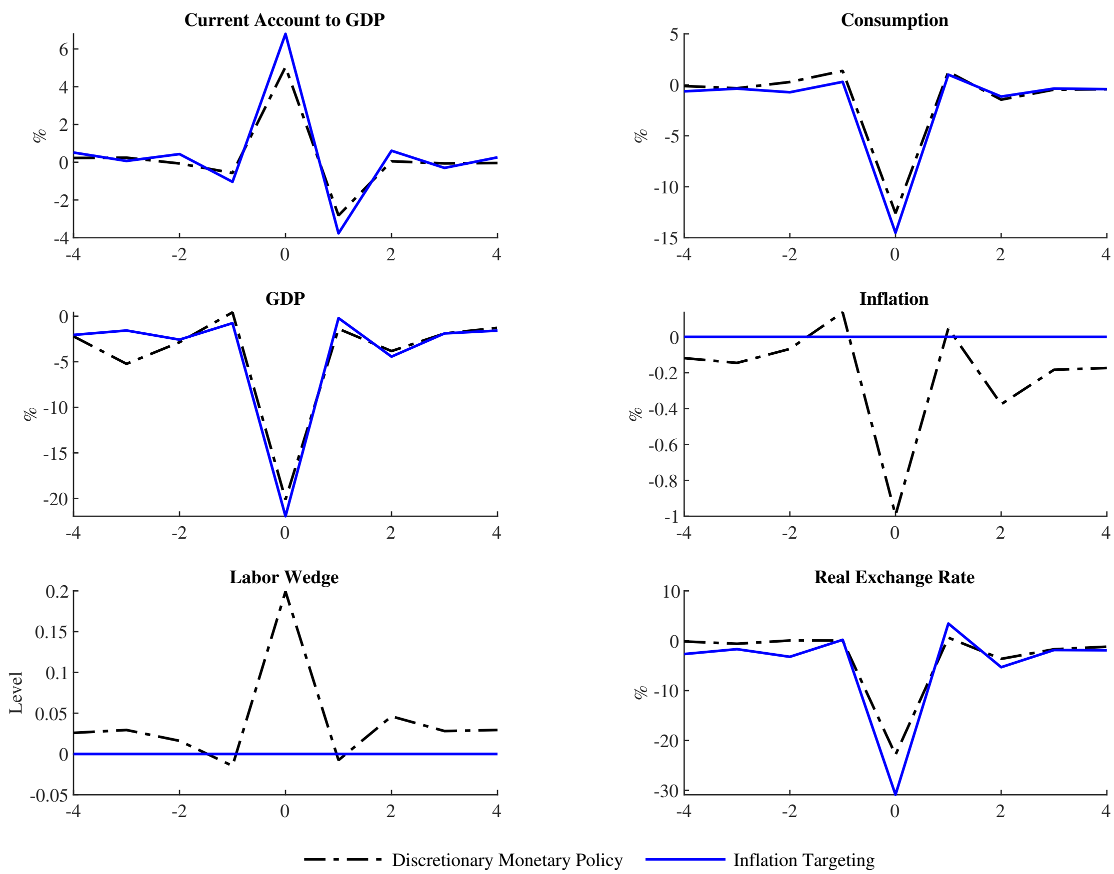
5.1.3 Prudential Monetary Policy under Discretion vs Inflation Targeting

Given that discretionary prudential monetary policy is not effective in addressing the financial inefficiencies of overborrowing and underinsurance, is there a benefit to deviating from the inflation targeting regime in the absence of additional prudential instruments? Next, I will investigate this question.

Figure 3 displays the ratios of policy functions in the discretionary prudential regime to those in the inflation targeting regime in the absence of capital controls. The only available option for monetary policy under discretion to address financial inefficiencies is to reduce the total financing of private agents from abroad. However, compared to inflation targeting regime (without prudential action), the total borrowing (sum of debt and equity issuance) is still higher under discretionary monetary policy (with prudential action). Under commitment, monetary policy is exclusively focuses on stabilizing inflation, even during a financial crisis, which makes sudden stops more acute. Thus, agents reduce their exposure by not only lowering their borrowing levels but also by increasing equity shares in total borrowing in the unconstrained region when there is a positive probability of a binding constraint in the future. Higher borrowing levels translate into higher consumption and a lower relative price of tradables under discretionary prudential monetary policy.

Although total debt repayment is higher under discretionary prudential monetary policy than under commitment, crisis episodes are less severe under the former than the latter, as shown in Figure 4. This

Figure 4: Event Window Analysis: Prudential Monetary Policy vs Inflation Targeting



Notes: This graph shows the averages of variables around the sudden stop events. In the x-axes, 0 denotes the timing of sudden stops, while minus and plus numbers show the before and after crises.

Table 3: Simulation Results

	Optimal Discretionary Monetary Policy			Inflation Targeting
	Distinct Capital Control Tax	Uniform Capital Control Tax	No Capital Control Tax	No Capital Control Tax
1. Crisis Dynamics				
Probability of crises	1.3	2.7	6.6	5.4
Change in				
Consumption(%)	-7.42	-8.81	-12.65	-14.52
CA/GDP	2.07	3.80	5.04	6.83
RER(%)	-14.50	-16.23	-22.86	-30.88
Labor wedge	0.09	0.12	0.19	0
GDP(%)	-13.54	-14.32	-20.11	-21.94
2. Long-run Moments				
Avg(Liability/GDP)	35.09	33.71	38.18	36.67
Avg(Equity Share)	0.46	0.22	0.26	0.29
Std(CA/GDP)	1.03	1.82	2.97	3.28
Std(RER)	5.26	5.31	6.97	7.04

Note: This table shows the simulation results for various policy regimes. CA and RER denote current account and real exchange rate; while Std and Avg denote standard deviation and average.

is because, under discretion, monetary policy can forgo price stability in order to increase the borrowing capacity of the economy by appreciating the currency in a crisis. However, the inflation targeting regime exclusively focuses on macroeconomic stabilization, regardless of the state of the economy. Importantly, as domestic agents anticipate this ex-post intervention, they take on too much risk under the prudential discretionary policy regime. This effect is stronger than the ex-ante prudential actions taken by monetary policy to induce agents to have less exposure.

