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ABSTRACT

This paper contributes to a literature that studies optimal capital control policy in open economy models with pecuniary externalities due to flow collateral constraints. It shows that the optimal policy calls for capital controls to be lowered during booms and to be increased during recessions. Moreover, in the run-up to a financial crisis optimal capital controls rise as the contraction sets in and reach their highest level at the peak of the crisis. These findings are at odds with the conventional view that capital controls should be tightened during expansions to curb capital inflows and relaxed during contractions to discourage capital flight.

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1 Introduction

This paper contributes to a literature that studies optimal capital control policy in open economy models with pecuniary externalities due to flow collateral constraints. A central question in this literature is whether this type of model can rationalize macroprudential policy. The concept of prudential capital control policy has at least two dimensions. One dimension concerns the long-run behavior of capital controls and asserts that capital controls should be positive on average to reduce overborrowing. The second dimension holds that capital control policy should be used countercyclically. Capital controls should be increased during booms and lowered during recessions. The existing literature has established that in open economy models with collateral constraints capital controls are indeed positive on average. Thus, this class of models is in line with the first dimension of macroprudential capital-control policy. The goal of this paper is to investigate whether in this class of models optimal capital-control policy is also consistent with the aforementioned second dimension of macroprudentiality.

To this end, we characterize Ramsey-optimal capital-control policy in an open economy with a flow collateral constraint. We focus on the case in which tradable and nontradable output have collateral value, because it is the type of flow collateral constraint most frequently studied in the related literature. This model features a pecuniary externality originating from the fact that the relative price of nontradable goods, which determines the value of collateral, is taken as given by households but does depend in equilibrium on their collective consumption and borrowing decisions.

The narrative of how this externality may call for countercyclical capital control policy is as follows. A positive shock that expands aggregate demand pushes the price of nontradables up raising the value of collateral and easing access to credit, which in turn amplifies the expansion in aggregate demand. Similarly, a negative shock that reduces aggregate demand leads to a decline in the relative price of nontradables making the value of nontradable output in terms of tradable goods fall and the collateral constraint tighten, which deepens the contraction. It is then natural to expect that a benevolent planner who internalizes the effect of domestic absorption on the value of collateral would have an incentive to tighten capital controls during booms and to ease them during busts, as a way to reduce the excess amplitude of the business cycle caused by the pecuniary externality.

We find that this intuition does not play out under plausible calibrations and sources of uncertainty. The Ramsey-optimal policy calls for capital control taxes to be lowered during booms and to be increased during recessions. Moreover, in the run-up to a financial crisis, defined as a period in which the collateral constraint binds, optimal debt taxes rise as the economy enters the pre-crisis recession and reach their highest level at the peak of the crisis.

This paper is related to a growing literature studying macroprudential policy in the context of open economy models with collateral constraints. Output-based flow collateral constraints were introduced in open economy models by Mendoza (2002). The externality that emerges when debt is denominated in tradable goods but leveraged on nontradable income and the consequent room for macroprudential policy is emphasized in Korinek (2011). Bianchi (2011) shows that the pecuniary externality leads to overborrowing and that the optimal capital control tax is positive on average. Benigno, Chen, Otrok, and Young (2013, 2014) introduce production and a subsidy on nontradables that makes the first best attainable. Uribe (2006, 2007) establishes that overborrowing does not depend on whether foreign lenders impose collateral constraints at the aggregate level or at the level of the individual household.

The remainder of the paper is presented in five sections. Section 2 presents the model. Section 3 characterizes the Ramsey-optimal capital control problem. Section 4 shows that optimal capital-control policy is procyclical in a version of the model driven by tradable and nontradable output shocks as in Bianchi (2011). Section 5 establishes that the procyclical nature of optimal capital control policy is robust to allowing for country-interest-rate shocks. Section 6 presents a discussion of the intuition behind the central result of the paper and concludes.

2 The Model

We perform the analysis in the context of a prototypical theoretical environment, as presented, for instance, in Bianchi (2011) or Uribe and Schmitt-Grohé (forthcoming, chapter 12). Consider a small open endowment economy in which households have preferences of the form

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

where c_t denotes consumption in period t, $U(\cdot)$ denotes an increasing and concave period utility function, $\beta \in (0,1)$ denotes a subjective discount factor, and $\mathbb{E}_t$ denotes the expectations operator conditional on information available in period t. The period utility function takes the CRRA form

$$U(c) = \frac{c^{1-\sigma} - 1}{1-\sigma},$$

with $\sigma > 0$. We assume that consumption is a composite of tradable and nontradable goods aggregated in a CES fashion,

$$c_t = A(c_t^T, c_t^N) \equiv \left[a {c_t^T}^{1-1/\xi} + (1-a){c_t^N}^{1-1/\xi}\right]^{1/(1-1/\xi)}, \tag{2}$$

where c_t^T denotes consumption of tradables in period t and c_t^N denotes consumption of nontradables in period t. Households are assumed to have access to a single, one-period, risk-free, internationally-traded bond denominated in terms of tradable goods that pays the interest rate r_t when held from periods t to $t+1$. The household's sequential budget constraint is given by

$$c_t^T + p_t c_t^N + d_t = y_t^T + p_t y_t^N + \frac{d_{t+1}}{1+r_t}, \tag{3}$$

where d_t denotes the amount of debt due in period t and d_{t+1} denotes the amount of debt assumed in period t and maturing in $t+1$. The variable p_t denotes the relative price of nontradables in terms of tradables, and y_t^T and y_t^N denote the endowments of tradables and nontradables, respectively. Both endowments are assumed to be exogenously given. The collateral constraint takes the form

$$d_{t+1} \leq \kappa(y_t^T + p_t y_t^N), \tag{4}$$

where $\kappa > 0$ is a parameter. Households internalize this borrowing limit. Yet, the borrowing constraint introduces an externality, because each individual household takes the real exchange rate, p_t, as exogenously determined, even though in equilibrium their collective absorption is a key determinant of this relative price.

Households choose a set of processes $\{c_t^T, c_t^N, c_t, d_{t+1}\}$ to maximize (1) subject to (2)-(4), given the processes $\{r_t, p_t, y_t^T, y_t^N\}$ and the initial debt position d_0. The first-order conditions of this problem are (2)-(4) and

$$U'(A(c_t^T, c_t^N))A_1(c_t^T, c_t^N) = \lambda_t, \tag{5}$$

$$p_t = \frac{1-a}{a}\left(\frac{c_t^T}{c_t^N}\right)^{1/\xi}, \tag{6}$$

$$\left(\frac{1}{1+r_t} - \mu_t\right)\lambda_t = \beta \mathbb{E}_t \lambda_{t+1}, \tag{7}$$

$$\mu_t \geq 0, \tag{8}$$

and

$$(d_{t+1} - \kappa y_t^T - \kappa p_t y_t^N)\mu_t = 0, \tag{9}$$

where $\beta^t \lambda_t$ and $\beta^t \lambda_t \mu_t$ denote the Lagrange multipliers on the sequential budget constraint (3) and the collateral constraint (4), respectively. The Euler equation (7) equates the marginal benefit of assuming more debt with its marginal cost. In periods in which the collateral constraint does not bind, one unit of debt payable in $t+1$ increases tradable consumption by $1/(1+r_t)$ units in period t, which increases utility by $\lambda_t/(1+r_t)$. The marginal cost of an extra unit of debt assumed in period t and payable in $t+1$ is the marginal utility of consumption in period $t+1$ discounted at the subjective discount factor, $\beta \mathbb{E}_t \lambda_{t+1}$. During financial crises, by which we mean periods in which the collateral constraint binds, the marginal utility of increasing debt falls to $[1/(1+r_t) - \mu_t]\lambda_t$, reflecting a shadow penalty for trying to increase debt when the collateral constraint is binding.

In equilibrium, the market for nontradables must clear. That is,

$$c_t^N = y_t^N.$$

Then, a competitive equilibrium is a set of processes $\{c_t^T, d_{t+1}, \mu_t\}$ satisfying

$$\left(\frac{1}{1+r_t} - \mu_t\right) U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N) = \beta \mathbb{E}_t U'(A(c_{t+1}^T, y_{t+1}^N))A_1(c_{t+1}^T, y_{t+1}^N), \tag{10}$$

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t}, \tag{11}$$

$$d_{t+1} \leq \kappa y_t^T + \kappa \left(\frac{1-a}{a}\right) c_t^{T\,1/\xi} y_t^{N\,1-1/\xi}, \tag{12}$$

$$\mu_t \left[\kappa y_t^T + \kappa \left(\frac{1-a}{a}\right) c_t^{T\,1/\xi} y_t^{N\,1-1/\xi} - d_{t+1}\right] = 0, \tag{13}$$

$$\mu_t \geq 0, \tag{14}$$

given processes $\{r_t, y_t^T, y_t^N\}$ and the initial condition d_0.

