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Capital Controls or Exchange Rate Policy? A Pecuniary Externality Perspective

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Abstract
In the aftermath of the global financial crisis, a new policy paradigm has emerged in which old-fashioned policies such as capital controls and other government distortions have become part of the standard policy toolkit (the so-called macro-prudential policies). On the wave of this seemingly unanimous policy consensus, a new strand of theoretical literature contends that capital controls are welfare enhancing and can be justified rigorously because of second-best considerations. Within the same theoretical framework adopted in this fast-growing literature, we show that a credible commitment to support the exchange rate in crisis times always welfare-dominates prudential capital controls as it can achieve the first best unconstrained allocation. In this benchmark economy, prudential capital controls are optimal only when the set of policy tools is restricted so that they are the only policy instrument available.

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1 Introduction

In response to the economic wreckage brought about by the recent global financial crisis, a new policy paradigm has quickly emerged in which old fashioned government distortions such as capital controls or other quantitative restrictions on credit flows are becoming part of the standard policy toolkit (the so called macro-prudential policies). Faced with strong capital inflows, appreciating currencies, and progressively tighter constraints on domestic monetary policy, many emerging countries have already adopted or tightened capital controls (with Brazil a well known case in point). Echoing these concerns within the emerging market world, even the traditionally conservative IMF changed its orthodox views on capital controls and is now actively advocating the use of such tools as part of the "macro-prudential" toolkit.

On the wave of this seemingly unanimous policy consensus, a new strand of theoretical literature has emerged contending that such measures can be justified on welfare grounds because of second-best considerations with the typical rigor of the DSGE methodology (e.g., Bianchi and Mendoza, 2010; Bianchi, 2011; Jeanne and Korinek, 2011a and 2011b).[1] [2]

In this novel theoretical framework, the scope for policy intervention arises because of a pecuniary externality stemming from the presence of a key relative price in the collateral constraint that private agents face. In this environment, prudential interventions may be desirable because they make agents internalize the aggregate consequences of their decisions, discourage financial excesses, and reduce the probability of financial crises, possibly enhancing welfare. As Jeanne (2012) put it, this literature *"transposes to international capital flows the closed-economy analysis of the macroprudential policies that aim to curb the boom-bust cycle in credit and asset prices".*

Using the same theoretical framework of this new literature on pecuniary externalities, in this paper we show that a credible commitment to a price support policy (in our case a promise to support the real exchange rate in crisis times) always welfare-dominates prudential taxes on debt (i.e. prudential capital controls), as they can achieve the first best unconstrained allocation. In particular, the desirability of capital controls is confined to the case in which they are the only policy tool available to the policymaker.

The paper also contributes methodologically to the literature on pecuniary externalities by showing that Ramsey optimal policy should be the preferred approach to policy design rather than the social planner approach typically used to study the normative implications

[1] See also Lorenzoni (2008). See Benigno *et al.* (2011, 2012) for more details on this new literature.

[2] The traditional rationale for introducing capital controls ranged from reducing the volume of capital inflows to limit pressure on the exchange rate to allowing for a more independent monetary policy stance (Magud, Reinhart, and Rogoff 2011).

of this class of models. In fact we show that the normative implications of the social planner problem are in general sensitive to the specific definition of efficiency adopted, an issue that does not arise in the context of the Ramsey planner.

As the vehicle to convey our message, we adopt the same model economy as in the influential article by Bianchi (2011).[3] This is a two-sector (tradables and nontradables) small open, endowment model economy with an occasionally binding borrowing constraint. Borrowing is limited by the value of current income generated from both the tradable and nontradable sectors. In this class of models, a financial crisis event (also labelled a Sudden Stop in capital or credit flows), only occurs when the constraint binds. In this framework, a capital control corresponds to a tax on international borrowing, while an exchange rate intervention is a policy aimed at controlling the behavior of the relative price of nontradables through a tax on either tradable or nontradable consumption.[4]

More specifically in our framework there are three possible distortionary policy tools (a tax on borrowing, a tax on nontradable consumption and a tax on tradable consumption). We show that the debt tax is welfare-dominated by the other two tools: while with the debt tax replicates the constrained-efficient allocation, with either one of the two consumption taxes it is possible to achieve the unconstrained first-best allocation.

The optimality of prudential capital controls in this model environment derives from a specific feature of the planner problem in the context of the endowment economy. In the endowment economy, there is no need to engage in any policy intervention during crisis times since the competitive allocation always coincides with the constrained social planner's one in those contingencies. The best that policy can do is then to minimize the probability that a crisis occurs. As a result, it becomes optimal to impose a tax on debt flows during tranquil times.

But this result hinges critically on limiting the set of policy tools available to the policymaker. As we show in the paper, a properly-designed consumption tax (on tradable or nontradable consumption) can achieve higher welfare by promising to manage the real exchange rate during crisis times with the aim of relaxing the borrowing constraint when it binds in bad times. In fact, in the paper we find that a commitment to a price support policy during crisis times can undo the borrowing constraint completely and, as a result, it supports an equilibrium in which agents behave as if they were in the unconstrained first-best allocation during normal times. The result is that crises cease to occur in equilibrium,

[3] Bianchi (2011) shows that this model successfully reproduces the business cycle and the crisis dynamics properties of Argentine data, and he uses it to quantify the optimal tax rate on foreign currency debt of one year maturity. Most of our results are analytical.

[4] The interpretation of the real exchange rate as the relative price of nontradables follows from Mendoza (2002), Caballero and Lorenzoni (2008) and Bianchi (2011).

and the optimal policy reduces to a commitment to intervene along an off-equilibrium path. Importantly, as we shall see, the policy supporting such an equilibrium is time-consistent. The promise to support the exchange rate, therefore, is a credible one.

From a methodological perspective, the approach usually followed in the literature on pecuniary externalities is to compare the competitive allocation with a social planner allocation. In this comparison, the social planner is constrained by the same borrowing constraint that private agents face, but internalizes the general equilibrium effects of her/his borrowing decisions on market prices. One then seeks a set of policy instruments and corresponding rules which replicates the social planner outcome in a decentralized equilibrium. An alternative approach, along the Ramsey-tradition of the modern optimal taxation theory, endows the policymaker with a set of instruments and solves for the policy rules that maximize welfare conditional on agents behaving as if they were in the competitive equilibrium allocation.

An important result of this paper is that, in this class of models with endogenous borrowing constraints, the Ramsey optimal policy can achieve higher welfare than the constrained-social planner problem. This is because with certain policy tools the Ramsey planner can manipulate the relative market price that enters the borrowing constraint so as to undo such constraint completely. This result points to a fragility in the social planner approach which might unintentionally limit the set of policy choices. In contrast, a Ramsey approach conditional on a given set of instruments naturally compares the relative strength of alternative policy tools.

Moreover the normative implications of the social planner approach are sensitive to the definitions of efficiency adopted. To define the planner problem in this class of models, one needs to specify how the relative price that enter the collateral constraint is determined in the social planner allocation. The literature has followed either of two alternatives proposed by Kehoe and Levine (1993): one possibility (which they refer to as the "general constrained-efficient problem") is to impose as additional constraint in the planner problem the competitive equilibrium *pricing rule*. A second possibility, which they refer to as the "conditionally-efficient problem", is to determine this relative market price by imposing as a constraint in the planner problem the competitive equilibrium *policy function* for such price.