5.1.4 Comparing Simulation Results for Different Regimes

The first panel of Table 3 summarizes the severity and frequency of sudden stops under the four different policy mixes considered so far. The first three columns show the results for discretionary monetary policy with distinct capital controls, uniform capital controls, and no capital controls; and the last column shows the outcomes for commitment to inflation targeting without capital controls.

In terms of the incidence of sudden stops, prudential monetary policy under discretion is the worst in the reducing frequency of financial crisis. Under discretion, having a uniform capital controls decreases the probability of crisis from 6.6% to 2.7% and having a distinct tax further reduces it to 1.3% in the ergodic distribution. Interestingly, even committing to a simple inflation targeting rule is better at reducing the probability of financial crisis. This is because, since private agents expect a more severe crisis under inflation targeting –as monetary policy focuses exclusively on price stabilization and thus does not ease the financial conditions– they insure themselves by accumulating total liability with more equity share.

Comparing in terms of the intensity of crises, no capital controls case is still the worst among the policy regimes under discretion. This shows prudential monetary policy, compared to capital controls, is not only ineffective at reducing the likelihood of a crisis but also the the severity of it. However, without capital controls, the economy under discretionary monetary policy has a milder crisis than the one under inflation targeting. Another observation is that having distinct capital controls that regulate both the level and composition of capital inflows reduces both the frequency and severity of financial crises.

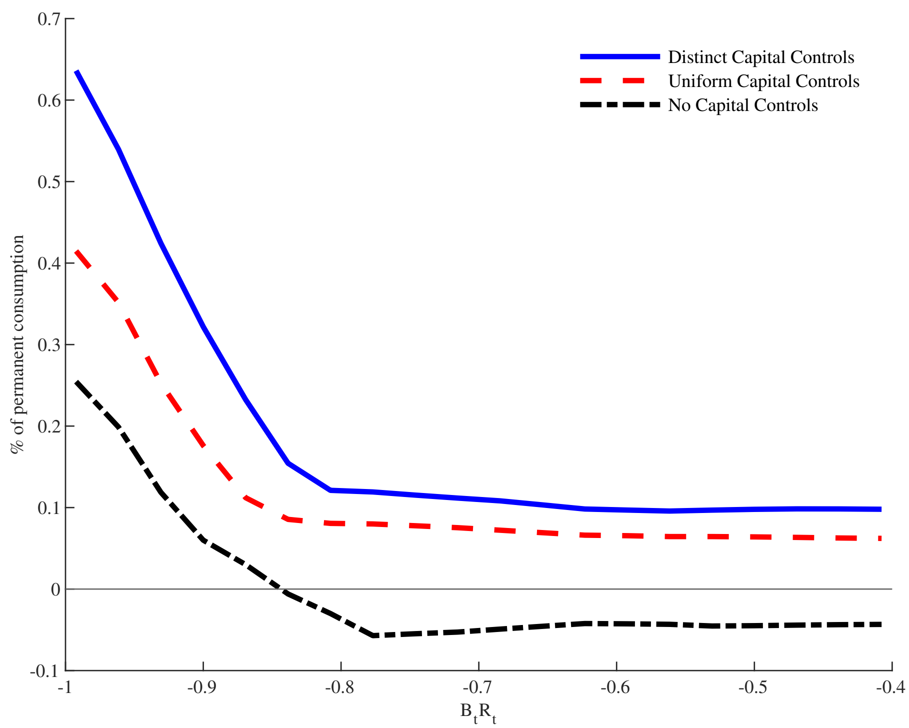
The second panel of Table 3 presents the long-run moments resulting from the simulation. Private agents borrow more with a higher share of risky instruments under discretionary prudential monetary policy as opposed to under discretionary monetary policy with distinct capital controls or compared to the inflation targeting regime. This is another evidence of ineffectiveness of prudential monetary policy compared to both the policy regimes with capital controls and to the inflation targeting regime. Capital controls also reduce the long-run volatility of the economy, as evident in the last two rows.

5.2 Welfare Implications

Figure 5 illustrates the state contingent welfare gains in terms of permanent consumption from discretionary prudential monetary policy (with no capital controls), discretionary monetary policy with uniform capital controls, and discretionary monetary policy with distinct capital controls relative to the inflation targeting regime without capital controls, conditional on a negative one standard deviation shock.

The figure shows that the ineffectiveness of discretionary prudential monetary policy manifests itself in welfare gains. Due to the existence of externalities, private agents tend to have too little wealth and issue too much debt in proportion. Capital controls are better tools than prudential monetary policy under discretion to address these financial inefficiencies. In both constrained and unconstrained regions, discretionary prudential monetary policy yields the lowest welfare compared to discretionary monetary policy regimes with capital controls. Also, there are significant welfare gains in having distinct capital controls that induce agents to borrow less in total with a smaller proportion of the riskier instrument, i.e., debt. Having more insurance and more wealth make sudden stops less frequent and less severe, hence the welfare gains. In the ergodic distribution, discretionary policies with distinct tax and uniform tax yield 0.36% and 0.24% higher welfare (in terms of permanent consumption) compared to the inflation

Figure 5: Welfare Gains Relative to the Inflation Targeting Regime



Note: This figure shows the state contingent welfare gains in terms of permanent consumption from discretionary prudential monetary policy (with no capital controls), discretionary monetary policies with uniform capital controls and with distinct capital controls relative to the inflation targeting regime without capital controls, conditional on a negative one standard deviation shock.

targeting regime.