The fact that c_t^T appears on the right-hand side of the equilibrium version of the collateral constraint (12) means that during contractions in which the absorption of tradables falls, the collateral constraint endogenously tightens. Individual agents do not take this effect into account in choosing their consumption plans. This is the nature of the pecuniary externality in this model.

From the perspective of the individual household, equations (3) and (4) define a convex set of feasible debt choices, d_{t+1}. That is, if two debt levels d^1 and d^2 satisfy (3) and (4), then any weighted average $\alpha d^1 + (1-\alpha)d^2$ for $\alpha \in [0,1]$ also satisfies these two conditions. From an equilibrium perspective, however, this ceases to be true in general. The reason is that the relative price of nontradables, p_t, which appears on the right-hand side of the collateral constraint (4) is increasing in consumption of tradables by equation (6), which, in turn, is increasing in d_{t+1} by the resource constraint (11). To see this, use equilibrium condition (11) to eliminate c_t^T from equilibrium condition (12) to obtain

$$d_{t+1} \leq \kappa y_t^T + \kappa \left(\frac{1-a}{a}\right)\left(y_t^T + \frac{d_{t+1}}{1+r_t} - d_t\right)^{1/\xi} y_t^{N\,1-1/\xi}.$$

It is clear from this expression that the right-hand side is increasing in the equilibrium level of external debt, d_{t+1}. Moreover, depending on the values assumed by the parameters κ, a, and ξ, the equilibrium value of collateral may increase more than one for one with d_{t+1}. In other words, an increase in debt, instead of tightening the collateral constraint may relax it. In this case, the more indebted the economy becomes, the less leveraged it is. Schmitt-Grohé and Uribe (2016) show that this feature of the model can give rise to self-fulfilling financial crises in which the price of collateral falls due to nonfundamental pessimistic sentiments. In the present paper, however, we limit attention to parameterizations for which the equilibrium is unique.

3 Optimal Capital Control Policy

The pecuniary externality created by the presence of the relative price of nontradables in the collateral constraint induces an allocation that is in general suboptimal, not only when compared to the allocation that would result in the absence of a collateral constraint, but also relative to the best allocation possible among all of the ones that satisfy the collateral constraint. As a result, the collateral constraint opens the door to welfare improving policy intervention. Here, like in much of the related literature (see Korinek, 2011; Bianchi, 2011) we study capital controls, because they essentially represent a tax on external borrowing, which is the variable most directly affected by the pecuniary externality. In fact, the optimal capital control policy fully internalizes the pecuniary externality, in the sense that it induces the representative household to behave as if it understood that its own borrowing choices influence the relative price of nontradables and therefore the value of collateral.

We assume that the government is benevolent in the sense that it seeks to maximize the well being of the representative household. Further, we assume that the government has the ability to commit to policy promises. That is, we characterize the Ramsey optimal capital control policy in the context of an open economy with a flow collateral constraint.

Let τ_t be a proportional tax on debt acquired in period t. If τ_t is positive, it represents a proper capital control tax, whereas if it is negative it has the interpretation of a borrowing subsidy. The revenue from capital control taxes is given by $\tau_t d_{t+1}/(1 + r_t)$. We assume that the government consumes no goods and that it rebates all revenues from capital controls to the public in the form of lump-sum transfers (lump-sum taxes if $\tau_t < 0$), denoted ℓ_t. The budget constraint of the government is then given by

$$\tau_t \frac{d_{t+1}}{1+r_t} = \ell_t. \tag{15}$$

The household's sequential budget constraint now becomes

$$c_t^T + p_t c_t^N + d_t = y_t^T + p_t y_t^N + (1-\tau_t)\frac{d_{t+1}}{1+r_t} + \ell_t.$$

This expression makes it clear that the capital control tax distorts the borrowing decision of the household. In particular, the gross interest rate on foreign borrowing perceived by the private household is no longer $1+r_t$, but $(1+r_t)/(1-\tau_t)$. All other things equal, the higher is τ_t, the higher is the interest rate perceived by households. Thus, by changing τ_t the government can encourage or discourage borrowing. All optimality conditions associated with the household's optimization problem (equations (5)-(9)) are unchanged, except for the debt Euler equation (7), which now takes the form

$$\left(\frac{1-\tau_t}{1+r_t} - \mu_t\right)\lambda_t = \beta \mathbb{E}_t \lambda_{t+1}.$$

A competitive equilibrium in the economy with capital control taxes is then a set of processes c_t^T, d_{t+1}, λ_t, μ_t, and p_t satisfying

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t}, \tag{16}$$

$$d_{t+1} \le \kappa\left[y_t^T + p_t y_t^N\right], \tag{17}$$

$$\lambda_t = U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N), \tag{18}$$

$$\left(\frac{1-\tau_t}{1+r_t} - \mu_t\right)\lambda_t = \beta \mathbb{E}_t \lambda_{t+1}, \tag{19}$$

$$p_t = \frac{A_2(c_t^T, y_t^N)}{A_1(c_t^T, y_t^N)}, \tag{20}$$

$$\mu_t[\kappa(y_t^T + p_t y_t^N) - d_{t+1}] = 0, \tag{21}$$

$$\mu_t \ge 0, \tag{22}$$

given a policy process τ_t, exogenous driving forces y_t^T, y_t^N, and r_t, and the initial condition d_0.

The benevolent government sets capital control taxes to maximize the household's lifetime utility subject to the restriction that the optimal allocation be supportable as a competitive equilibrium. It follows that all of the above competitive equilibrium conditions are constraints of the Ramsey government's optimization problem. Formally, the Ramsey-optimal competitive equilibrium are processes τ_t, c_t^T, d_{t+1}, λ_t, μ_t, and p_t that solve the problem of maximizing

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(A(c_t^T, y_t^N)) \tag{23}$$

subject to (16)-(22), given processes y_t^T, y_t^N and r_t and the initial condition d_0. In the welfare function (23), we have replaced consumption of nontradables, c_t^N, with the endowment of nontradables, y_t^N, because the Ramsey planner takes into account that in a competitive equilibrium the market for nontradables clears at all times.

The above equilibrium conditions look like a formidable set of constraints. Fortunately, it is possible to reduce the set of constraints considerably. In particular, it turns out that any processes c_t^T and d_{t+1} satisfy equilibrium conditions (16)-(22) if and only if they satisfy (16) and

$$d_{t+1} \leq \kappa \left[y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{\frac{1}{\xi}} y_t^N \right]. \tag{24}$$

To see this, suppose c_t^T and d_{t+1} satisfy (16) and (24). We must establish that (16)-(22) are also satisfied. Obviously, the resource constraint (16) holds. Now pick p_t to satisfy (20). This is possible, because the process c_t^T is given. Now use this expression to eliminate p_t from (17). The resulting expression is (24), establishing that (17) holds. Next, pick λ_t to satisfy (18). Now, set $\mu_t = 0$ for all t. It follows immediately that the slackness condition (21) and the non-negativity condition (22) are satisfied. Finally, pick τ_t to ensure that (19) holds, that is,

$$\tau_t = 1 - \beta(1+r_t)\mathbb{E}_t \frac{U'(A(c_{t+1}^T, y_{t+1}^N))A_1(c_{t+1}^T, y_{t+1}^N)}{U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N)}. \tag{25}$$

Next, we need to show the reverse statement, that is, that processes c_t^T and d_{t+1} that satisfy (16)-(22) also satisfy (16) and (24). Obviously, (16) is satisfied. Combining (17) with (20) yields (24). This completes the proof of the equivalence of the constraint sets (16)-(22) and (16) and (24).