In the paper, we compare the two alternative definitions of efficiency commonly adopted in the literature and show how the normative analysis of this class of models might not be robust to such differences. For the specific case of the endowment economy that we examine here, these two alternative definitions give exactly the same results. More generally, however, we show that in the conditionally-efficient problem the gap between competitive and social planner allocations will be much smaller than in the constrained-efficient problem. This is because, in the former, the key market price that enters the collateral constraint coincides in the two allocations for any given state of the economy. From a policy perspective, this implies that the scope for policy intervention (either when the constraint does not bind or when it does, labeled the ex ante or ex post perspectives, respectively) will be reduced in the conditionally-efficient problem relative to the constrained-efficient one. For instance, in the case of a production version of our economy, we find that changing the definition of efficiency changes completely the results of the normative analysis.

Other modeling approaches to capital controls have been proposed in the literature. Costinot, Lorenzoni and Werning (2012) in particular study how capital controls might affect the inter-temporal terms of trade, while De Paoli and Lipinska (2012) focuses on the intra-termporal terms of trade. These are complementary studies of the normative properties of capital controls. Our approach is based on the pecuniary externality.

The rest of the paper is organized as follows. Section 2 describes the model and its competitive equilibrium. Section 3 discusses the social planner allocation under alternative definitions of efficiency. Section 4 analyzes the implementation problem with capital controls. Section 5 analyzes the implementation problem with exchange rate policy. Section 6 concludes.

2 The Model and Its Competitive Equilibrium

We consider a small open economy in which there is a continuum of households $j \in [0,1]$ that maximize the utility function

$$U^j \equiv E_0 \sum_{t=0}^{\infty} \left\{ \beta^t u\left(C_j\right) \right\}, \tag{1}$$

with C_j denoting the consumption basket for an individual j and β the subjective discount factor. The period utility function is isoelastic:

$$u\left(C_j\right) \equiv \frac{1}{1-\rho} \left(C_{j,t}\right)^{1-\rho}.$$

The consumption basket, C_t, is a CES aggregate of tradable and nontradable goods, where:[5]

$$C_t \equiv \left[\omega^{\frac{1}{\kappa}} \left(C_t^T\right)^{\frac{\kappa-1}{\kappa}} + (1-\omega)^{\frac{1}{\kappa}} \left(C_t^N\right)^{\frac{\kappa-1}{\kappa}} \right]^{\frac{\kappa}{\kappa-1}}. \tag{2}$$

[5] We omit the subscript j to simplify notation, but it is understood that all choices are made at the individual level.

The parameter κ is the elasticity of intratemporal substitution between consumption of tradable and nontradable goods, while ω is the relative weight of the two goods in the utility function.

We normalize the price of tradable goods to 1 and denote the relative price of the nontradable goods with P^N. The aggregate price index is then given by

$$P_t = \left[\omega + (1-\omega)\left(P_t^N\right)^{1-\kappa}\right]^{\frac{1}{1-\kappa}}.$$

Here, we note that there is a one-to-one link between the aggregate price index P and the relative price P^N.

Households maximize utility subject to their budget constraint, which is expressed in units of tradable consumption, and a borrowing constraint. The asset menu includes only a one-period bond denominated in units of tradable consumption.

Each household has two stochastic endowment streams of tradable and non-tradable output, $\{Y_t^T\}$ and $\{Y_t^N\}$. For simplicity, we assume that both $\{Y_t^T\}$ and $\{Y_t^N\}$ are Markov processes with finite, strictly positive support. Therefore the current state of the economy can be completely characterized by the triplet $\{B_t, Y_t^T, Y_t^N\}$. The budget constraint each household faces thus is

$$C_t^T + P_t^N C_t^N + B_{t+1} = Y_t^T + P_t^N Y_t^N + (1+r) B_t, \tag{3}$$

where B_{t+1} denotes the bond holding at the end of period t, and $1+r$ is a given world gross interest rate with $\beta(1+r) < 1$.

Access to international financial markets is not only incomplete but also imperfect as we assume that the amount that each individual can borrow internationally is limited by a multiple of his current total income:

$$B_{t+1} \geqslant -\frac{1-\phi}{\phi}\left[Y_t^T + P_t^N Y_t^N\right]. \tag{4}$$

The key feature of this international borrowing constraint is that it captures currency mismatches in the balance sheet of our small open economy model (see Krugman 1999 for a discussion). In fact borrowing in the model is denominated in units of tradable consumption, while both the tradable and the nontradable endowment can be pledged as collateral. Indeed, currency mismatches have been one of the main vulnerability of emerging market economies in the numerous financial crises in the 1990s and the 2000s and in the ongoing European crisis.

While imposed in an *ad hoc* fashion, as in the related literature on pecuniary externalities and prudential policies, this constraint can in principle be derived from explicit microfoundations. For instance, one way to justify it is to refer to an environment in which the borrower engages in fraud activities in the period in which the debt is contracted (see Bianchi 2011 and Bianchi and Mendoza (2010) for a discussion).

We also assume that in our economy there is a lower bound which is strictly greater than the natural debt limit, $\underline{B}$, such that $B_t \geqslant \underline{B}$, for all t.[6] This lower bound guarantees that the competitive equilibrium allocation without government intervention and the international borrowing constraint (4) (i.e. the first-best unconstrained allocation) is well defined. In particular, it guarantees that this equilibrium has an ergodic distribution of debt with finite support, and both tradable and nontradable consumption have a strictly positive lower bound, while the nontradable price also has finite support with strictly positive lower bound. Finally, in order to focus on non-trivial policies, we also assume that, given Y_t^T and Y_t^N, when $B_t = \underline{B}$, the competitive equilibrium allocation always violates the borrowing constraint (4).[7]

Households maximize (1) subject to (3) and (4) by choosing C_t^N, C_t^T and B_{t+1}. The Lagrangian of this problem is

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \frac{1}{1-\rho} C_{j,t}^{1-\rho} + \lambda_t \left(B_{t+1} + \frac{1-\phi}{\phi} \left[Y_t^T + P_t^N Y_t^N \right] \right) + \\ \mu_t \left(Y_t^T + P_t^N Y_t^N - B_{t+1} + (1+r) B_t - C_t^T - P_t^N C_t^N \right) \end{array} \right]$$

with λ_t and μ_t denoting the multipliers on the borrowing constraint and the budget constraint, respectively. The first order conditions of this problem are

$$C_T : u'(C_t) C_{C^T} = \mu_t, \tag{5}$$

$$C_N : u'(C_t) C_{C^N} = \mu_t P_t^N, \tag{6}$$

$$B_{t+1} : \mu_t = \lambda_t + \beta (1+r) E_t \left[\mu_{t+1} \right]. \tag{7}$$

Combining (5) and (6) to obtain

$$\frac{(1-\omega)^{\frac{1}{\kappa}} \left(C_t^N \right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}} \left(C_t^T \right)^{-\frac{1}{\kappa}}} = P_t^N, \tag{8}$$

[6] The natural debt limit is defined as the level of debt where tradable consumption C_t^T equals zero. In our model, this level equals (minus) the annuity value of the lowest value of the tradable endowment. If C^T and C^N are strong substitutes, this constraint may bind; since the evidence is against strong substitutibility between tradable and non tradable consumption, we can ignore this possibility.

[7] This restriction amounts to a lower bound on ϕ.

the competitive equilibrium allocation of the economy can be characterized by the first order conditions (7) and (8) and the goods market equilibrium conditions.