Importantly, if capital controls are not available, commitment to inflation targeting yields lower welfare than under discretion in the constrained region, since sudden stops are more severe under the latter. However, in the unconstrained region, strict inflation targeting is a better policy than discretionary prudential monetary policy. In the ergodic distribution, the inflation targeting regime yields 0.04% higher overall welfare in terms of permanent consumption.

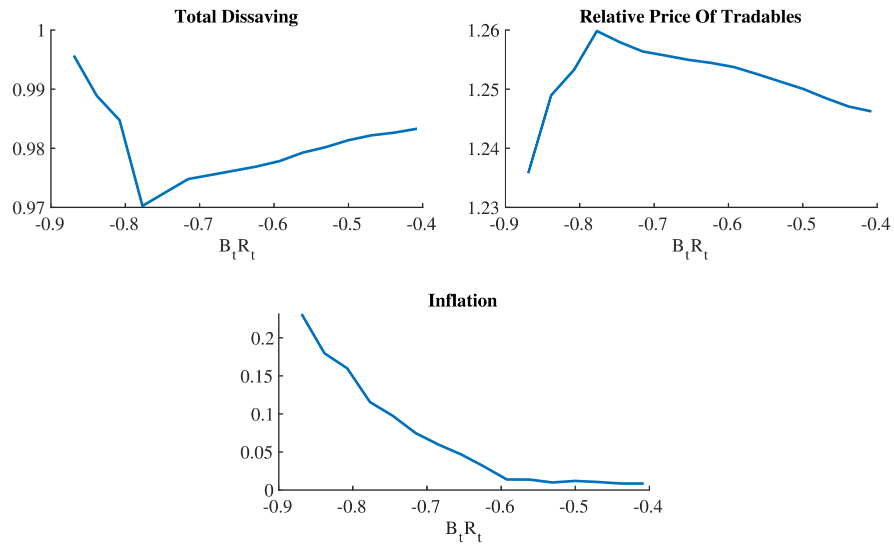
5.3 Prudential Monetary Policy under Heterogenous Capital Flows vs Uniform Flows

How does having multiple securities for external financing affect the potency of prudential monetary policy compared to single bond setups? To make this comparison fair, I create a synthetic instrument that is composed of the same bond and equity as before. I take their shares from the equilibrium of the discretionary monetary policy without capital controls case. As previously shown, the lower volume of total borrowing increases the share of the risky instrument, holding everything else constant. This decreases the marginal benefit of reducing total borrowing by having prudential monetary policy. For given marginal cost of deviating from perfect macroeconomic stabilization, this reduces the motivation of the policymaker for financial stabilization. This means that, if the liability shares were to remain constant, we would expect the policymaker to have a more prudential monetary policy, at the expense of macroeconomic stabilization in normal times. As the synthetic instrument allows for changing the volume without impacting the composition, it enables us to test this idea.

The result is given in Figure 6. The figure depicts the ratios of policy functions from the synthetic single security setup to those of multiple borrowing instruments, under the assumption of discretionary monetary policy without capital controls. In the single bond case, monetary policy reduces total borrowing more, especially in the regions where the probability of a financial crisis in the next period is higher. This requires more deviation from price stability, thus higher inflation in normal times. Moreover, the lower level of overall external liabilities reduces the need for appreciation of the local currency to relax the constraint in a crisis and therefore, less drop in the nontradable goods prices.

Having a smaller amount of borrowing translates into fewer and less severe sudden stops. Compared to the multiple bond setup, the single bond setup has a lower risk of financial crises (6.6% vs. 5.7%) and less painful sudden stops (12.65% vs 9.83% consumption drop). Therefore, this exercise shows that bond-only analyses have a tendency to overestimate the effectiveness of prudential monetary policy. Under multiple security setup, monetary policy is more ineffective in addressing financial inefficiencies associated with capital inflows.

Figure 6: Policy Function Ratios of Prudential Monetary Policy under Single Asset to Multiple Assets



Note: The monetary policy is assumed to be under discretion in both cases.

6 Conclusion

This paper describes optimal prudential monetary policy in EMEs that face volatile and different forms of capital flows, both analytically and quantitatively. Except for two cases—when there are distinct capital controls or when monetary policy is discretionary and capital controls are uniform for all types of capital inflows—optimal monetary policy always has a prudential element. However, this prudential monetary policy is highly ineffective for reducing the frequency and severity of financial crises, especially without commitment power. Notably, when the total volume of capital flows is restricted without manipulating the composition, private agents realize that the severity and frequency of financial crises decrease, and therefore choose an even higher proportion of riskier financing instruments. In this sense, they undo some of the benefits of a prudential policy. Combining this with the fact that without a credible threat, monetary policy cannot alter the composition of private liabilities, implies that monetary policy (especially under discretion) alone is ineffective for improving financial stability. Committing to a simple objective of inflation targeting yields a higher level of welfare compared with discretionary monetary policy with a prudential component. These results suggest that the primary tool for managing financial inefficiencies created by capital inflows should be prudential instruments, such as capital controls. Importantly, these tools should be employed not only to reduce the total level but also to alter the composition of capital flows.