A discussion of why the Lagrange multiplier μ_t can be taken to be nil at all times the above proof is in order. First, it is important to note that μ_t is the Lagrange multiplier associated with the individual household's collateral constraint, not the Ramsey planner's. The multiplier μ_t can be nil even if for the country as a whole the shadow value of collateral is strictly positive. Second, the result that μ_t can be chosen to be nil at all times does not mean that the collateral constraint will never bind in equilibrium. It simply means that the policymaker can pick the capital control policy in such a way that when the collateral constraint binds, individual agents feel that they would make the same debt choice whether they were constrained by the collateral restriction or not. That is, the collateral constraint binds but individually, given the taxes they face, households do not feel restricted thereby. Alternatively, we could have picked a tax policy such that the private sector's Lagrange multiplier μ_t is positive in states in which the collateral constraint binds. In other words, μ_t and τ_t are indeterminate in states in which the collateral constraint is binding in equilibrium. The proof of this result is straightforward: if the collateral constraint binds, then the slackness condition (21) is satisfied regardless of the value of μ_t. In addition, the Euler equation (19) features both τ_t and μ_t, so any combination of these two variables that makes this equation hold and that satisfies $\mu_t \geq 0$ (i.e., equilibrium condition (22)), given the process λ_t represents a solution. None of the remaining equilibrium conditions contains either μ_t or τ_t, so this completes the proof that μ_t and τ_t are indeterminate in states in which the collateral constraint binds.

We can then state the Ramsey problem as

$$\max_{\{c_t^T, d_{t+1}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(A(c_t^T, y_t^N)) \tag{23}$$

subject to

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t}, \tag{16}$$

$$d_{t+1} \leq \kappa \left[y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{\frac{1}{\xi}} y_t^N \right]. \tag{24}$$

Note that the constraints of the Ramsey planner's problem may not be a convex set. That is, if two pairs (c_t^T, d_{t+1}) satisfy both constraints given d_t, then a linear combination of these two pairs may not. This is because the right-hand side of the second constraint is convex in c_t^T for $\xi < 1$. Nonetheless, generically, the Ramsey allocation is unique because it is the outcome of a maximization problem. Another characteristic of the above maximization problem is that the Ramsey planner internalizes the pecuniary externality. That is, he understands that individual consumption of tradables affects the relative price of nontradables, p_t, and therefore also the value of collateral. This is evident from the fact that c_t^T appears on the right-hand side of the second constraint. This means that endowing the Ramsey planner with a single distorting policy instrument, namely, the capital control tax τ_t, allows him to induce agents to fully internalize the pecuniary externality. Our focus is to characterize the cyclical properties of capital controls under the Ramsey optimal policy, with an eye on ascertaining whether they are used in a countercyclical fashion.

4 Is Optimal Capital Control Policy Countercyclical?

The equilibrium dynamics of the present economy cannot be derived analytically for empirically realistic stochastic driving processes. For this reason we resort to a quantitative analysis. The baseline calibration of the model follows the one in Bianchi (2011), which assumes that the economy is driven by endowment shocks. In section 5, we consider an alternative shock structure in which business cycles are driven by tradable-endowment and interest-rate shocks.

The time unit is one year. The natural logarithms of the traded and nontraded endowments are assumed to follow a bivariate AR(1) process. This process is estimated on annual, HP-filtered Argentine data spanning the period 1965 to 2007.[1] The process takes the form

$$\begin{bmatrix} \ln y_t^T \\ \ln y_t^N \end{bmatrix} = \begin{bmatrix} 0.901 & -0.453 \\ 0.495 & 0.225 \end{bmatrix} \begin{bmatrix} \ln y_{t-1}^T \\ \ln y_{t-1}^N \end{bmatrix} + \epsilon_t; \quad \epsilon_t \sim N\left(\emptyset, \begin{bmatrix} 0.00219 & 0.00162 \\ 0.00162 & 0.00167 \end{bmatrix}\right), \tag{26}$$

where ϵ_t is assumed to be i.i.d. This process implies unconditional standard deviations of 6 percent and a serial correlation of about 0.5 for both endowments, and a contemporaneous correlation of 0.8.

The above driving process is discretized using 4 distinct values for y_t^T and 16 distinct pairs $(\ln y^T, \ln y^N)$. The endogenous state, $d_t/(1+r)$, is discretized using 800 evenly spaced points ranging from 0.4 to 1.02. The interest rate is assumed to be constant and equal to 4 percent per year. The subjective discount factor, β, is set at 0.91. Thus, $\beta(1+r) = 0.9464$, which implies that agents are quite impatient relative to the market interest rate. This gives them a strong incentive to front load consumption by borrowing against future endowments. The remaining parameters are $\sigma = 2$, $\xi = 0.83$, $a = 0.31$, and $\kappa = 0.32(1+r)$. The value of κ is not exactly the same as in Bianchi (2011), namely 0.32, because we specify the collateral constraint as $d_{t+1} \leq \kappa(y_t^T + p_t y_t^N)$, whereas Bianchi uses the specification $d_{t+1}/(1+r) \leq \kappa(y_t^T + p_t y_t^N)$. Setting κ to $0.32(1+r)$ in the present model makes both calibrations equivalent. Table 1 summarizes the calibration and the discretization of the state space. We solve the unregulated equilibrium by an Euler-equation iteration procedure and the Ramsey equilibrium by value function iteration.

[1] Bianchi measures traded output as the sum of value added in manufacturing and primary products, and nontraded output as total GDP minus traded output.

Table 1: Calibration of the Economy with Endowment Shocks

Parameter	Value	Description
κ	0.3328	Parameter of collateral constraint
σ	2	Inverse of intertemporal elast. of subst.
β	0.91	Subjective discount factor
r	0.04	Interest rate (annual)
ξ	0.83	Intratemporal elast. of subst.
a	0.31	Weight on tradables in CES aggregator
y^N	1	Steady-state nontradable output
y^T	1	Steady-state tradable output
n_y	16	Number of grid points for $(\ln y_t^T, \ln y_t^N)$
n_d	800	Number of grid points for d_t, equally spaced
$\left[\ln \underline{y}^T, \ln \overline{y}^T\right]$	[-0.1093,0.1093]	Range for tradable output
$\left[\ln \underline{y}^N, \ln \overline{y}^N\right]$	[-0.1328,0.1328]	Range for nontradable output
$[\underline{d}/(1+r), \overline{d}/(1+r)]$	[0.4 1.02]	Range for debt

Note. The time unit is one year. The calibration is taken from Bianchi (2011).

4.1 Optimal Capital Controls During Boom-Bust Cycles

We start by examining the behavior of optimal capital controls and macroeconomic indicators of interest around boom-bust episodes. That is, episodes in which a large expansion in aggregate activity is followed by a large contraction. The question we wish to address is whether the Ramsey planner curbs the expansion in aggregate demand by raising capital controls during the boom phase and fosters absorption by lowering capital controls during the contractionary phase.

We define a boom-bust episode as a situation in which tradable output starts above trend and is below trend three years later. Recalling that the discretized version of y_t^T takes on only 4 distinct values (two above the mean and 2 below), our definition implies that the economy is on average 5 percent above trend at the peak of the boom and 5 percent below trend at the trough of the bust. This is a large contraction. The standard deviation of the log of traded output is 5.6 percent. Thus, from peak to trough tradable output contracts by 1.7 standard deviations.

To characterize the typical boom-bust cycle, we simulate the model for one million years and extract all windows containing a boom-bust cycle. The economy experiences 12 non-overlapping boom-bust episodes every century. We refer to the average dynamics over all boom-bust episodes as the typical boom-bust cycle. We then use the same sequence of one-million realizations of the exogenous states and the same initial level of debt to simulate one million years of data from the Ramsey economy to compare its behavior to that of the unregulated economy.

Figure 1 displays the dynamics of the model economy during the typical boom-bust cycle. The exogenous boom-bust cycle in tradable output produces endogenous boom-bust cycles in total output ($y_t \equiv y_t^T + p_t y_t^N$)), consumption, the relative price of nontradables, and the value of collateral. External debt, by contrast, is remarkably flat. The lack of response of external debt to large swings in the endowments is driven primarily by the fact that agents are extremely impatient. So much so that the consumption smoothing motive is dominated by the desire to front load consumption. Although the contraction of the economy from peak to trough is quite large, the collateral constraint remains slack throughout the typical boom-bust cycle.

