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## **Abstract<sup>1</sup>**

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 tool kit (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, this paper shows that a credible commitment to support the exchange rate in crisis times always welfare-dominates prudential capital controls, as it can achieve unconstrained allocation.

**JEL Classification:** E52, F37, F41

**Keywords:** Capital controls, Exchange rate policy, Financial frictions, Financialcrises, Financial stability, Optimal taxation, Prudential policies, Planning problem

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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 and other quantitative restrictions on credit flows are becoming part of the standard policy toolkit (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 (see Blanchard and Ostry, 2012; and IMF, 2012).

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 DSGE methodology (e.g., Bianchi, 2010; Bianchi, 2011; Bianchi and Mendoza, 2010; Jeanne and Korinek, 2011a and 2011b).<sup>2</sup>

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. Capital controls can act as Pigouvian taxes and constitute an optimal response at the country level, helping agents to internalize the external effects of their borrowing. 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." Similarly, Ostry, Ghosh and Korinek (2012), in referring to the aforementioned strand of literature, advocate capital controls for financial stability purposes.<sup>3</sup>

Using the same theoretical framework and thus taking a pecuniary externality perspective on capital controls, we show that a credible commitment to a price support policy in the event of a crisis (in the specific case of our model a promise to support the

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<sup>2</sup>See also Lorenzoni (2008).

<sup>3</sup>The "consensus" status of this perspective is evidenced by the fact that several prominent scholars and policy analysts refer to the work by Bianchi (2011) or Korinek (2011) as providing "the rationale for prudential policies that attempt to prevent excessive borrowing". A partial list of these contributions include Gertler, Kiyotaki and Queralto (2012), Christiano and Ikeda (2012), Gorton and Ordóñez (2012), Fahri and Werning (2012), and Jeanne, Subramaniam and Williamson (2012).

real exchange rate in crisis times) always welfare-dominates prudential taxes on debt (i.e., prudential capital controls), as it can achieve the unconstrained allocation. Our results differ from the existing literature because we consider a broader set of policy instruments. The literature largely focuses on whether a policymaker should do nothing or use capital controls. If that were the choice set, capital controls would of course be welfare enhancing. But when the set of instruments is expanded to include also other means of intervening within the same exact theoretical framework, capital controls turn out to be dominated and are no longer needed.

This paper also contributes methodologically to the literature on pecuniary externalities by showing that an optimal policy approach where the government optimizes given private sector behavior for a given set of instruments should be the preferred approach to policy design rather than the constrained social planner approach typically used to study the normative implications of this class of models.<sup>4</sup> 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 an optimal policy approach.

As the vehicle to convey our messages, we adopt the same model economy as in the influential article by Bianchi (2011).<sup>5</sup> This is a two-sector (tradables and nontradables) small open, endowment model economy with an occasionally binding international borrowing constraint. Borrowing, denominated in units of tradable consumption, is limited by the value of current income generated from both the tradable and nontradable sectors. When the borrowing constraint binds, the relative price of non-tradables has a balance sheet effect on the constraint, leading to a Fisherian debt-deflation spiral. 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 our framework three possible distortionary policy tools could be used: a tax on borrowing, a tax on nontradable consumption and a tax on tradable consumption. The tax on borrowing is usually interpreted as a capital control, while a tax on either tradable or nontradable consumption can be interpreted in terms of real exchange rate intervention because it directly affects the relative price of nontradables.<sup>6</sup> We show that interventions targeting the real exchange rate always dominate capital controls in wel-

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<sup>4</sup>In what follows we refer to the (constrained) social planner problem as the problem of a planner that maximizes agents' utility subject to the resource and technological constraint and the borrowing constraint (see also Lorenzoni, 2008).

<sup>5</sup>Bianchi (2011) shows that this model successfully reproduces the business cycle and the crisis dynamics properties of Argentine data.

<sup>6</sup>The interpretation of the real exchange rate as the relative price of nontradables is standard in the literature. See for instance Bianchi (2011), Caballero and Lorenzoni (2009), Mendoza (2002), Korinek (2011) and Jeanne (2012), among others.

fare terms. In fact, while the tax on borrowing can be used to replicate the constrained-efficient allocation, with either of the two consumption taxes it is possible to achieve the unconstrained allocation.

The reason why capital controls in the endowment economy can be optimal is that in this model environment the competitive allocation always coincides with the constrained social planner's one when the borrowing constraint is binding. In this setting, when capital controls are the only policy tools available, the best that policy can do is 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 to the tax on borrowing. As we show in the paper, a credible promise to support the real exchange rate through a consumption tax (either on tradable or non-tradable consumption) during crisis times, and hence to relax the borrowing constraint when it binds in bad times, can achieve higher welfare. In fact, in the paper we show that a commitment to such a price support policy during crisis times can undo the borrowing constraint completely and, as a result, support an equilibrium in which agents behave as if they were in the unconstrained allocation during normal times. The result is that crises cease to occur in equilibrium, 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 real exchange rate or more generally the key relative price that enters the borrowing constraint, therefore, is fully credible.

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 lines of the Ramsey tradition of 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.

A second contribution of this paper is to show that, in this class of models with endogenous borrowing constraints, the optimal policy can achieve higher welfare than the constrained social planner problem. This is because with certain policy tools a government that is optimizing over the given instruments can manipulate the relative market price that enters the borrowing constraint so as to undo that constraint completely. This result points to a shortcoming of the social planner approach which might

unintentionally limit the set of policy choices. In contrast, an optimal policy approach conditional on a given set of instruments naturally compares the relative strength of alternative policy tools.<sup>7</sup>

Moreover, we also show that 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 enters 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 on 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 on the planner problem the competitive equilibrium policy function for that price (see also the discussion by Lorenzoni, 2008, on this topic.)