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Appendix A Proofs

A.1 Proof of Proposition 1

The policymaker solves the following problem

$$
\begin{aligned}
&\max_{\{p_t, C_t^T, C_t^N, L_t, B_{t+1}^s, \pi_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t) \\
&\text{s.t.} \\
\lambda_{1,t}: \quad & U_{T,t} = p_t U_{N,t}, && \text{(A.1)}\\
\lambda_{2,t}: \quad & C_t^N = A_t L_t \left(1 - \frac{\varphi}{2}\pi_t^2\right), && \text{(A.2)}\\
\lambda_{3,t}: \quad & C_t^T = Y_t^T + B_t - \mathbb{E}_t\left[B_{t+1}^s / R_{t+1}^s\right], && \text{(A.3)}\\
\lambda_{4,t}: \quad & \varphi \pi_t (1 + \pi_t) = \pi_t^{rhs} && \text{(A.4)}\\
\lambda_{5,t}: \quad & U_{T,t+1}^s R_{t+1}^s = U_{T,t+1}^{s'} R_{t+1}^{s'} \quad \forall s, s' \in S \text{ with } s \neq s' && \text{(A.5)}\\
\lambda_{6,t}: \quad & U_{T,t} = \beta \mathbb{E}_t\left[U_{T,t+1}^s R_{t+1}^s\right] + \mu_t^{CE} && \text{(A.6)}\\
\mu_t^*: \quad & -\mathbb{E}_t\left[B_{t+1}^s / R_{t+1}^s\right] \leq \kappa_t^T Y_t^T + \frac{\kappa_t^N}{p_t}. && \text{(A.7)}
\end{aligned}
$$

where $\pi_t^{rhs} \equiv (1-\varepsilon)\left(1 + \frac{U_{L,t}}{AU_{N,t}}\right) + \frac{\varphi}{L_t}\mathbb{E}_t\left[\Theta_{t,t+1}^s L_{t+1}^s \pi_{t+1}^s \left(1 + \pi_{t+1}^s\right)\right]$.

The first order conditions are given by

$$
\lambda_{1,t} U_{N,t} - \frac{\mu_t^* \kappa_t^N}{p_t^2} = 0 \tag{A.8}
$$

$$
\begin{aligned}
U_{T,t} + \lambda_{1,t}(p_t U_{NT,t} - U_{TT,t}) - \lambda_{3,t} + \lambda_{4,t}\pi_{T,t}^{rhs} + \lambda_{4,t-1}\pi_{T,t-1}^{rhs} - \lambda_{5,t-1} U_{TT,t} R_t \\
+ \lambda_{6,t} U_{TT,t} - \beta \lambda_{6,t-1} U_{TT,t} R_t = 0
\end{aligned} \tag{A.9}
$$

$$
\begin{aligned}
U_{N,t} + \lambda_{1,t}(p_t U_{NN,t} - U_{TN,t}) - \lambda_{2,t} + \lambda_{4,t}\pi_{N,t}^{rhs} + \lambda_{4,t-1}\pi_{N,t-1}^{rhs} - \lambda_{5,t-1} U_{TN,t} R_t \\
+ \lambda_{6,t} U_{TN,t} - \beta \lambda_{6,t-1} U_{TN,t} R_t = 0
\end{aligned} \tag{A.10}
$$

$$
U_{L,t} + \lambda_{2,t} A \left(1 - \frac{\varphi}{2}\pi_t^2\right) + \lambda_{4,t}\pi_{L,t}^{rhs} + \lambda_{4,t-1}\pi_{L,t-1}^{rhs} = 0 \tag{A.11}
$$

$$
\lambda_{3,t} + \beta \mathbb{E}\left[\lambda_{3,t+1} R_{t+1}^s\right] + \mu_t^* = 0 \tag{A.12}
$$

$$
-\lambda_{2,t}\varphi \pi_t A L_t + \lambda_{4,t}\varphi(1 + 2\pi_t) + \lambda_{4,t-1}\pi_{\pi,t}^{rhs} = 0 \tag{A.13}
$$

where I obtain expression (A.12) by integrating all the first order conditions with respect to B_{t+1}^s with $er_{t+1}^s \equiv R_{t+1}^s - R_{t+1}^{s'}$. The terms $\pi_L^{rhs}, \pi_T^{rhs}, \pi_N^{rhs}, \pi_{B_{t+1}}^{rhs}, \pi_\pi^{rhs}$ denote the derivative of π^{rhs} with respect to L, C^T, C^T, B_{t+1}^s, π, respectively.

Combining (A.11) and (A.13) we have

$$\lambda_{4,t} = \frac{-\pi_t L_t U_{L,t} + \lambda_{4,t-1}\left(\pi_t L_t \pi^{rhs}_{L,t-1} - \pi^{rhs}_{\pi,t}\left(1-\varphi/2\pi_t^2\right)/\varphi\right)}{\left(1+2\pi_t\right)\left(1-\frac{\varphi}{2}\pi_t^2\right) + \pi^{rhs}_{L,t}\pi_t L_t} \tag{A.14}$$

Also combining (A.10) and (A.11) gives

$$\lambda_{1,t} = \frac{U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right) + \lambda_{4,t}\left(\frac{\pi^{rhs}_{L,t}}{A(1-\frac{\varphi}{2}\pi_t^2)} + \pi^{rhs}_{N,t}\right) - \lambda_{6,t}U_{TN,t} + \Psi^{\pi}_{N,t-1} + \Psi^{B}_{N,t-1}}{U_{TN,t} - p_t^T U_{NN,t}} \tag{A.15}$$

with

$$\Psi^{\pi}_{N,t-1} \equiv \lambda_{4,t-1}\left(\frac{\pi^{rhs}_{L,t-1}}{A(1-\frac{\varphi}{2}\pi_t^2)} + \pi^{rhs}_{N,t-1}\right)$$

$$\Psi^{B}_{N,t-1} \equiv \beta\lambda_{6,t-1}U_{TN,t}R_t - \lambda_{5,t-1}U_{TN,t}R^s_t$$