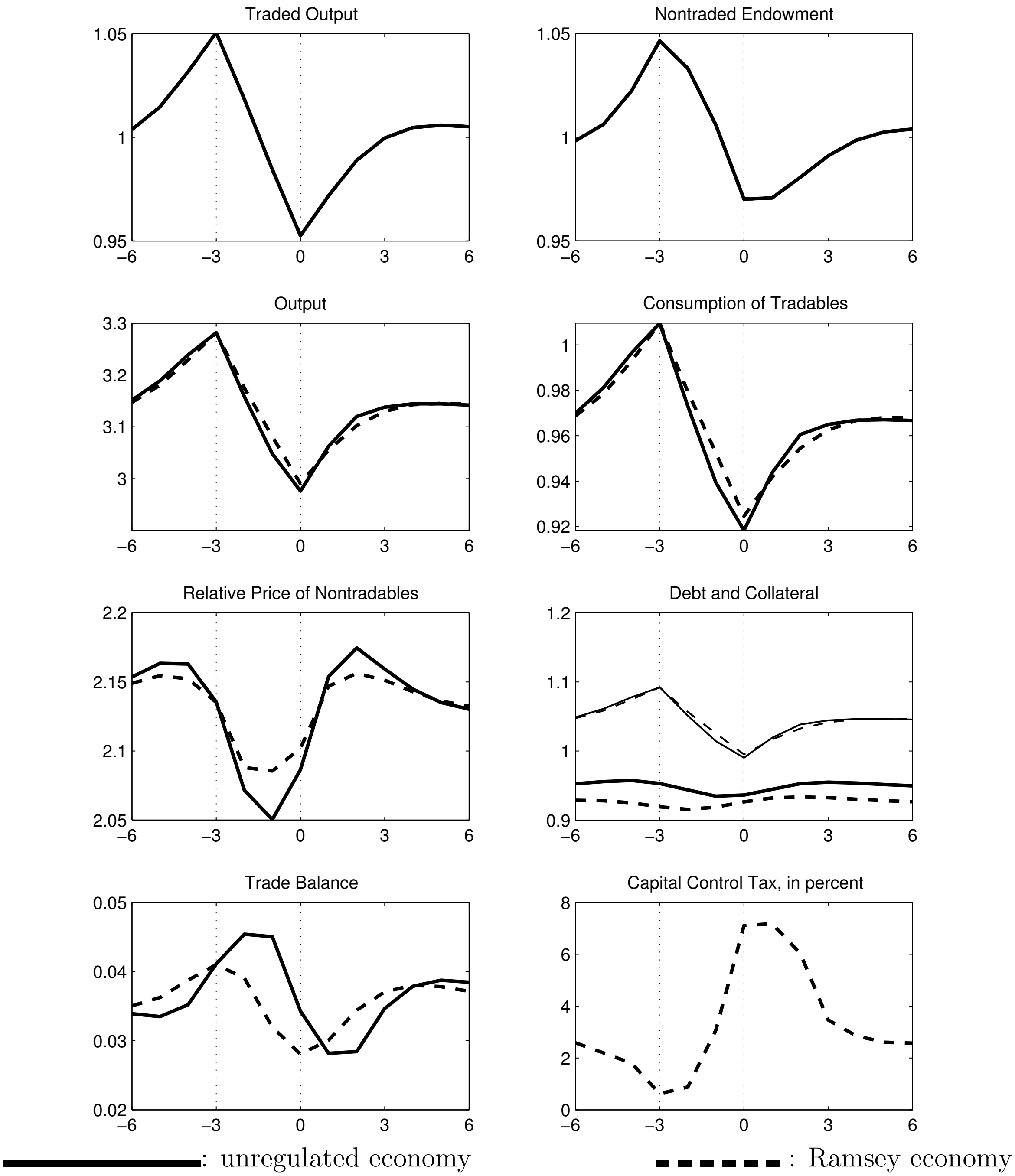
The figure displays with broken lines the behavior of the economy over the typical boom bust cycle under the Ramsey-optimal policy. The predicted booms and busts in output and consumption of tradable goods are remarkably similar in the unregulated and the Ramsey economies. This suggests that the pecuniary externality induces little amplification of the typical boom-bust cycle.

The Ramsey planner moves capital controls significantly over the typical boom-bust cycle (bottom-right panel of figure 1). However, the movements in capital controls do not follow a countercyclical pattern. On the contrary, during the boom phase of the cycle capital controls are lowered from 3 to 1 percent, and during the bust phase of the cycle they are increased to 7 percent. We interpret these predicted dynamics as suggesting that in the present model the collateral constraint does not call for tightening capital controls during booms as a prudential measure. Instead, the prescription of the Ramsey plan is to wait until the economy is in a recession before starting to discourage external borrowing via increases in capital controls.

4.2 Optimal Capital Controls Around Financial Crises

We have shown that optimal capital controls do not behave in a countercyclical manner during a typical boom-bust cycle. Another perspective to gauge whether optimal capital control policy is countercyclical is to consider the behavior of optimal capital controls during financial crises. To this end, we characterize the behavior of the unregulated and Ramsey economies around episodes in which the collateral constraint binds in the unregulated economy. As in the analysis of boom-bust cycles, we simulate the unregulated economy for one million years. We then extract all eleven-year windows centered around a period in which the collateral constraint binds. This yields 85,242 windows. Thus, the unregulated economy suffers on average one financial crisis every 12 years (table 2). We then use the same sequence

Figure 1: The Typical Boom-Bust Cycle



Note. Each line is the mean across all windows containing a boom-bust cycle in a time series of 1 million years. For the capital-control tax rate, the figure displays the median instead of the mean across windows because this variable is skewed, with an unconditional mean of 4.2 percent and an unconditional median of 2.5 percent. Because, as shown in section 3, the capital control tax rate is indeterminate when the collateral constraint binds under the Ramsey policy, this variable is given a number only if the collateral constraint is slack under the Ramsey policy. Replication file typical_boom_bust.m in sgu_endowment_shocks.zip.

Table 2: Debt, Frequency of Crises, and Optimal Capital Controls

Environment	Debt-to-Output Ratio		Frequency of Crises		Optimal Capital Controls	
	Unregulated	Ramsey	Unregulated	Ramsey	median (τ_t)	corr(τ_t, y_t)
y_t^T and y_t^N shocks	29.2%	28.5%	12 years	26 years	2.5%	-0.8
y_t^T and r_t shocks	29.3%	28.3%	14 years	37 years	1.9%	-0.1

Note. The debt-to-output ratio is the unconditional mean of $\frac{d_{t+1}/(1+r_t)}{y_t}$. The variable $y_t \equiv y_t^T + p_t y_t^N$ denotes output in terms of tradables. A crisis is defined as a period with a binding collateral constraint. The environment with y_t^T and y_t^N shocks is studied in section 4 and the environment with y_t^T and r_t shocks is studied in section 5. Replication files: for line 1, table.m in sgu_endowment_shocks.zip, and for line 2, table.m in sgu_rshocks.zip.