The properties of the competitive equilibrium of this economy are well known (see for instance Mendoza (2002) and Bianchi (2011)). However, it is important to note that, while in this paper we shall focus on the normative properties of this model, from a positive perspective, Bianchi (2011) shows that this very same model accounts reasonably well for observed business cycles (including the high volatility of consumption and the strong procyclicality of capital flows), as well as the incidence and severity of financial crises, in Argentina.

3 Social Planner Equilibrium

It is well known that in our model environment private decisions fail to internalize their effect on the equilibrium relative price that enters the borrowing constraint, and such price in turn affects the borrowing constraint, creating inefficient amplification effects.[8] In these economies, therefore, there is scope for policy intervention to improve upon the competitive equilibrium allocation.

As in the related literature, in this paper, we focus on planning problems in which the planner faces the same credit constraint as the private agents in the competitive equilibrium. To define this planner's problem, one needs to specify how this relative price is determined in the social planner equilibrium. To do so, we follow Kehoe and Levine (1993), who consider two alternatives:[9] one possibility (which they refer to as the "general constrained-efficient problem") is to determine the relative price by imposing as additional constraint in the planner problem the competitive equilibrium *pricing rule* (in our case equation (8)). A second possibility, which they refer to as the "conditionally-efficient problem", is to determine this relative market price by imposing as a constraint in the social planner problem the competitive equilibrium *policy function* (in our case $P_t^N = f^{CE}(B_t, Y_t^N, Y_t^T)$).[10]

While in the specific case of our model there is no particular reason to prefer one definition to the other, but in general this choice is very important for the results of the normative analysis of these model environments.In fact, for the specific case of the endow-

[8] Such a mechanism operates also if an asset price enters the collateral constraint, such as the price of a fixed stock of land (e.g., Bianchi and Mendoza (2010), Jeanne and Korinek (2011a and 2011b). Suitably modified, our analysis and results extend to these alternative environments.

[9] See also the discussion in Lorenzoni (2008).

[10] This policy function is obtained from the solution of the non-linear system of equilibrium conditions that define the competitive equilibrium of the model. A policy function is the non-linear equilibrium relation between the endogenous variables of the model and its exogenous and endogenous state variables (in our case, the triplet $\{B_t, Y_t^N, Y_t^T\}$).

ment economy that we examine here, as we shall see below, these two alternative definitions of efficiency do not affect the results of the normative analysis. In general, however, in the conditionally-efficient problem the gap between competitive and social planner allocations will be quantitatively smaller than in the constrained-efficient problem. This is because, in the former, the relative price that enters the collateral constraint (P_t^N in our case) coincides in the two allocations for any given state of the economy. From a policy perspective, this implies that the scope for policy intervention (either when the constraint does not bind or when it does, labeled the *ex ante* or *ex post* perspectives, respectively) will be reduced in the conditionally-efficient problem relative to the constrained-efficient one.

This coincidence under conditional efficiency is particularly important when the borrowing constraint is binding (i.e., in crisis periods, according to the definition of financial crisis adopted in the literature). In fact the coincidence implies that the amplification mechanism induced by the constraint via its externality on the relative price in the competitive equilibrium allocation is "efficient" in the sense defined above. Under conditional efficiency, therefore, financial crises might be "efficient" events that distort the allocation only outside crisis states. From a normative perspective, this implies that the only scope for policy intervention arises before entering a crisis state, which biases the normative results of the analysis.[11]

This issue is even more important for planning problems with collateral constraints that depend on asset prices like in the case of Bianchi and Mendoza (2010) and Jeanne and Korinek (2011b). Asset prices are forward looking variables and, technically, it is difficult or it might be not feasible to compute the "constrained efficient" planning problem because it becomes non-recursive in the natural set of state variables. By using conditional efficiency, the computational problem becomes tractable at the cost of possibly biasing the normative results.

In related work, consistent with standard practice in the optimal taxation literature, Benigno et al. (2009, 2011, 2012) and Lorenzoni (2008) use constrained-efficiency. Bianchi and Mendoza (2010) use conditional-efficiency to study their production economy in which the collateral constraint depend on an asset price. Interestingly, however, Bianchi (2011) uses constrained efficiency to set up the planner problem for the endowment version of his economy and conditional efficiency in the planner problem of the production version of his economy.

[11] Indeed, actual policy makers pursue both crisis resolution and crisis prevention policies. In addition, as Benigno et al (2012) show, in an environment in which the planner has scope for intervening both in and out of crisis states, the economy's behavior in normal times depends on its behavior in crisis times. Therefore, restricting the normative analysis to environments in which the crisis is "efficient" is not only counterfactual but may also bias the results in favour of ex ante policies.

As we noted already, in our simple model environment, the specific definition of efficiency adopted does not affect the normative analysis. Nonetheless, for illustrative purposes, and to help understand the peculiar nature of the results in the related literature, in the rest of this section, we shall analyze the planner problem of our model under both definitions of efficiency.

3.1 The constrained-efficient planning problem

We first study the constrained efficient social planner problem. The planner maximizes (1) subject to the resource constraints, the international borrowing constraint from an aggregate perspective and the competitive pricing rule as in (8). By combining the household budget constraint with the equilibrium condition in the nontradables good market, we obtain the current account equation of our small open economy:

$$C_t^T = Y_t^T - B_{t+1} + (1+r)\, B_t. \tag{9}$$

The nontradable goods market equilibrium condition implies that

$$C_t^N = Y_t^N. \tag{10}$$

From the perspective of the planner, the international borrowing constraint can be expressed as in (4), where the relative price is determined by the competitive rule (8).

The Lagrangian of the planner problem becomes

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \frac{1}{1-\rho} \left(C_{j,t}\right)^{1-\rho} + \mu_{1,t}^{SP} \left(Y_t^T - B_{t+1} + (1+r)\, B_t - C_t^T\right) + \\ +\mu_{2,t}^{SP} \left(Y_t^N - C_t^N\right) + \lambda_t^{SP} \left(B_{t+1} + \frac{1-\phi}{\phi} \left[Y_t^T + \left(\frac{(1-\omega)\left(C_t^T\right)}{\omega Y_t^N} \right)^{\frac{1}{\kappa}} Y^N \right] \right) \end{array} \right],$$

where $\mu_{1,t}^{SP}$, $\mu_{2,t}^{SP}$ and λ_t^{SP} denote the corresponding Lagrangian multipliers. The planner chooses the optimal path for C_t^T, C_t^N and B_{t+1}, and the first order conditions for its problem are

$$C_T : u'(C_t) C_{C^T} = \mu_{1,t}^{SP} - \lambda_t^{SP} \Sigma_t^{SP}, \tag{11}$$

$$C_N : u'(C_t) C_{C^N} = \mu_{2,t}^{SP}, \tag{12}$$

$$B_{t+1} : \mu_{1,t}^{SP} = \lambda_t^{SP} + \beta\,(1+r)\, E_t \left[\mu_{1,t+1}^{SP}\right]. \tag{13}$$

where $\Sigma_t^{SP} \equiv \frac{1-\phi}{\phi} \frac{\partial P_t^N}{\partial C_t^T} Y_t^N = \frac{1-\phi}{\phi} \frac{1}{\kappa} \frac{(1-\omega)}{\omega} \left(\frac{(1-\omega)\left(C_t^T\right)}{\omega} \right)^{\frac{1}{\kappa}-1} \left(Y_t^N\right)^{\frac{\kappa-1}{\kappa}}.$

The key difference between the planning allocation and the competitive equilibrium follows from examining equations (11) and (5). From the planner perspective, there is an additional marginal benefit in consuming one more unit of tradable consumption, represented by the term $\lambda_t^{SP}\Sigma_t$, which captures the increase in the price of non-tradable derived from the marginal increase of tradable consumption. This terms drives a gap between the planner and the competitive allocation when the constraint does not bind but is expected to bind in the future with positive probability.