Using the expression for λ_1 from (A.15) together with (A.8) yields an expression for monetary policy in a target form:

$$U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right) + \lambda_{4,t}\left(\frac{\pi^{rhs}_{L,t}}{A(1-\frac{\varphi}{2}\pi_t^2)} + \pi^{rhs}_{N,t}\right) + \Psi^{\pi}_{N,t-1} = \frac{\mu_t^*\kappa_t^N\left(U_{TN,t} - p_t U_{NN,t}\right)}{U_{N,t}p_t^2} + \lambda_{6,t}U_{TN,t} - \beta\lambda_{6,t-1}U_{TN,t}R_t + \lambda_{5,t-1}U_{TN,t}R^s_t \tag{A.16}$$

For the proofs for this section, consider a path from $t=0$ with $\lambda_{4,-1} = \lambda_{5,-1} = \lambda_{6,-1} = 0$.

- **Proof of part 1.** First, note that without the borrowing constraint $\mu_t^* = 0$ for all t. Next, I first consider a relaxed problem by dropping the implementability constraints (A.5) and (A.6). This means the Lagrange multipliers of the omitted constraints (λ_5, λ_6) are zero. Then I will argue that $\pi_t = \tau = 0$ is the optimal policy, and with this policy the constraints (A.5) and (A.6) are always satisfied. Starting from $\lambda_{4,t-1} = 0$, by (A.14), $\pi_t = 0$ implies that $\lambda_{4,t} = 0$. Then we have $\lambda_{1,t} = 0$. Also, $\pi_t = \pi_{t+1} = 0$ requires that $\tau_t = 0$ by (A.4). Thus $\tau_t = \pi_t = \mu_t^* = 0$ satisfies the monetary policy expression (A.16). Then the optimality condition (A.9) gives $\lambda_{3,t} = U_{T,t}$. Replacing the lagrange multipliers in expression (A.12) without integrating we obtain

$$U_{T,t} = \beta U^s_{T,t+1}R^s_{t+1} \quad \forall s \in S \tag{A.17}$$

  which can be decomposed in to the constraints (A.5) and (A.6) as in the main text. Therefore all the constraints, including the omitted implementability conditions are satisfied. This completes the proof.

Note that a similar argument shows that if there is no possibility of a binding constraint in the future, then $\lambda_5 = \lambda_6 = 0$ satisfies all the equilibrium conditions. Then monetary policy expression (A.16) does not include λ_5 and λ_6 which shows monetary policy is not prudential.

- **Proof of part 2.(a)**. Under distinct capital controls tax, the household Euler equation as well as the optimality condition for portfolio choice do not constitute a constraint to the policymaker, therefore $\lambda_{5,t} = \lambda_{6,t} = 0\ \forall t$. Also, if the last crisis is sufficiently past, we have $\lambda_{4,t-1} \approx 0$. Then, A.16 becomes

$$U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right)+\lambda_{4,t}\left(\frac{\pi_{L,t}^{rhs}}{A(1-\frac{\varphi}{2}\pi_t^2)}+\pi_{N,t}^{rhs}\right)=\frac{\mu_t^*\kappa_t^N\left(U_{TN,t}-p_t^T U_{NN,t}\right)}{U_{N,t}(p_t^T)^2} \tag{A.18}$$

If the borrowing constraint is not binding, then we have $\mu^* = 0$. Then $\pi_t = \tau_t = 0$ satisfies the above expression, and the rest of the first order conditions collapse to those of private agents, showing that $\pi_t = \tau_t = 0$ is an optimal policy. This also shows that monetary policy is not prudential. When the borrowing constraint is binding, on the other hand, ($A.18$) shows that $\pi_t = \tau_t = 0 = \lambda_{4,t} = 0$ can no longer be an optimal policy, and the policymaker must a strike a balance between macroeconomic stabilization and relaxing the constraint.

- **Proof of part 2.(b)** With uniform capital controls, the policymaker can adjust total borrowing so household's Euler equation is not a constraint, $\lambda_{6,t} = 0\ \forall t$. However, households can allocate the total borrowing as they wish. In normal times ($\mu_t = 0$), the monetary policy expression ($A.16$) implies that $\pi_t = \tau_t = 0$ cannot be an optimal policy if $\lambda_{5,t-1} \neq 0\ \forall t$, otherwise the policymaker takes into account the promise from the last period.

- **Proof of part 2.(c)** When there is no other prudential policy is available, both households' Euler and portfolio optimality conditions enter to the policymaker's problem as constraints, $\lambda_{5,t} \neq 0$ and $\lambda_{6,t} \neq 0$. It is obvious that even in normal times $\mu_t = 0$, the monetary policy expression ($A.16$) implies that $\pi_t = \tau_t = 0$ cannot be an optimal policy.

  Note that in a sudden stop $\mu_t^* \neq 0$, and therefore the right hand side of the policy expression (A.16) includes the first term. This shows another consideration of monetary policy while setting the relative price of tradables.