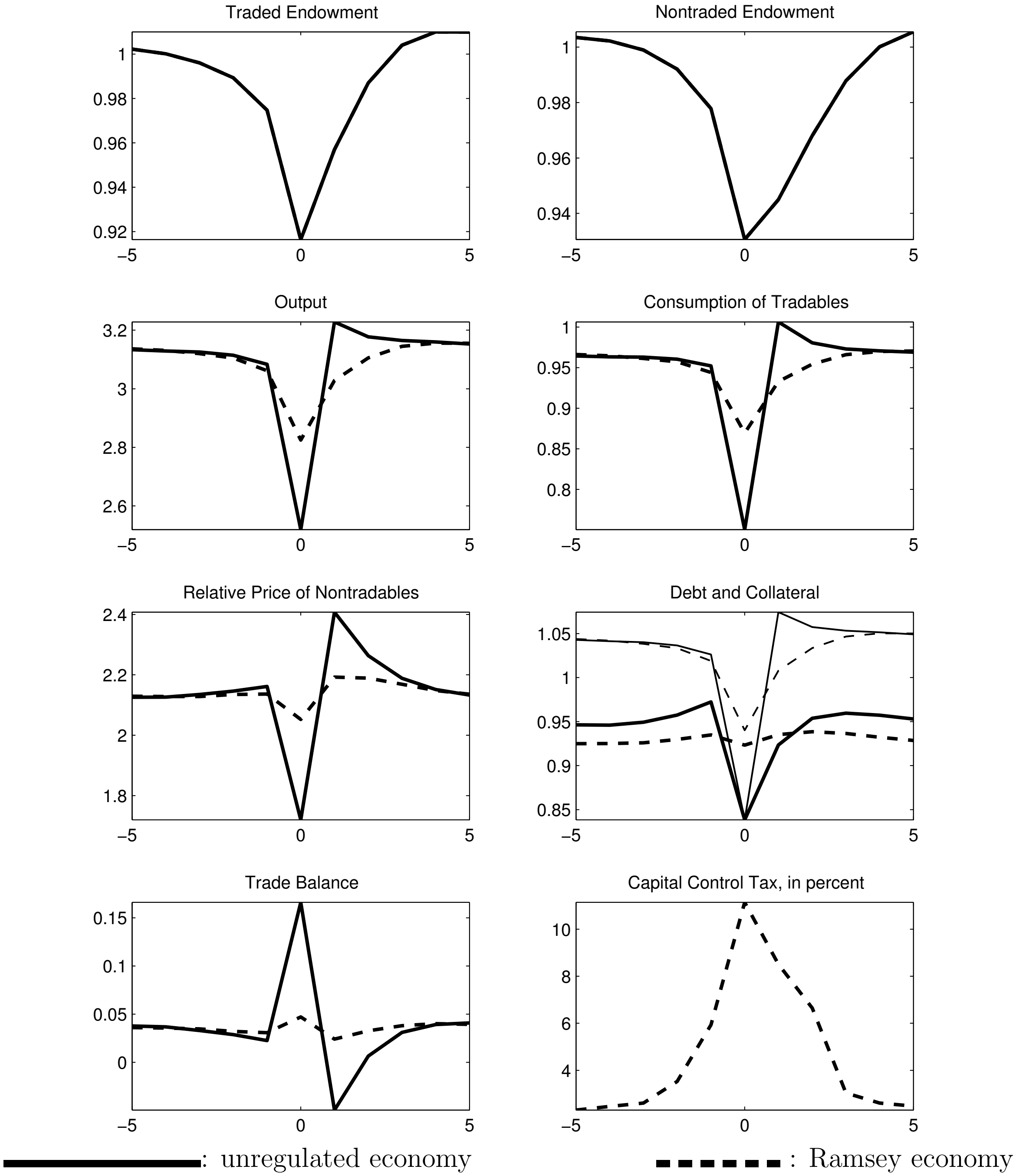
of one-million realizations of the exogenous states and the same initial level of debt to simulate one million years of data from the Ramsey economy. Over these one million periods, the Ramsey economy experiences 38,612 episodes of a binding constraint. This means that the Ramsey optimal capital control policy cuts the frequency of financial crises from once every 12 years to once every 26 years (table 2). It follows that the pecuniary externality makes the economy more vulnerable to financial crises.

Figure 2 displays with a solid line the mean across all 85,242 windows in which the unregulated economy suffers a crisis. We refer to these average dynamics as the typical financial crisis implied by the present model economy. In the figure, the time of the crisis is normalized to period 0. The crisis occurs after a string of increasingly negative endowment shocks. In the period of the crisis, both endowments are about 8 percent below average.

The run-up to the crisis does not feature an unusually large accumulation of debt. Between periods -5 and -1, external debt does increase, but not significantly (less than half a standard deviation). Thus, the typical financial crisis in the present model does not capture well the narrative that financial crises are preceded by externally financed credit booms. However, the typical crisis predicted by the model does bear some of the signs of a sudden stop. Consumption of tradables contracts by more than output causing a large improvement in the trade balance of more than 10 percent of tradable output. At the time of the crisis, the economy deleverages, with external debt falling by about 15 percent. This sharp reduction in external liabilities requires a similarly large contraction in aggregate absorption, which in turn causes a Fisherian deflation, with the relative price of nontradables falling by 20 percent. The Fisherian deflation aggravates the fall in collateral, which is already quite depressed by the fall in both endowments.

Although the financial crisis is quite severe, it is short lived. Just one period after the crisis the economy is above steady state and the trade balance reverses sign from a large

Figure 2: The Typical Financial Crisis



Note. Each line is the mean across all 11-year windows containing a binding collateral constraint in the center in a one-million-year time series from the unregulated economy. For the capital-control tax rate, the figure displays the median instead of the mean across windows because this variable is skewed, with an unconditional mean of 4.2 percent and an unconditional median of 2.5 percent. Because, as shown in section 3, the capital control tax rate is indeterminate when the collateral constraint binds under the Ramsey policy, this variable is given a number only if the collateral constraint is slack under the Ramsey policy. Replication file typical_crisis.m in sgu_endowment_shocks.zip.

surplus to a deficit. Interestingly, this quick recovery happens in a context in which both endowments are still more than 5 percent below average. The reason for the swift recovery is that the deleveraging that occurs in period 0 places the economy in a sound financial position in period 1. In particular, with low levels of debt at the beginning of period 1, households can afford a higher level of absorption of all goods traded and nontraded. In turn, the fact that the endowment of nontradables is still quite depressed implies that its price must increase to ensure market clearing. The relative price of nontradables overshoots from 20 percent below mean in period 0 to 13 percent above mean in period 1. This large real appreciation increases the value of collateral and loosens the collateral constraint. These predicted dynamics are at odds with a growing empirical literature that finds that financial crises are associated with slow recoveries (see, for example, Cerra and Saxena, 2008; Reinhart and Reinhart, 2010; and Reinhart and Rogoff, 2014).

How does the Ramsey planner handle situations that, in the absence of policy intervention, end up in crises? Figure 2 displays with broken lines the implied dynamics under the Ramsey-optimal capital control policy. The optimal capital control policy manages to fend off the typical crisis. The right panel on the third row of the figure shows with a thin broken line the value of collateral, $\kappa(y_t^T + p_t y_t^N)$, under the Ramsey policy and with a thick broken line the level of external debt assumed in period t, d_{t+1}, under the Ramsey policy. In both the Ramsey and the unregulated economies collateral falls sharply in period 0 due to the collapse in both endowments. However, the Ramsey economy is less exposed to external debt than its unregulated counterpart, and therefore displays more slack in the collateral constraint. As a result, the fall in collateral due to the fall in endowments does not end up in a binding collateral constraint in the Ramsey economy. This, in turn, implies that this economy does not suffer a Fisherian deflation with its negative feedback on the value of collateral. Indeed, the left panel of row 3 of the figure shows that under the Ramsey policy the relative price of nontradables is little changed in period 0. The Ramsey planner manages to arrive at period 0 with less debt by a capital control policy whose long-run and cyclical properties are conducive to avoiding a binding constraint in recessions. Specifically, capital controls are positive on average (the median value of τ_t is 2.5 percent), which implies that on average, the Ramsey economy has 2.3 percent (or 0.7 percent of output) less debt than the unregulated economy (see table 2). This appears to be a small difference, but it is finely calculated by the Ramsey planner to avoid a binding constraint. The Ramsey-optimal policy trades off the desire of impatient households to front-load consumption and accumulate debt against avoiding a binding collateral constraint.

The capital control policy displays significant movements around the financial crisis. The Ramsey planner increases capital controls as the economy enters in recession to discourage the build up of debt. As the economy falls into an increasingly deep recession prior to period 0, the capital-control tax rate increases from 2.3 percent in period -5 to 11 percent in period 0. In this regard, the optimal capital-control policy is not countercyclical in nature. As in the case of boom-bust cycles, the planner waits until the economy has entered into the recession before increasing capital controls.

The conclusion that optimal capital-control policy is not countercyclical in open economies with a pecuniary externality due to collateral constraints holds not only for large boom-bust cycles or financial crises but also over regular business cycles. As shown in table 2, the unconditional correlation of the optimal capital-control tax with output is -0.8. Thus, the Ramsey planner lowers capital controls during expansions and raises them during contractions.