When the constraint binds for both allocations (i.e. in crisis states), however, the competitive equilibrium of the model is exactly the same as the social planner allocation even under constrained efficiency. This is because, in the special case of an endowment economy, for any given state in which the constraints binds in both allocations, consumption of tradables is the same across allocations, driven by the constraint itself. In the special case of an endowment economy, therefore, even under constrained efficiency, financial crises are "efficient" events that can distort only the allocation outside crisis states. From a normative perspective, this implies that the only scope for policy intervention is before entering a crisis state, which can bias the normative conclusions of the analysis as we discussed above.

3.2 The conditionally-efficient planning problem

In the conditionally efficient planner problem, the planner maximizes (1) subject to the resource constraints, the international borrowing constraint from an aggregate perspective and the pricing function $P_t^N = f^{CE}(B_t, Y_t^N, Y_t^T)$. So we can rewrite the international borrowing constraint as

$$B_{t+1} \geqslant -\frac{1-\phi}{\phi}\left[Y^T + f^{CE}(B_t, Y_t^N, Y_t^T)Y^N\right].$$

The Lagrangian of the planner's problem becomes

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \frac{1}{1-\rho}\left(C_{j,t}\right)^{1-\rho} + \mu_{1,t}^{SP}\left(Y_t^T - B_{t+1} + (1+r)\,B_t - C_t^T\right) + \\ +\mu_{2,t}^{SP}\left(Y_t^N - C_t^N\right) + \lambda_t^{SP}\left(B_{t+1} + \frac{1-\phi}{\phi}\left[Y_t^T + f^{CE}(B_t, Y_t^N, Y_t^T)Y_t^N\right]\right). \end{array} \right]$$

The planner chooses the optimal path for C_t^T, C_t^N and B_{t+1}, and the first order conditions for its problem are:

$$C_T : u'(C_t)C_{C^T} = \mu_{1,t}^{SP}, \tag{14}$$

$$C_N : u'(C_t)C_{C^N} = \mu_{2,t}^{SP}, \tag{15}$$

$$B_{t+1} : \mu_{1,t}^{SP} = \lambda_t^{SP} + \beta (1+r) E_t \left[\mu_{1,t+1}^{SP} \right] \tag{16}$$
$$+ \frac{1-\phi}{\phi} \beta E_t \left[\lambda_{t+1}^{SP} f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T) Y_{t+1}^N \right].$$

The difference between the constrained and the conditional efficient problem emerges once we compare the first order conditions of the two problems. In the constrained efficient problem the planner takes into account the pecuniary externality through his choice of tradable consumption (see (11)); in the conditional efficient problem the planner internalizes the externality via the choice of debt (see (16)). In fact we can rewrite the intertemporal condition for B_{t+1} as

$$u'(C_t) C_{C_t^T} = \lambda_t^{SP} + \beta (1+r) E_t [u'(C_{t+1}) C_{C_{t+1}^T}]$$
$$+ \frac{1-\phi}{\phi} \beta E_t \left[\lambda_{t+1}^{SP} f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T) Y_{t+1}^N \right].$$

which is similar to the intertemporal condition (13). With conditional efficiency, in (16), when the constraint does not bind (i.e., when $\lambda_t^{SP} = 0$), the marginal social benefit from reducing one unit of C_t^T depends on the covariance between the future multiplier λ_{t+1}^{SP} and the sensitivity of the price function to changes in debt, $f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T)$. Intuitively, as we decrease B_{t+1} (we reduce debt) we increase future consumption of tradables and hence the relative price of non-tradable, so that $f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T) < 0$. At the same time, the probability of entering the constrained region tomorrow increases with B_{t+1}, implying a positive covariance between λ_{t+1}^{SP} and $f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T)$.

Despite the formal differences, in the context of our endowment economy, the two social planner allocations deliver exactly the same allocation in terms of tradable consumption and borrowing decisions, both in tranquil and crisis times. But this is generally not the case: for instance, for more general economies, such as the production economy of Bianchi (2011), Bianchi and Mendoza (2011) or Benigno et al (2012), the two social planner allocations would differ.

To illustrate this point, Figures 1 and 2 show the policy functions for debt, tradable consumption, and the relative price of nontradables for the endowment economy of Bianchi (2011) as well as the production economy studied by Benigno et al (2012). The pictures plot the policy functions of the competitive and social planner equilibria under both definitions of efficiency, with the two economies calibrated as in Bianchi (2011) and Benigno (2012), respectively.

In the endowment case, the policy functions of the social planner allocation for tradable consumption and debt under alternative definitions of efficiency In the aftermath of the global financial crisis, a new policy paradigm has emerged in which old-fashioned policies such as capital controls and other government distortions have become part of the standard policy toolkit (the so-called macro-prudential policies). On the wave of this seemingly unanimous policy consensus, a new strand of theoretical literature contends that capital controls are welfare enhancing and can be justified rigorously because of second-best considerations. Within the same theoretical framework adopted in this fast-growing literature, we show that a credible commitment to support the exchange rate in crisis times always welfare-dominates prudential capital controls as it can achieve the first best unconstrained allocation. In this benchmark economy, prudential capital controls are optimal only when the set of policy tools is restricted so that they are the only policy instrument available, both in the constrained and unconstrained region (Figure 1). The policy function of the relative price of nontradables instead is different under constrained efficiency in the non-constrained region. Such a difference in the policy function for P^N , however, is irrelevant in the endowment economy since prices do not affect the real allocation when the constraint is not binding.

In the constrained region, in the endowment economy, the price of nontradables falls dramatically both in the competitive equilibrium and in the social planner allocation under both definitions of efficiency. This decline sets off the "Fisherian deflation" mechanism emphasized in the pecuniary externality literature—a decline in P^N that reduces the value of the nontradable endowment, tightening the borrowing constraint and reducing the consumption of tradables, which in turn again reduces P^N, and so on. As Figure (1) shows, however, the collapse in P^N is "efficient" in this model since the policy functions in the competitive and social planner allocation coincide in crisis times under both definitions of efficiency.

In the more general case of a production economy, the definition of efficiency matters.[12] As Figure 2 shows, the two social planner allocations differ significantly. In particular, as we noted above, the gap between the competitive allocation and the conditional efficient planner problem is much smaller than the gap between the constrained efficient allocation and the competitive equilibrium. The implications of these differences are summarized in Figure 3, which reports the ergodic distribution of debt for these three allocations. While the constrained efficient allocation has less debt than the competitive allocation (i.e., there is underborrowing), with conditional efficiency there is less borrowing than in the competitive allocation (i.e., there is overborrowing): changing definition of efficiency turns the results of the normative analysis upside down.

[12] In the production economy of Benigno et al (2012) the planner can manipulate not only the marginal rate of substitution between tradable and non tradable goods, but also their marginal rate of transformation.