A.2 Proof of Proposition 2

$$\max_{\{p_t, C_t^T, C_t^N, L_t, B_{t+1}^s, \pi_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t)$$

s.t.

$$\lambda_{1,t}: \quad U_{T,t} = p_t U_{N,t}, \tag{A.19}$$

$$\lambda_{2,t}: \quad C_t^N = A_t L_t \left(1 - \frac{\varphi}{2}\pi_t^2\right), \tag{A.20}$$

$$\lambda_{3,t}: \quad C_t^T = Y_t^T + B_t - \mathbb{E}_t\left[B_{t+1}^s / R_{t+1}^s\right], \tag{A.21}$$

$$\lambda_{4,t}: \quad \varphi\pi_t\left(1+\pi_t\right) = \pi_t^{rhs} \tag{A.22}$$

$$\lambda_{5,t}: \quad U_{T,t+1}^s R_{t+1}^s = U_{T,t+1}^{s'} R_{t+1}^{s'} \quad \forall s, s' \in S \text{ with } s \neq s' \tag{A.23}$$

$$\lambda_{6,t}: \quad U_{T,t} = \beta \mathbb{E}_t\left[U_{T,t+1}^s R_{t+1}^s\right] + \mu_t^{CE} \tag{A.24}$$

$$\mu_t^*: \quad -\mathbb{E}_t\left[B_{t+1}^s / R_{t+1}^s\right] \leq \kappa_t^T Y_t^T + \frac{\kappa_t^N}{p_t}. \tag{A.25}$$

where $\pi_t^{rhs} \equiv (1-\varepsilon)\left(1 + \frac{U_{L,t}}{AU_{N,t}}\right) + \frac{\varphi}{L_t}\mathbb{E}_t\left[\Theta_{t,t+1}^s L_{t+1}^s \pi_{t+1}^s\left(1+\pi_{t+1}^s\right)\right]$.

The first order conditions are given by

$$\lambda_{1,t} U_{N,t} - \frac{\mu_t^* \kappa_t^N}{p_t^2} = 0 \tag{A.26}$$

$$U_{T,t} + \lambda_{1,t}\left(p_t U_{NT,t} - U_{TT,t}\right) - \lambda_{3,t} + \lambda_{4,t}\pi_{T,t}^{rhs} + \lambda_{6,t} U_{TT,t} = 0 \tag{A.27}$$

$$U_{N,t} + \lambda_{1,t}\left(p_t U_{NN,t} - U_{TN,t}\right) - \lambda_{2,t} + \lambda_{4,t}\pi_{N,t}^{rhs} + \lambda_{6,t} U_{TN,t} = 0 \tag{A.28}$$

$$U_{L,t} + \lambda_{2,t} A\left(1 - \frac{\varphi}{2}\pi_t^2\right) + \lambda_{4,t}\pi_{L,t}^{rhs} = 0 \tag{A.29}$$

$$\lambda_{3,t} + \beta\mathbb{E}\left[\lambda_{3,t+1} R_{t+1}^s\right] + \mu_t^* = 0 \tag{A.30}$$

$$-\lambda_{2,t}\varphi\pi_t A L_t + \lambda_{4,t}\varphi(1+2\pi_t) = 0 \tag{A.31}$$

where I obtain expression (A.30) by integrating all the first order conditions with respect to B_{t+1}^s with $er_{t+1}^s \equiv R_{t+1}^s - R_{t+1}^{s'}$. The terms $\pi_L^{rhs}, \pi_T^{rhs}, \pi_N^{rhs}, \pi_{B_{t+1}^s}^{rhs}, \pi_\pi^{rhs}$ denote the derivative of π^{rhs} with respect to L, C^T, C^T, B_{t+1}^s, π, respectively.

Combining (A.29) and (A.31) we have

$$\lambda_{4,t} = \frac{-\pi_t L_t U_{L,t}}{\left(1+2\pi_t\right)\left(1 - \frac{\varphi}{2}\pi_t^2\right) + \pi_{L,t}^{rhs}\pi_t L_t} \tag{A.32}$$

Also combining (A.28) and (A.29) gives

$$\lambda_{1,t} = \frac{U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right)+\lambda_{4,t}\left(\frac{\pi_{L,t}^{rhs}}{A(1-\frac{\varphi}{2}\pi_t^2)}+\pi_{N,t}^{rhs}\right)-\lambda_{6,t}U_{TN,t}}{U_{TN,t}-p_t^T U_{NN,t}} \tag{A.33}$$

Using the expression for λ_1 from (A.33) together with (A.26) yields an expression for monetary policy in a target form:

$$U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right)+\lambda_{4,t}\left(\frac{\pi_{L,t}^{rhs}}{A(1-\frac{\varphi}{2}\pi_t^2)}+\pi_{N,t}^{rhs}\right)=\frac{\mu_t^*\kappa_t^N\left(U_{TN,t}-p_tU_{NN,t}\right)}{U_{N,t}p_t^2}+\lambda_{6,t}U_{TN,t}$$

- **Proof of part 1.** First, note that without the borrowing constraint $\mu_t^*=0$ for all t. Next, I first consider a relaxed problem by dropping the implementability constraints (D.54) and (D.55). This means the Lagrange multipliers of the omitted constraints (λ_5, λ_6) are zero. Then I will argue that $\pi_t=\tau=0$ is the optimal policy, and with this policy the constraints (D.54) and (D.55) are always satisfied.By (A.32), $\pi_t=0$ implies that $\lambda_{4,t}=0$. Then we have $\lambda_{1,t}=0$. Also, $\pi_t=\pi_{t+1}=0$ requires that $\tau_t=0$ by (D.53). Thus $\tau_t=\pi_t=\mu_t^*=0$ satisfies the monetary policy expression (A.34). Then the optimality condition (A.27) gives $\lambda_{3,t}=U_{T,t}$. Replacing the lagrange multipliers in expression (A.30) without integrating we obtain

  $$U_{T,t}=\beta U_{T,t+1}^s R_{t+1}^s \quad \forall s\in S \tag{A.34}$$

  which can be decomposed in to the constraints (D.54) and (D.55) as in the main text. Therefore all the constraints, including the omitted implementability conditions are satisfied. This completes the proof.