5 Interest-Rate Shocks and the Cyclicality of Optimal Capital-Control Policy

Thus far, we have considered an economy driven purely by endowment shocks. We found that in the context of that environment the cyclical component of optimal capital control policy is not countercyclical, for the Ramsey planner increases capital controls when the economy is in recession and lowers them when the economy is expanding. We now change the stochastic environment by introducing interest-rate shocks. The rationale for introducing this type of shock is twofold. First, movements in the world interest rate and in country spreads, the two components of the country interest rate, have been shown to be an important driver of business cycles in emerging countries (Uribe and Yue, 2006). Second, in principle, there are reasons to imagine that interest-rate shocks may have a significant effect on the cyclical properties of optimal capital control policy. During periods of low interest rates, households have an incentive to increase consumption and to borrow more. The expansion in aggregate absorption pushes up the price of nontradables, raising the value of collateral, and thereby making room for the expansion in external borrowing. At the end of this phase of low interest rates, the economy is more leveraged and therefore more vulnerable to negative shocks. In this environment, the Ramsey planner may have an incentive to put sand in the wheels of capital flows during periods of low interest rates, to avoid a rough landing in the contractionary phase of the cycle. The purpose of this section is to ascertain whether this intuition actually plays out when we feed the model with a realistic process for the country interest rate.

The structure of the model economy is unchanged, except that now the sources of uncertainty are the interest rate, r_t, and the endowment of tradables, y_t^T. The endowment of nontradables is assumed to be constant and normalized to unity, $y_t^N = y^N = 1$ for all t. We assume that y_t^T and r_t follow a bivariate AR(1) process. Specifically, we annualize the quarterly process estimated in Schmitt-Grohé and Uribe (forthcoming). There, we use Argentine quarterly data over the period 1983:Q1 to 2001:Q4.[2] The annual AR(1) representation is

$$\begin{bmatrix} \ln y_t^T \\ \ln \frac{1+r_t}{1+r} \end{bmatrix} = \begin{bmatrix} 0.48 & -0.77 \\ -0.08 & 0.68 \end{bmatrix} \begin{bmatrix} \ln y_{t-1}^T \\ \ln \frac{1+r_{t-1}}{1+r} \end{bmatrix} + \epsilon_t; \quad \epsilon_t \sim N\left(\emptyset, \begin{bmatrix} 0.0031 & -0.0015 \\ -0.0015 & 0.0014 \end{bmatrix}\right), \tag{27}$$

and $r = 0.1325$, where ϵ_t is assumed to be i.i.d. The average interest rate of 13.25 percent per year reflects the fact that Argentina faced high country premia over the estimation period. The estimated AR(1) process implies high volatilities of both the interest rate and the natural logarithm of tradable output, of 6.5 percentage points and 11.7 percent, respectively.[3] Also, the interest rate and tradable output display negative comovement, with a contemporaneous correlation of -0.87. This means that both variables reinforce their cyclical macroeconomic effects on aggregate demand. Periods of low interest rates tend to coincide with high levels of tradable endowment, both giving incentives for households to expand spending. Similarly, periods of high interest rates tend to be accompanied by low levels of tradable endowment, both inducing a contraction in aggregate demand.

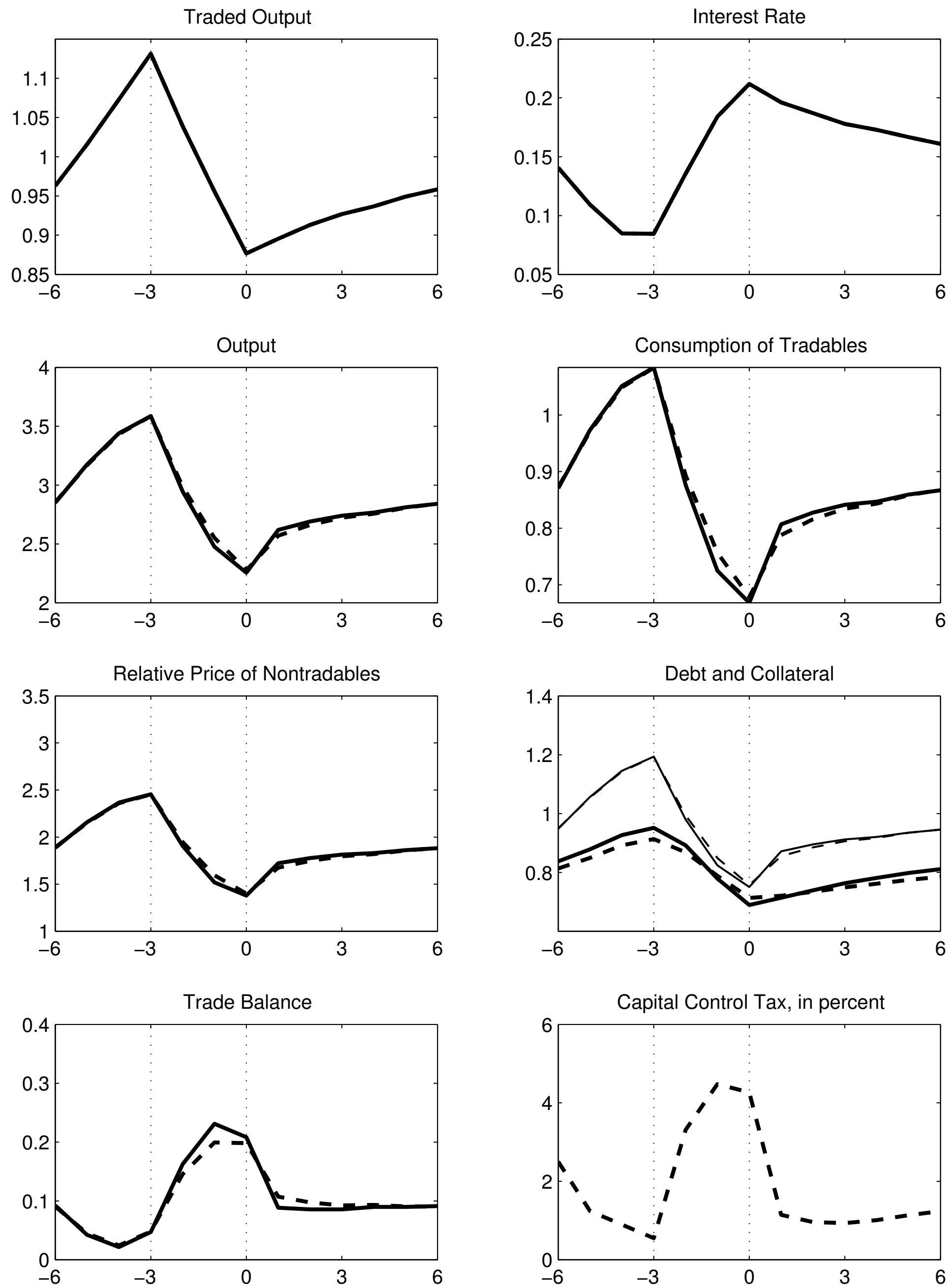
We discretize the above process using 21 equally spaced points for the natural logarithm of y_t^T and 11 equally spaced points for the natural logarithm of $(1+r_t)/(1+r)$ (see table 3 for the respective ranges). The transition probability matrix is estimated using the simulation approach developed in Schmitt-Grohé and Uribe (2009). The calibration of the remaining parameters of the model is unchanged, except for the subjective discount factor, β. We set β to preserve the relative impatience of the representative household in the endowment-shock economy, that is, to maintain the difference between the subjective and market discount rates assumed in the endowment-shock economy. Specifically, we calibrate β so that $\beta(1 + r)$ is the same in the present calibration and in the calibration of the endowment-shock economy. This requires setting β equal to 0.8357. This calibration choice ensures similar debt levels in both economies (see table 2). Table 3 summarizes the calibration of the present economy.

Figure 3 displays the dynamics of the unregulated and Ramsey-optimal economies over a typical boom-bust episode. Here we define a typical boom-bust episode as one in which tradable output starts below mean, is one standard deviation above mean three years later,

[2]The measure of traded output is value added in agriculture, forestry, fishing, mining, and manufacturing. The data source is INDEC. The cyclical component is obtained by removing a log-quadratic time trend.

[3]The implied process for traded output is twice as volatile as the one implied by (26). The explanation for this discrepancy is most likely the detrending method. Uribe and Schmitt-Grohé (forthcoming, Chapter 1) show that the standard deviation of the cyclical component of Argentine annual GDP over the period 1960 to 2011 falls from 10.7 percent under log-quadratic detrending to 6.3 percent under HP-100 filtering.

Figure 3: Interest-Rate Shocks and The Typical Boom-Bust Cycle



——: unregulated economy - - - -: Ramsey economy

Note. Each line is the mean across all windows containing a boom-bust cycle in a time series of 1 million years. For the capital-control tax rate, the figure displays the median. Replication file typical_boom_bust.m in sgu_rshocks.zip.