These differences are reflected also in the probability of a crisis and the welfare ranking between allocations, which are completely reversed by changing the efficiency definition. With conditional efficiency we have a higher probability of crisis than in the competitive equilibrium, while with constrained efficiency the probability is lower. By the same token, with conditional efficiency, the welfare gains of moving from the competitive equilibrium to the social planner allocation are more than 1/100 of those with constrained efficiency (switching from 0.18 percent of permanent consumption to 0.004 percent).[13]

4 Capital Controls

We now study the implementation of the social planner allocations through a tax on newly-issued debt. In what follows we will refer to it as a capital control consistent with the rest of the literature. In the competitive equilibrium, the household's budget constraint becomes

$$C_t^T + P_t^N C_t^N = Y_t^T + P_t^N Y_t^N + T_t - B_{t+1}(1+\tau_t^B) + (1+r)\,B_t, \tag{17}$$

where $\tau_t^B > (<)0$ is a subsidy (or a tax) on debt issued at time t, and T_t is a lump sum transfer or tax. In the competitive equilibrium the government budget constraint must also hold:

$$T_t = \tau_t^B B_{t+1}. \tag{18}$$

All other assumptions are the same as above. In particular, international financial market access is constrained by (4) as before. As in the case without government intervention, we make the same assumption on the lower limit of debt $\underline{B} \leqslant B_t$ for all t.

The competitive equilibrium allocation is then characterized by

$$u'(C_t)C_{C^T}(1+\tau^B) = \lambda_t + \beta\,(1+r)\,E_t\left[u'(C_{t+1})C_{C^T}\right] \tag{19}$$

with

$$\lambda_t\left[B_{t+1} + \frac{1-\phi}{\phi}\left[Y^T + P_t^N Y^N\right]\right] = 0$$

$$\frac{(1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{-\frac{1}{\kappa}}} = P_t^N$$

along with the goods market equilibrium condition.

We now analyze the extent to which it is possible to use $\left(1+\tau_t^B\right)$ to decentralize the social planner equilibrium under the two alternative definitions of efficiency discussed above.

[13] Welfare gains are generally small in the literature because financial crises are rare events.

4.1 Constrained-efficiency

Under constrained-efficiency, we can rewrite the Euler equation for the planner problem as

$$u'(C_t^{SP})C_{C_t^T}^{SP} + \lambda_t^{SP}\Sigma_t^{SP} = \lambda_t^{SP} + \beta(1+r)E_t[u'(C_{t+1}^{SP})C_{C_{t+1}^T}^{SP} + \lambda_{t+1}^{SP}\Sigma_{t+1}^{SP}]. \tag{20}$$

Recall that the Euler equation for the competitive equilibrium (19) is

$$(1+\tau_t^B)u'(C_t)C_{C_t^T} = \lambda_t + \beta(1+r)E_t[u'(C_{t+1})C_{C_{t+1}^T}]. \tag{21}$$

The following proposition then holds:

Proposition 1. *In an economy defined by (1), (3), and (4), with a tax on debt τ^B as the government policy instrument, there exists policy for τ^B under which competitive equilibrium allocation implements the social planner one—Bianchi (2011).*

Proof. Since the resource constraints and the credit constraints are identical in the competitive equilibrium and the social planner problem, we are only concerned with the intertemporal Euler equations (20) and (21). In order for the competitive equilibrium allocation to coincide with the social planner one, the government must set

$$\tau_t^B = \left(u'(C_t^{SP})C_{C_t^T}^{SP}\right)^{-1}\left(\lambda_t^{SP}\Sigma_t^{SP} - \beta(1+r)E_t[\lambda_{t+1}^{SP}\Sigma_{t+1}^{SP}]\right) \tag{22}$$

where the superscript SP denotes the values from the social planner problem. With this state-contingent policy rule, the Euler equations are identical and hence the two allocation coincide. As Bianchi (2011) notes, when $\lambda_t = 0$ and $E_t\left[\lambda_{t+1}^{SP}\Sigma_{t+1}^{SP}\right] > 0$, so that the credit constraint is not currently binding but in the next period it will bind with positive probability, τ^B is negative (i.e., is a tax). On the other hand, when the constraint binds, setting $\tau_t^B = 0$ implements the constrained efficient allocation since the borrowing of the planner and the private agents coincide. *Q.E.D.*

So the tax on debt (or capital control) is precautionary in the sense that by taxing debt today the planner can lower the probability of a crisis tomorrow. The tax is zero for levels of debt at which the constraint binds in the current period. It is only when the constraint does not bind today but will bind tomorrow with a positive probability that the tax does take negative values.

The state contingent tax policy rule that implements the constrained efficient allocation also has other properties summarized by the following proposition:

Proposition 2. *The tax policy above is both Ramsey optimal and time-consistent. However it does not achieve the first best unconstrained allocation.*

Proof. The tax policy above, together with the household first order conditions,replicates the solution of the social planner problem with constrained-efficiency, which is identical to a Ramsey problem for this economy. The Ramsey planner maximizes (1) subject to (10), (4), (17), (19), (18) and (8). The tax policy (22) along with the household first order conditions satisfy the Ramsey constraints and replicate the social planner equilibrium so that the tax policy is Ramsey optimal. In addition, since the tax policy decentralizes the social planner problem, which is a recursive problem that can be represented by value iteration and only depends on the current state $\{B_t, Y_t^T, Y_t^N\}$, the equilibrium would be subgame perfect and time-consistent.

To see that the social planner problem does not achieve the first-best unconstrained allocation, notice that, if the first-best unconstrained allocation were achieved ($\lambda_t \equiv 0$ for all t), the FOCs of the social planner problem (14), (15), and (16) would be identical to the FOCs of competitive equilibrium without the international borrowing constraint (4). Therefore since $\beta(1+r) < 1$, B_t would eventually converge to the lower limit $\underline{B}$ where the credit constraint (4) would be violated by assumption. *Q.E.D.*

4.2 Constrained-efficiency

Since the social planner problem under conditional efficiency delivers the same allocation as under constrained efficiency, it is immediate to show that under the former definition of efficiency the same policy function for τ_t^B as in (22) would implement the social planner equilibrium with the same properties.

5 Exchange Rate Policy

We now consider alternative policy instruments. In the context of our endowment economy there are two alternative options: taxing tradable or nontradable consumption. As we shall see, these policy tools have a direct interpretation in terms of exchange rate policy. Indeed, they directly control the relative price of nontradable goods, which in the context of this economy is a measure of the real exchange rate.

5.1 Tax on nontradables consumption

Let's start by examining the nontradable consumption tax. When we introduce a tax on nontradable consumption, $(1+\tau_t^N)$, the constraint that each household faces becomes

$$C_t^T + P_t^N(1+\tau_t^N)C_t^N = Y_t^T + P_t^N Y_t^N + T_t - B_{t+1} + (1+r)\,B_t, \tag{23}$$

where $\tau_t^N > (<)\ 0$ is a tax (or a subsidy) on nontradable consumption and $T_t > (<)\ 0$ is a government lump-sum transfer (or tax). As in the case of capital controls, we assume that the government runs a balanced budget:

$$T_t = \tau_t^N P_t^N C_t^N. \tag{24}$$

Thus, the competitive equilibrium is now characterized by the following conditions:

$$u'(C_t)C_{C^T} = \lambda_t + \beta\,(1+r)\,E_t\left[u'(C_{t+1})C_{C^T}\right] \tag{25}$$

with

$$\frac{(1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{-\frac{1}{\kappa}}} = P_t^N\left(1+\tau_t^N\right). \tag{26}$$

$$\lambda_t\left[B_{t+1} + \frac{1-\phi}{\phi}\left[Y_t^T + P_t^N Y_t^N\right]\right] = 0. \tag{27}$$

Note here that (26) directly links the relative price of nontradables to the tax on nontradables. It is also evident that in an economy in which the borrowing constraint does not bind, this policy tool is neutral in the sense that it will not affect the consumption allocation but only the real exchange rate. In fact, the Euler equation and the goods market equilibrium conditions are all that is needed to determine consumption of nontradables and tradables. In our endowment economy, however, this tax is no longer neutral when the constraint binds and can be used to affect the collateral value, and hence also the allocation of tradable consumption.