  Note that a similar argument shows that if there is no possibility of a binding constraint in the future, then $\lambda_5=\lambda_6=0$ satisfies all the equilibrium conditions. Then monetary policy expression (A.34) does not include λ_5 and λ_6 which shows monetary policy is not prudential.

- **Proof of part 2.(a)**. Under distinct and uniform capital controls tax, the household Euler equation (D.54) does not constitute a constraint to the policymaker, therefore $\lambda_{6,t}=0\ \forall t$. Then, A.34 becomes

  $$U_{N,t}\left(1+\frac{\tau-1}{1-\frac{\varphi}{2}\pi_t^2}\right)+\lambda_{4,t}\left(\frac{\pi_{L,t}^{rhs}}{A(1-\frac{\varphi}{2}\pi_t^2)}+\pi_{N,t}^{rhs}\right)=\frac{\mu_t^*\kappa_t^N\left(U_{TN,t}-p_t^TU_{NN,t}\right)}{U_{N,t}(p_t^T)^2} \tag{A.35}$$

  If the borrowing constraint is not binding, then we have $\mu^*=0$. Then $\pi_t=\tau_t=0$ (and therefore $\lambda_4=0$) satisfies the above expression, and the rest of the first order conditions collapse to those of private agents, showing that $\pi_t = \tau_t = 0$ is an optimal policy. This also shows that monetary policy is not prudential. When the borrowing constraint is binding, on the other hand, ($A.35$) shows that $\pi_t = \tau_t = 0 = \lambda_{4,t} = 0$ can no longer be an optimal policy, and the policymaker must a strike a balance between macroeconomic stabilization and relaxing the constraint.

- **Proof of part 2.(b)** When there is no other prudential policy is available, both households' Euler and portfolio optimality conditions enter to the policymaker's problem as constraints, $\lambda_{5,t} \neq 0$ and $\lambda_{6,t} \neq 0$. It is obvious that even in normal times $\mu_t = 0$, the monetary policy expression ($A.34$) implies that $\pi_t = \tau_t = 0$ cannot be an optimal policy.

  Note that in a financial crisis $\mu_t^* \neq 0$, and therefore the right hand side of the policy expression (A.34) includes the first term. This shows another consideration of monetary policy while setting the relative price of tradables.

Appendix B Model With Composite Securities

Suppose instead of a complete Arrow securities, domestic agents can borrow or lend using one-period internationally traded composite securities. Let B_{t+1}^i denote the holding of asset i with $i = 1, \ldots, I$ whose price is Q_t^i at time t and pays out dividend D_{t+1}^i at time $t+1$. Both price Q_t^i and dividend D_t^i are denominated in units of internationally tradable good. Agents in the small open economy take Q_t^i and D_t^i as given. At time t, let B_{t+1} be the total asset holdings; γ_{t+1}^i be the portfolio share of asset i; and R_t be the real return on the portfolio:

$$B_{t+1} \equiv \sum_{i=1}^{I} Q_t^i B_{t+1}^i$$

$$\gamma_{t+1}^i \equiv \frac{Q_t^i B_{t+1}^i}{B_{t+1}}$$

$$R_t \equiv \sum_{i=1}^{I} \left(\gamma_t^i \frac{Q_t^i + D_t^i}{Q_{t-1}^i} \right)$$

As a result, households are subject to the following sequence of flow budget constraints expressed in local currency

$$P_t^N C_t^N + P_t^T C_t^T + \mathscr{E}_t B_{t+1} \leq W_t L_t + P_t^T Y_t^T + \mathscr{E}_t B_t R_t + \Pi_t + T_t, \tag{B.36}$$

Also the borrowing constraint takes the form

$$-\mathscr{E}_t B_{t+1} \leq \kappa^T P_t^T Y_t^T + \kappa^N P_t^N. \tag{B.37}$$

Then households optimality conditions become

$$U_{T.t} = p_t^T U_{N.t} \tag{B.38}$$

$$-\frac{U_{L,t}}{U_{N,t}} = \frac{W_t}{P_t^N} \tag{B.39}$$

$$U_{T,t} = \beta \mathbb{E}_t \left[U_{T,t+1} R_{t+1}\right] + \mu_t \tag{B.40}$$

$$\mathbb{E}_t \left[U_{T,t+1}(er_{t+1}^i)\right] = 0 \quad \forall i = 1, ..., I-1, \tag{B.41}$$

where p_t^T is price of the tradable good relative to the nontradable good P_t^T / P_t^N; U_T, U_N, U_L are marginal utilities of tradable goods consumption, nontradable goods consumption and work, respectively; μ_t is the lagrange multiplier on the borrowing constraint; er^i is excess return of asset i relative to some reference asset which is labeled as I:

$$er_{t+1}^i \equiv \frac{Q_{t+1}^i + D_{t+1}^i}{Q_t^i} - \frac{Q_{t+1}^I + D_{t+1}^I}{Q_t^I}.$$

The production side remains the same except for the fact that variables are now not indexed by state but time. The policymaker solves the following problem

$$\max_{\{p_t, C_t^T, C_t^N, L_t, B_{t+1}, \gamma_{t+1}^i, \pi_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t)$$

s.t.