Table 3: Calibration of the Economy with Interest-Rate Shocks

Parameter	Value	Description
κ	0.3328	Parameter of collateral constraint
σ	2	Inverse of intertemporal elast. of subst.
β	0.8357	Subjective discount factor
r	0.1325	Steady state country interest rate
ξ	0.83	Intratemporal elast. of subst.
a	0.31	Weight on tradables in CES aggregator
y^N	1	Nontradable output
y^T	1	Steady-state tradable output
n_{y^T}	21	Grid points for $\ln y_t^T$, equally spaced
n_r	11	Grid points for $\ln\left(\frac{1+r_t}{1+r}\right)$, equally spaced
n_d	800	Grid points for d_t, equally spaced
$\left[\ln \underline{y}^T, \ln \overline{y}^T\right]$	[-0.3706,0.3706]	Range for tradable output
$\left[\ln\left(\frac{1+\underline{r}}{1+r}\right), \ln\left(\frac{1+\overline{r}}{1+r}\right)\right]$	[-0.2040,0.2040]	Range for interest rate
$[\underline{d}, \overline{d}]$	[-0.5,1.5]	Range for debt

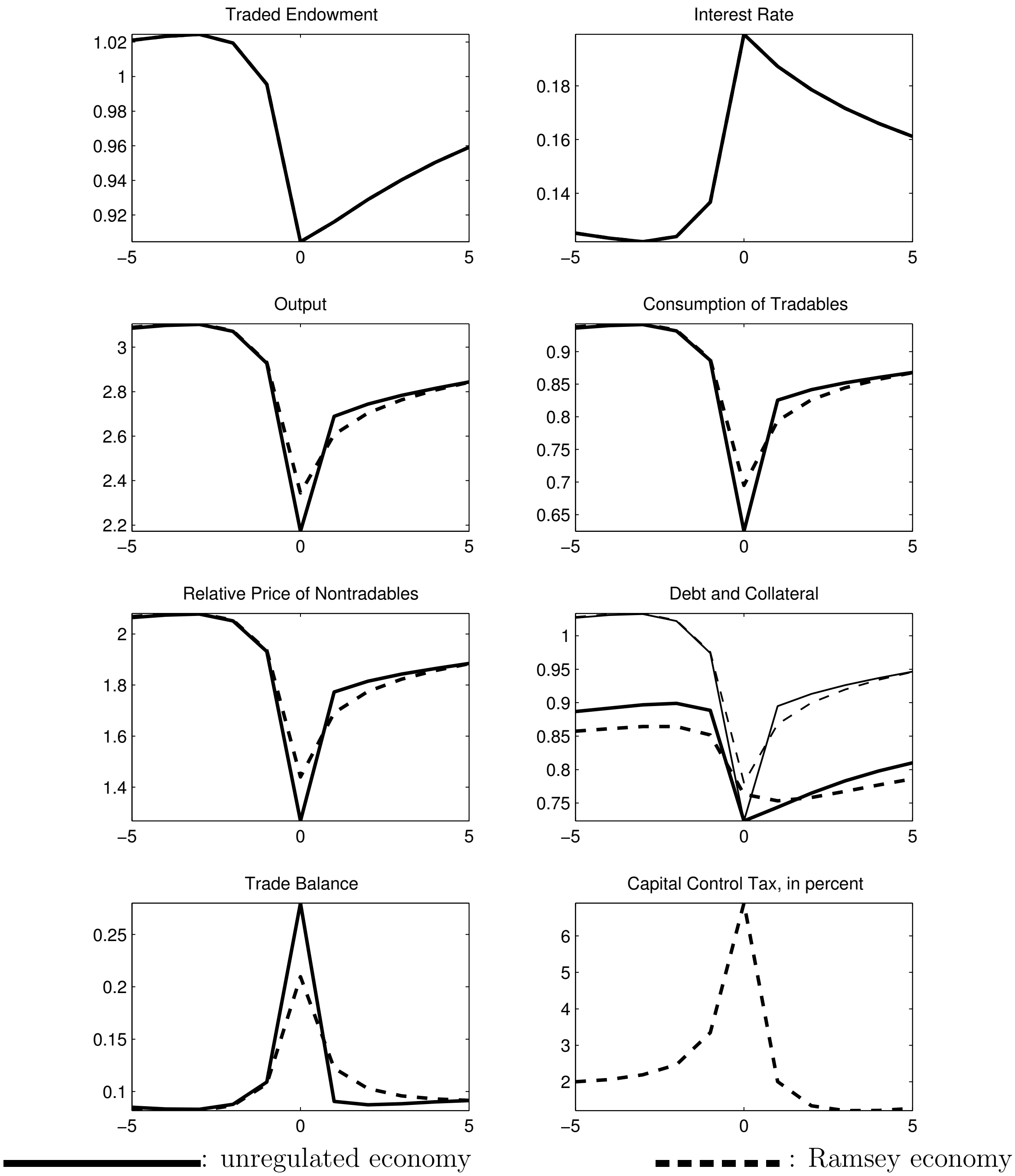
Note. The time unit is one year.

and then falls to one standard deviation below mean in the subsequent three years. We are able to give a more precise definition of a boom-bust cycle than was possible in the endowment-shock economy because the discretization of the endowment is finer (21 versus 4 points). Because y_t^T and r_t are highly negatively correlated, we could have similarly defined a boom-bust cycle in terms of the interest rate. This is evident from the top panel of figure 3.

The main message conveyed by the figure is that, as in the endowment-shock economy, optimal capital-control policy is not countercyclical. On the contrary, the Ramsey planner decreases capital controls during booms and increases them during contractions.

The Ramsey planner also takes a procyclical policy stands during financial crises. Figure 4 depicts the dynamics of a typical financial crisis in the interest-rate shock economy. As before, we define a financial crisis as a situation in which the collateral constraint binds. The typical financial crisis occurs after a combination of large adverse shocks to the country interest rate and tradable output. The country interest rate increases by almost 8 percentage points between periods -2 and 0, and tradable output falls by about 12 percent in the same short period. A financial crisis occurs slightly less frequently than in the endowment-shock economy (once every 14 years versus once every 12 years; see table 2). As in the endowment-shock economy, a financial crisis is associated with a large contraction in traded absorption, a significant improvement in the trade balance, debt deleveraging, and a Fisherian deflation in the value of collateral as embodied in the sharp depreciation of the real exchange rate (i.e., the sharp fall in p_t).

Figure 4: The Typical Financial Crisis in the Interest-Rate Economy



Note. Each line is the mean across all 11-year windows containing a binding collateral constraint in the center in a one-million-year time series from the unregulated economy. For the capital-control tax rate, the figure displays the median instead of the mean across windows because this variable is highly skewed. Because the capital control tax rate is indeterminate when the collateral constraint binds under the Ramsey policy, in the figure this variable is given a number only if the collateral constraint is slack under the Ramsey policy. Replication file typical_crisis.m in sgu_rshocks.zip.

An improvement of the present model over the endowment-shock economy is that now, in line with the data, financial crises are associated with a slow recovery. Five years after the crisis, output and consumption remain below trend and the real exchange rate remains depreciated. However, the reason for the slow recovery is not the presence of the collateral constraint, but the persistence of interest-rate shocks, which are fully exogenous. As in the endowment-shock economy, the deleveraging that occurs in period 0 puts the economy in a better financial standing in period 1, which is conducive to a quick recovery of aggregate demand. However, in the present environment interest rates remain high for a protracted period of time, which discourages spending and borrowing.

Figure 4 also displays the equilibrium dynamics under Ramsey-optimal capital-control policy, that is, when the pecuniary externality is fully internalized. Most of the time, the Ramsey planner manages to avoid financial crises. The frequency of financial crises falls from once every 14 years in the unregulated economy to once every 37 years under the Ramsey-optimal capital-control policy (table 2). As in the endowment-shock economy, the Ramsey planner achieves this reduction in the frequency of crises in two ways. First, the capital control tax rate is positive on average, with an unconditional median of 1.9 percent (table 2). As a consequence, agents borrow less than in the unregulated economy. The unconditional debt to output ratio is 28.3 percent compared to 29.3 percent in the unregulated economy (see again table 2). The lower average level of debt also has a positive effect on collateral. The reason is that less indebted households, by devoting a smaller fraction of their income to debt service, can enjoy a higher level of consumption, which in equilibrium boosts the price of nontradables, raising the collateral value of nontraded output. Thus, the result that the pecuniary externality induced by the collateral constraint calls for positive capital control taxes on average is robust to introducing interest-rate shocks.[4]

The second way in which the planner avoids financial crises is through the cyclical component of capital controls. Figure 4 shows that as the economy enters in a recession, the planner increases capital controls to discourage households from financing the fall in income by borrowing from the rest of the world. It follows that, as in the endowment-shock economy, capital control policy is not countercyclical in nature. The Ramsey planner waits until the economy is in recession to increase capital controls, as opposed to raising capital controls during booms to allow the economy to enter recessions with a lower debt burden.