The following proposition establishes how the use of such a tax can assure that the constraint is never binding in equilibrium in our economy ($\lambda_t \equiv 0$ for all t) via its impact on the relative price on non tradable.

Proposition 3. *In an economy defined by (1), (4), (23) and (24)in which a tax on nontradable consumption τ_t^N is the government policy instrument, there exists a policy for τ_t^N that decentralizes the first-best unconstrained allocation and it is time-consistent.*

Proof. For a given stochastic process of $\left\{Y_t^N, Y_t^T\right\}$ and a given state B_t, let B_{t+1}^{uncon} be the policy function of next period debt and $P_t^{N,uncon}$ be the relative price in the current period in the economy defined by (1) and (3) but without credit constraint (4). Define $\hat{P}_t^N$ to be the minimum price such that the credit constraint would be met if it existed,

$$\hat{P}_t^N = \max\left\{0, -\frac{B_{t+1}^{uncon} + \frac{1-\phi}{\phi}Y_t^T}{\frac{1-\phi}{\phi}Y_t^N}\right\}.$$

In the economy with credit constraint, the Ramsey planner maximizes (1) subject to (10), (4), (26), (23), (24) and (25) and can set τ^N such that $\hat{P}_t^N(1+\tau_t^N) \le P_t^{N,uncon}$ so that the credit constraint does not bind. In other words, let $\hat{\tau}_t^N = P_t^{N,uncon}/\hat{P}_t^N - 1$. Then any $\tau_t^N \in (-1, \hat{\tau}_t^N]$ is the tax rate which eliminates the credit constraint. Under this tax policy, $\lambda_t = 0$ for all t and the competitive equilibrium coincides with the first best unconstrained allocation. Moreover, this policy satisfies the first order conditions of the competitive equilibrium allocation. Since the Ramsey planner can achieve at best the unconstrained allocation, this tax policy is the optimal solution to the Ramsey problem in which the government chooses optimally the non-tradables consumption tax. Such policy is completely determined by the current state $\{B_t, Y_t^T, Y_t^N\}$ and therefore it is time-consistent.
Q.E.D.

The proposition establishes a tax policy that is able to replicate the unconstrained first best allocation: this policy promises to relaxes the borrowing constraint by supporting the relative price of non tradeable whenever the constraint binds in such a way that the constraint never binds in equilibrium. Under this policy, during tranquil times, private agents behaves as if the constraint does not exist. In doing so their consumption of tradables goods will be higher than in the competitive allocation and in the constrained social planner allocation. For a given endowment of nontradable goods, this equilibrium entails a higher relative price of nontradables during tranquil times, which in turn increases the borrowing capacity of private agents, and makes the borrowing constraint never binding ex post.

Three remarks are in order here. First, the proposition above shows that exchange rate policy dominates the precautionary capital control policy discussed in Section 4 in welfare terms. In fact, under optimal policy with τ^N the probability of a financial crisis is zero and the economy replicates the unconstrained first-best allocation. In contrast, capital controls can achieve only a second best allocation.

Second, the policy function for τ^N is a promise to intervene off the equilibrium path (i.e. when the constraint bind, which never happens in equilibrium) and eliminates completely the effects of the pecuniary externality. More broadly, this type of policy can be interpreted as a price support intervention that avoids the collapse of the relative prices (including asset prices) when a crisis does occur. But since the crisis state never occurs, the policy actually is never enacted in equilibrium. Importantly, this policy commitment is a time consistent equilibrium.

Third, the Ramsey allocation achieves higher welfare than the social planner allocation defined in Section 3. This counter-intuitive result is due to the fact that the social planner problem is constrained by the pricing rule as defined in (8). In contrast, the Ramsey problem in which the policy tools is the tax on nontradables consumption is constrained by (26). The Ramsey planner therefore can manipulate the relative price of non tradables directly so as to undo the constraint completely without creating further distortions.

From this result it follows that the normative prescriptions obtained by comparing the social planner allocation with the competitive equilibrium are sensitive to the way in which alternative policy tools affect the specification of the pricing equation. In this sense, it becomes evident that the normative analysis of this class of models suggests that a better way to conduct the normative analysis is by the computation of the optimal Ramsey problem conditional on the set of available instruments rather than the social planner problem as usually done in the related literature. In fact in the Ramsey problem the pricing equation is part of the set of relations describing the private sector's behavior.

5.2 Tax on tradables consumption

We now consider a tax on tradable consumption as the government's policy tool. Each household now faces the following budget constraint:

$$(1+\tau_t^T)C_t^T + P_t^T C_t^N = Y_t^T + P_t^N Y_t^N + T_t - B_{t+1} + (1+r)B_t. \tag{28}$$

As before, the government budget constraint continues to be balanced:

$$T_t = \tau_t^T C_t^T. \tag{29}$$

Thus, the competitive equilibrium is now characterized by the following conditions:

$$\frac{u'(C_t)C_{C_t^T}}{1+\tau_t^T} = \lambda_t + \beta\,(1+r)\,E_t\left[\frac{u'(C_{t+1})C_{C_{t+1}^T}}{1+\tau_{t+1}^T}\right]. \tag{30}$$

with

$$\frac{(1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{-\frac{1}{\kappa}}} = \frac{P_t^N}{1+\tau_t^T}. \tag{31}$$

$$\lambda_t \left[B_{t+1} + \frac{1-\phi}{\phi} \left[Y^T + P_t^N Y^N \right] \right] = 0. \tag{32}$$

We note here that the tax on tradable consumption now affects not only the intratemporal relative price (see (31)), but also the intertemporal allocation of resources (see (30)). Despite this interaction, the next proposition shows that it is possible to find a state contingent tax policy that replicates the outcome of the optimal nontradable tax policy.

Proposition 4. *In an economy defined by (1), (3), (28) and (29) with a tax on tradable consumption* τ_t^T *as the government instrument, there exists a policy for* τ_t^T *that decentralizes the first-best unconstrained allocation and it is time-consistent.*

Proof. Let the optimal non-tradable consumption tax be τ_t^N. It is easy to see that in the Ramsey problem, if we set $\frac{1}{1+\tau_t^T} = 1 + \tau_t^N$, we achieve the first best unconstrained allocation and $\lambda_t \equiv 0$. Since the tax on tradable consumption affects also the intertemporal allocation of resources (30) we need to show that the tax policy that replicates the unconstrained first best equilibrium is constant so that the intertemporal margin is not affected. As in the previous proposition, such policy is naturally time-consistent. By comparing Euler equations in both social planner problem and competitive equilibrium, and using $\lambda_t \equiv 0$, it is sufficient to find τ_t^T so that

$$\frac{1}{1+\tau_t^T} = \frac{E_t \left[\frac{u'(C_{t+1}^{SP}) C^{SP}_{C^T_{t+1}}}{1+\tau_{t+1}^T} \right]}{E_t[u'(C_{t+1}^{SP}) C^{SP}_{C^T_{t+1}}]}, \tag{33}$$

and the international borrowing constraint (4) is satisfied, in order for the competitive equilibrium to achieve the unconstrained first best allocation.