$$\lambda_{1,t}: \quad U_{T,t} = p_t^T U_{N,t}, \tag{B.42}$$

$$\lambda_{2,t}: \quad C_t^N = A_t L_t \left(1 - \frac{\varphi}{2}\pi_t^2\right), \tag{B.43}$$

$$\lambda_{3,t}: \quad C_t^T = Y_t^T + B_t R_t - B_{t+1}, \tag{B.44}$$

$$\lambda_{4,t}: \quad \varphi \pi_t (1 + \pi_t) = \pi_t^{rhs} \tag{B.45}$$

$$\lambda_{5,t}^i: \quad \mathbb{E}_t \left[U_{T,t+1} er_{t+1}^i\right] = 0, \quad \forall i = 1, ..., N-1 \tag{B.46}$$

$$\lambda_{6,t}: \quad U_{T,t} = \beta \mathbb{E}_t \left[U_{T,t+1} R_{t+1}\right] + \mu_t^{CE} \tag{B.47}$$

$$\mu_t^*: \quad -B_{t+1} \leq \kappa_t^T Y_t^T + \frac{\kappa_t^N}{p_t^T}. \tag{B.48}$$

where $\pi_t^{rhs} \equiv (1-\varepsilon)\left(1 + \frac{U_{L,t}}{AU_{N,t}}\right) + \frac{\varphi}{L_t}\mathbb{E}_t\left[\Theta_{t,t+1} L_{t+1} \pi_{t+1}(1+\pi_{t+1})\right].$

Depending on the commitment assumption, this problem yields very similar expressions to the ones either in Appendix A.1 or Appendix A.2. Therefore, the proofs of the propositions 1 and 2 follow the same steps.

Appendix C Alternative for Distinct Capital Controls: Reserve Accumulation

As an alternative to capital controls, the policymaker might also accumulate reserves for prudential purposes as in Arce et al. (2019). Without a borrowing constraint, as the government accumulates reserves and finances them via lump sum tax expressed in tradables, households also increase their borrowing, hence "undo" the impacts of reserve accumulation, in line with the Ricardian logic. With the borrowing constraint, however, households can do so only until they hit the borrowing constraint. After that point, any additional reserve accumulation reduces the net borrowing of the country. Unlike capital controls, this policy increases the gross flows but improves net flows. The government can also change the composition of overall asset position of the country by adjusting the composition of reserve accumulation. As a result, both the level and composition of net asset position can be set to the socially optimal levels.

I assume that the government has access to the same international financial markets as households and reserve accumulation is not associated with any other cost. Therefore, it can trade the same set of assets by facing the same price as households. Denoting $A^{*^i}_{t+1}$ as the government's accumulation of an asset denominated in i at time t, the government budget identity becomes

$$\mathscr{E}_t \sum_{i=1}^{I} Q^h_t A^{*^i}_{t+1} = \mathscr{E}_t \sum_{i=1}^{I} (Q^i_t + D^i_t) A^{*^i}_t + T_t \tag{C.49}$$

In this setup, capital controls and reserve accumulation are perfect substitutes. They both distort households intertemporal decisions and do not incur any cost to the policymaker to implement. In other formulations of reserve accumulation in the literature, reserve accumulation is usually costly to the policymaker and economy. If this was the case here, then capital controls would be superior instruments than reserve accumulation.

Note that while capital controls can be used to target total borrowing without interfering households' optimality decisions for portfolio shares via uniform tax, this is not possible under reserve accumulation. Therefore, if the reserve accumulation is possible and government has access to the same financial instruments as private agents, then both the level and composition of net debt of the country can be adjusted by the policymaker.

Appendix D Details of the Quantitative Model

The quantitative model is a version of the model with composite securities laid out in Appendix B. The total saving at the end of period t is given by $B_{t+1} = B^d_{t+1} + q^e_{t+1} B^e_{t+1}$, with B^d and B^e debt and security holdings, and q^e is the price of equity in terms of tradable goods. The time consistent policymaker looks for a Markov perfect equilibrium:

$$\max_{\{p_t, C^T_t, C^N_t, L_t, B_{t+1}, \gamma^i_{t+1}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C^T_t, C^N_t, L_t)$$

s.t.

$$\lambda_{1,t}: \quad U_{T,t} = p_t U_{N,t}, \tag{D.50}$$

$$\lambda_{2,t}: \quad C^N_t = A_t L_t \left(1 - \frac{\varphi}{2} \pi^2_t\right), \tag{D.51}$$

$$\lambda_{3,t}: \quad C^T_t = Y^T_t + B_t R_t - B_{t+1}, \tag{D.52}$$

$$\lambda_{4,t}: \quad \varphi \pi_t (1 + \pi_t) = \pi^{rhs}_t \tag{D.53}$$

$$\lambda_{5,t}: \quad \mathbb{E}_t [U_{T,t+1} er_{t+1}] = 0 \tag{D.54}$$

$$\lambda_{6,t}: \quad U_{T,t} = \beta \mathbb{E}_t [U_{T,t+1} R_{t+1}] + \mu^{CE}_t \tag{D.55}$$

$$\mu^*_t: \quad -B_{t+1} \leq \kappa^T_t Y^T_t + \frac{\kappa^N_t}{p_t}. \tag{D.56}$$

where $\pi^{rhs}_t \equiv (1-\varepsilon)\left(1 + \frac{U_{L,t}}{AU_{N,t}}\right) + \frac{\varphi}{L_t} \mathbb{E}_t [\Theta_{t,t+1} L_{t+1} \pi_{t+1} (1 + \pi_{t+1})]$, and er_{t+1} is the expected excess return of equity.