The lack of countercyclicality of the optimal capital-control policy also holds unconditionally. The unconditional correlation of τ_t with $\ln(y_t^T + p_t y^N)$ is -0.1 (table 2), which means

[4]It can be shown numerically that the average optimal capital-control tax rate and the frequency of crises are sensitive to the value assumed for the relative patience factor, $\beta(1+r)$. The closer is the relative patience factor to one, the lower are the average optimal capital-control tax rate and the frequency of crises.

that expansions in output are accompanied by reductions in capital-control taxes and vice versa.

6 Conclusion

This paper shows that the conventional view according to which policymakers should increase capital controls during economic booms and loosen them during contractions is not supported as a Ramsey optimal outcome in open economy models with pecuniary externalities due to flow collateral constraints. It shows that in this class of models, the Ramsey planner waits until recessions have set in before increasing capital controls, as opposed to raising capital controls during booms to ensure that the economy enters the contractionary phase of the business cycle with sound financial fundamentals.

To understand the logic behind the optimality of a procyclical capital control policy in the context of the present economy, it is important to understand that a key ingredient of most models in this class is the assumption of high impatience on the part of households. For example, in the present calibration, which is a typical one, the relative impatience factor, $\beta(1+r)$, is 0.95. That is, agents subjective discount rate is 5 percentage points higher than the market discount rate. This means that households have a strong incentive to front load consumption via the accumulation of external debt. The desire to front load is so strong that, for the purpose of understanding the inner workings of the model, one can safely ignore the consumption smoothing motive—the backbone of the intertemporal approach to the balance of payments. The second key ingredient is the collateral constraint. Hitting the collateral constraint is highly costly because it forces agents to deleverage, which, in turn, entails cutting present consumption in favor of future consumption, precisely what they do not like to do. The third key ingredient of the model is the pecuniary externality created by the fact that the value of collateral depends on a price which is endogenous to the economy, but exogenous to individual households. This pecuniary externality causes the laissez-faire economy to be caught with a binding collateral constraint more often than it would were agents to internalize the pecuniary externality. The Ramsey planner, therefore, constantly negotiates a tradeoff between allowing agents to front load consumption and preventing them from hitting the collateral constraint too often. The economy is at the highest risk of hitting the constraint in bad times. This is because during recessions all of the components of collateral, namely, tradable output, nontradable output, and the relative price of nontradables, are depressed. As a result, it is during these circumstances that the Ramsey planner has the highest incentive to discourage borrowing. And the instrument he has to do so are capital control taxes.

What theoretical features could be added to the model in order to reconcile its predictions regarding the cyclicality of optimal capital controls with the conventional wisdom? One possibility is to incorporate nominal rigidities. In Schmitt-Grohé and Uribe (forthcoming), for example, we show that open economy models with downward nominal rigidity and non-optimal exchange-rate policy, such as a currency peg, can deliver the result that Ramsey-optimal capital control policy is countercyclical. In that environment, a negative demand shock, such as an increase in the country interest-rate, causes a contraction in the demand for goods. In turn the contraction in the aggregate demand for goods translates into a weaker demand for labor. Market clearing in the labor market requires a fall in the real wage. However, if nominal wages are downwardly inflexible and the nominal exchange rate is fixed, the real wage is unable to fall, giving rise to involuntary unemployment. Under these circumstances, the Ramsey planner has an incentive to lower capital controls as a way to foster debt-financed domestic absorption. During booms, market clearing in the labor market calls for an increase in the real wage. With the nominal exchange rate fixed, this requires an increase in nominal wages. But such an increase sows the seeds of larger unemployment in the contractionary phase of the cycle, given the combination of downward nominal wage rigidity and a fixed exchange rate. Individual agents understand this mechanism but are too small to internalize the fact that their own increase in demand during the boom phase exacerbates the cycle. Thus, the Ramsey planner finds it optimal to increase capital controls during the boom phase as a way to restrain demand by making agents internalize the externality.

It would be of interest to characterize the cyclical properties of optimal capital control policy in the context of an economy that incorporates both a collateral constraint and downward nominal rigidity to ascertain whether the resulting policy prescription conforms with the conventional wisdom.

Finally, the central theme of the present paper is normative. We focus on characterizing the cyclical properties of optimal capital control policy in economies with a pecuniary externality due to a flow collateral constraint. An alternative perspective is to consider the positive aspects of the problem. The cyclical properties of observed capital control policies lie in between the conventional wisdom and the optimal capital control policy predicted by the model. Fernández, Rebucci, and Uribe (2015), for example, construct a cross-country panel of capital control measures for 95 countries over the period 1995-2011. They find that capital controls are remarkably stable over the business cycle. This empirical regularity provides further motivation for exploring theoretical environments that incorporate both nominal and financial frictions. The fact that the former call for countercyclical capital controls and the latter for procyclical capital controls opens the possibility of rendering optimal capital controls acyclical as observed in the data.

References

Benigno, Gianluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R. Young, “Financial Crises and Macro-Prudential Policies,” *Journal of International Economics 89,* 2013, 453-470.

Benigno, Gianluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R. Young, “Optimal Capital Controls and Real Exchange Rate Policies: A Pecuniary Externality Perspective,” CEPR Discussion Paper No. 9936, April 2014.

Bianchi, Javier, “Overborrowing and Systemic Externalities in the Business Cycle,” *American Economic Review 101,* December 2011, 3400-3426.

Cerra, Valerie, and Sweta Chaman Saxena, “Growth Dynamics: The Myth of Economic Recovery,” *American Economic Review 98,* March 2008, 439-457.

Fernández, Andrés, Alessandro Rebucci, and Martín Uribe, “Are Capital Controls Countercyclical?,” *Journal of Monetary Economics 76,* 2015, 1-14.

Korinek, Anton, “Excessive Dollar Borrowing in Emerging Markets: Balance Sheet Effects and Macroeconomic Externalities,” University of Maryland, July 2011.

Mendoza, Enrique G., “Credit, Prices, and Crashes: Business Cycles with a Sudden Stop,” in Sebastian Edwards and Jeffrey A. Frankel (Eds.), *Preventing Currency Crises in Emerging Markets,* University of Chicago Press, Chicago, IL, 2002, 335-392.

Reinhart, Carmen M., and Vincent R. Reinhart, “After the fall,” Proceedings, Economic Policy Symposium, Jackson Hole, Federal Reserve Bank of Kansas City, 17-60, 2010.

Reinhart, Carmen M., and Kenneth S. Rogoff, “Recovery from Financial Crises: Evidence from 100 Episodes,” *American Economic Review: Papers & Proceedings 104,* May 2014, 50-55.

Schmitt-Grohé, Stephanie, and Martín Uribe, “Finite-State Approximation Of VAR Processes: A Simulation Approach,” Columbia University, 2009.

Schmitt-Grohé, Stephanie and Martín Uribe, “Downward Nominal Wage Rigidity, Currency Pegs, And Involuntary Unemployment,” Journal of Political Economy, forthcoming.

Schmitt-Grohé, Stephanie and Martín Uribe, “Multiple Equilibria in Open Economy Models with Collateral Constraints: Overborrowing Revisited,” Columbia University, 2016.

Uribe, Martín, “On Overborrowing,” *American Economic Review Papers and Proceedings 96,* May 2006, 417-421.

Uribe, Martín, “Individual Versus Aggregate Collateral Constraints and the Overborrowing Syndrome,” NBER working paper 12260, May 2007.

Uribe, Martín, and Stephanie Schmitt-Grohé, *Open Economy Macroeconomics,* Princeton, NJ: Princeton University Press, forthcoming.

Uribe, Martín and Z. Vivian Yue, "Country Spreads and Emerging Countries: Who Drives Whom?," *Journal of International Economics 69,* June 2006, 6-36.