First we note that a constant tax policy will satisfy (33). Secondly, by inspection of the first-best unconstrained allocation, non-tradable price has a strictly positive lower limit. Therefore there exists $\underline{\tau}^T$ such that the borrowing constraint (4) is always satisfied for any $\tau^T \geqslant \underline{\tau}^T$). Thus, any constant tax policy of the form $\tau_t^T \equiv \tau^T \geqslant \underline{\tau}^T$) is an optimal policy such that the competitive equilibrium replicates the first best unconstrained allocation. *Q.E.D.*

6 Conclusions

In response to the recent global financial crisis, a new policy paradigm has quickly emerged. In this new paradigm, macro-prudential policies—i.e., old fashioned government distortions such as capital controls or other quantitative restrictions on credit flows—have become part of the standard policy toolkit arguably because they can prevent or mitigate financial crises. On the wave of this seemingly unanimous policy consensus, a new strand of theoretical literature is contending that such measures can be rigorously justified on welfare grounds (e.g. Bianchi, 2011; Bianchi and Mendoza 2010; Jeanne and Korinek 2011b). This literature reaches this conclusion by comparing competitive equilibrium allocations with that of a social planner.

In our work we compare the competitive equilibrium and social planner allocations studied in the literature with those characterized by the solution of a Ramsey optimal policy problem. Our main result is that exchange rate policy always dominates capital controls in welfare terms. This policy is time-consistent and delivers the first best unconstrained allocation. In contrast, prudential capital controls can at best achieve a second-best allocation of resources in which the collateral constraint continues to limit borrowing and gives rise to the occasional crisis. The reason for this result, which is in sharp contrast to the existing literature, is that a Ramsey planner can deliver an allocation with higher welfare than the constrained social planner in this class of models. This result follows from the fact that the Ramsey planner in this environment can choose policies to directly manipulate the key relative price that enters the borrowing constraint and, conditional on the available policy tools, can relax the constraint by supporting this key market price.

We suggest here that future work on macroprudential policies should follow the modern optimal taxation approach as in the Ramsey tradition. While a social planner problem can lead one to identify the need for policy intervention, it is not informative on the relative merit of alternative policy tools to do so. In contrast, working directly with the Ramsey problem requires one to specify the set of policy instruments before the analysis, which naturally induces one to consider policy instruments that lead to the best outcomes.

Moreover, we have shown that the specification of the constrained social planner problem might be very sensitive to the definition of efficiency adopted, possibly biasing the normative analysis significantly. For instance, in the case of a production economy, we show that changing the definition of efficiency changes completely the results of the normative analysis. It follows that the normative analysis of this class of models should either justify carefully the definition of efficiency adopted, show robustness to the alternative, or more simply, adopt the Ramsey approach which is fully transparent in terms of the constraints imposed on the normative analysis.

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Figure 1: Endowment Economy Decision Rules

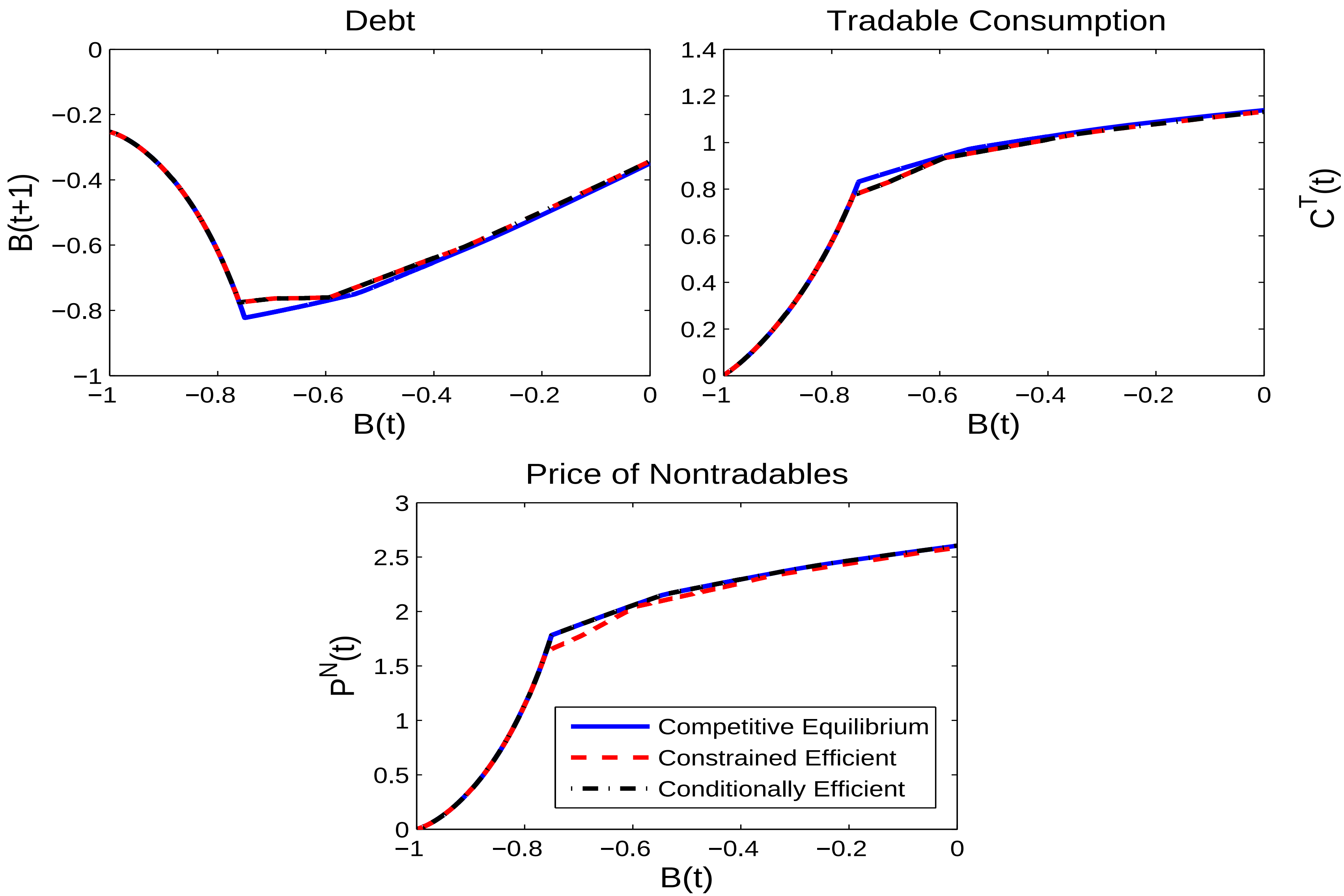


Figure 2: Production Economy Decision Rules

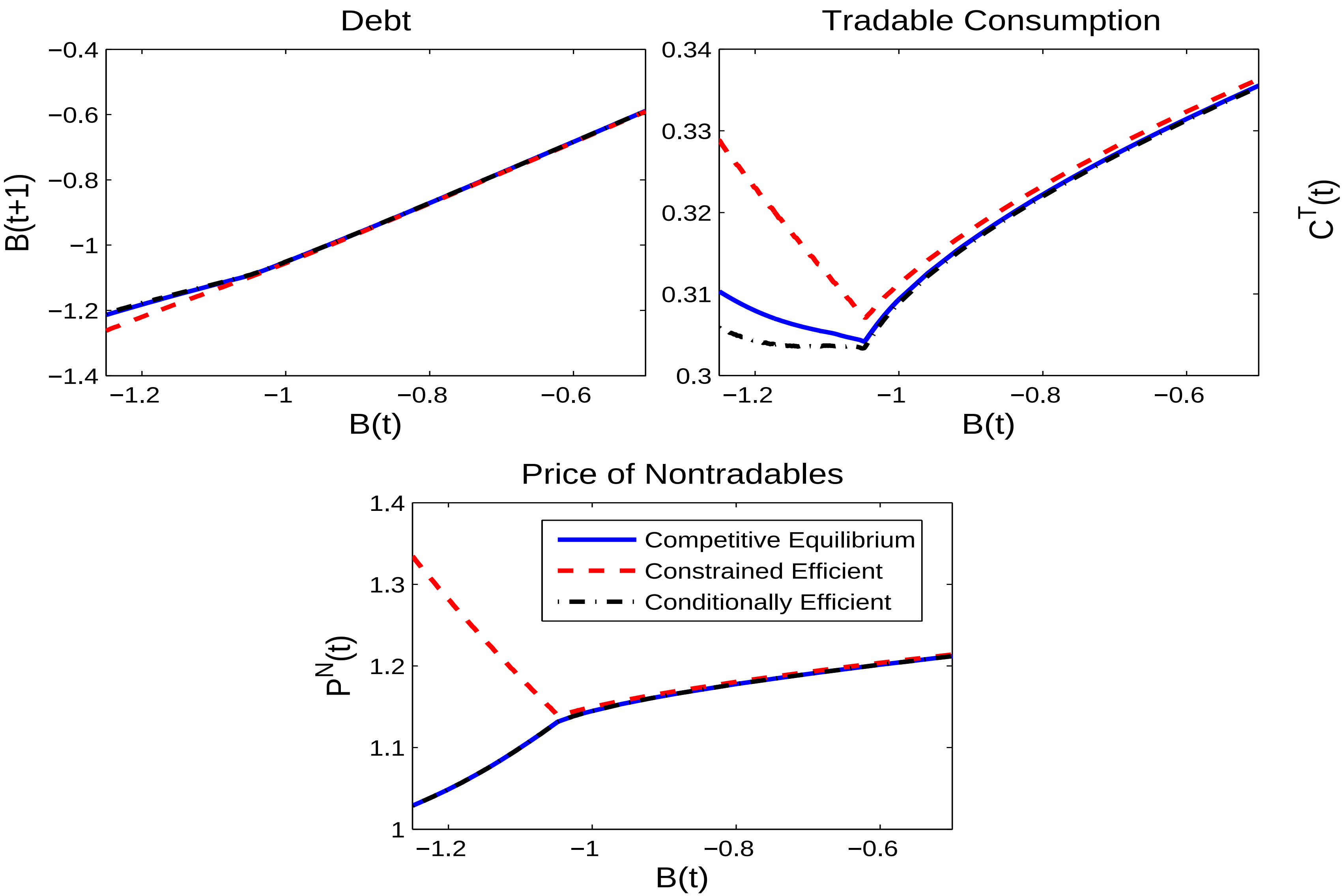
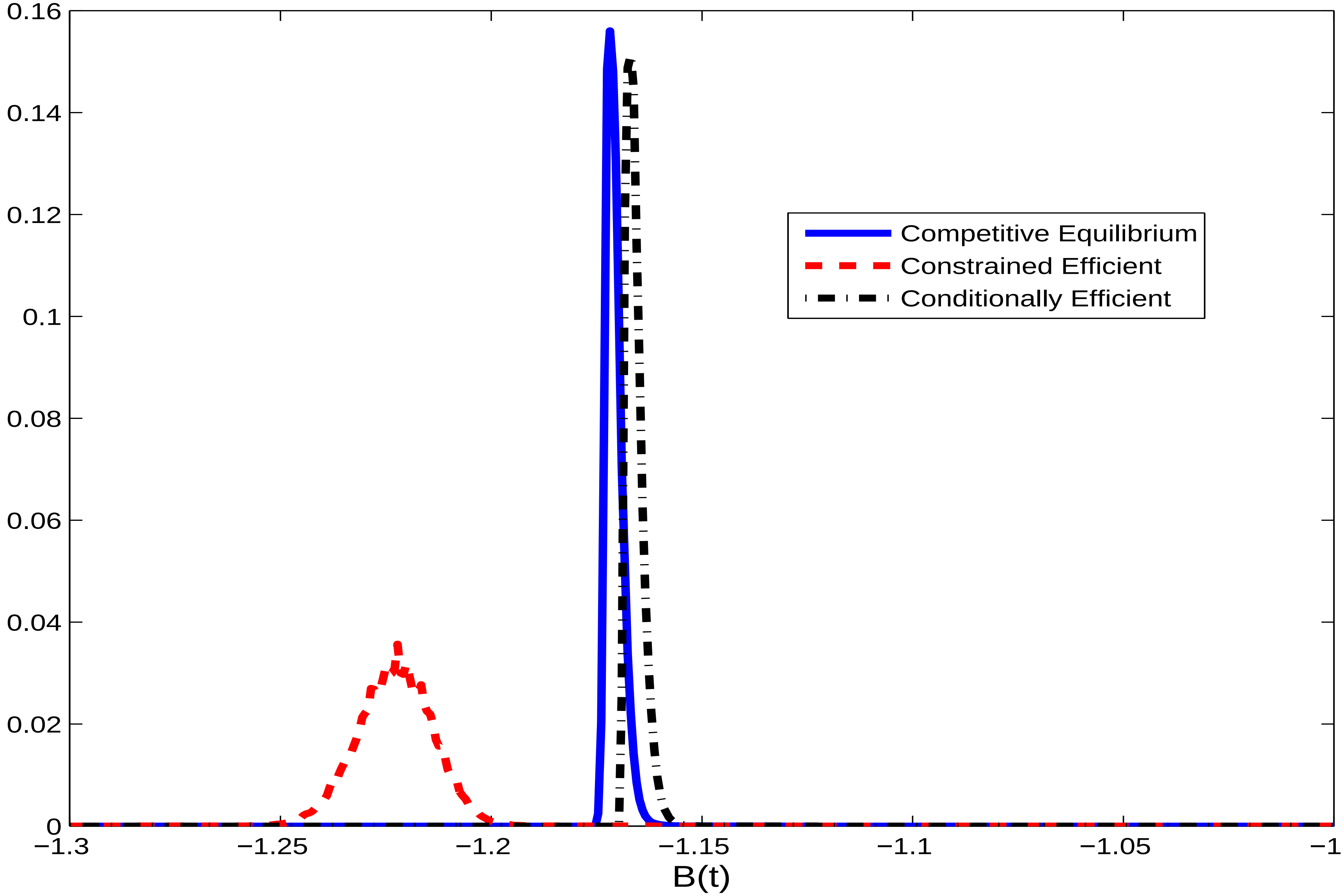


Figure 3: Production Economy Ergodic Distribution of Debt



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