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 depends on those differences. We show that in the conditionally-efficient problem the gap between competitive and social planner allocations will generally 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 respectively the *ex ante* or *ex post* perspectives in the literature) 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, qualitatively and quantitatively, highlighting the possible lack of robustness of a growing body of literature. In the specific case of the endowment economy, however, these two alternative definitions give exactly the same results.

Other modeling approaches to capital controls have been proposed in the literature. In particular, Costinot, Lorenzoni and Werning (2012) study how capital controls might affect intertemporal terms of trade, and Schmitt-Grohe and Uribe (2012) examine the role of capital controls in an economy with downward nominal wage rigidity,

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<sup>7</sup>While in the context of the endowment economy the difference between the constrained social planner and the optimal policy approach depends on the set of instruments available, in the case of the production economy Benigno et al. (2012b) show that the same set of instruments that replicates the social planner problem could be used optimally to replicate the unconstrained allocation. That is, the difference between constrained social planner and optimal policy depends on the fact that the use of policy tools is not optimized in the social planner framework.



while De Paoli and Lipinska (2012) focus on how capital controls affect intratemporal terms of trade. These are complementary studies of the normative properties of capital controls. Our approach is based on the pecuniary externality arising from the presence of credit frictions.

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 policy problem with real exchange rate management. 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

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

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

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

The consumption basket,  $C_t$ , is a CES aggregate of tradable and nontradable goods, where:<sup>8</sup>

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

The parameter  $\kappa$  is the elasticity of intratemporal substitution between consumption of tradable and nontradable goods, while  $\omega$  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

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

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

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<sup>8</sup>We omit the subscript  $j$  to simplify notation, but it is understood that all choices are made at the individual level.

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 is thus

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

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:

$$B_{t+1} \geq -\frac{1 - \phi}{\phi} [Y_t^T + P_t^N Y_t^N]. \quad (4)$$

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, who adopts the same constraint, 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  $B_t \geq \underline{B}$ , for all  $t$ .<sup>9</sup> This lower bound guarantees that the competitive equilibrium allocation without government intervention and the international borrowing constraint (4) (i.e., the unconstrained allocation) is well

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<sup>9</sup>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 substitutability between tradable and nontradable consumption, we can ignore this possibility.

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).<sup>10</sup>

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

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

with  $\lambda_t$  and  $\mu_t$  denoting the multipliers on the borrowing constraint and the budget constraint, respectively. The first order conditions of this problem are

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

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

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

Combining (5) and (6) to obtain

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

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, Bianchi, 2011, and Mendoza, 2002). Nonetheless, while in this paper we shall focus on its normative properties, it is important to note that from a positive perspective Bianchi (2011) shows that this very same model, despite the fact that it is a simple endowment economy, accounts well for some of the business cycles statistics as well as the incidence and severity of financial crises in the data.

### 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 that price in turn affects the borrowing constraint, creating inefficient amplification ef-

<sup>10</sup>This restriction amounts to a lower bound on  $\phi$ .

fects.<sup>11</sup> 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) and the discussion in Lorenzoni (2008), who consider two alternatives. One possibility (which they refer to as the "general constrained-efficient problem") is to determine the relative price by imposing as an 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  $P_t^N = f^{CE}(B_t, Y_t^N, Y_t^T)$ ).<sup>12</sup>

While in the specific case of our model there is no particular reason to prefer one definition to the other, in general this choice is important for the results of the normative analysis of these model environments. In fact, for the specific case of the endowment 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 is 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* and *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, this coincidence implies that the amplification mechanism in the competitive equilibrium allocation induced by the constraint via its externality on the relative price is "efficient" in the sense defined above. Under conditional efficiency, therefore, financial crises might be "efficient" events that distort

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<sup>11</sup>Such a mechanism also operates if an asset price enters the collateral constraint, such as the price of a fixed stock of land (e.g., Bianchi and Mendoza, 2010, and Jeanne and Korinek, 2011a and 2011b). Suitably modified, our analysis and results extend to these alternative environments.

<sup>12</sup>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  $\{B_t, Y_t^N, Y_t^T\}$ ).

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 in favor of ex ante policies.<sup>13</sup> In other words, this assumption implies that crisis events generated by debt-deflation spirals are "efficient" and that there is nothing that policy can do other than try to avoid the occurrence of these events to begin with.

As we noted above, in our simple endowment model, the specific definition of efficiency adopted does not affect the normative analysis, although in a more general production economy the specific definition adopted could have important qualitative and quantitative implications. To illustrate the peculiar nature of 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. We also apply alternative definitions of efficiency to the production economy of Benigno (2012a).

### 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:

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

The nontradable goods market equilibrium condition implies that

$$C_t^N = Y_t^N. \quad (10)$$

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

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

<sup>13</sup>In practice, actual policy makers pursue both crisis resolution and crisis prevention policies. In addition, as Benigno et al. (2012a, 2012b) 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 also biases the results in favor of ex ante policies.

where  $\mu_{1,t}^{SP}$ ,  $\mu_{2,t}^{SP}$  and  $\lambda_t^{SP}$  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

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

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

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

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

The key difference between the planning allocation and the competitive equilibrium follows from examining equations (11) and (5). From the planner's 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 nontradables derived from the marginal increase of tradable consumption. This term drives a wedge 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

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

The Lagrangian of the planner's problem becomes

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

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:

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

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

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

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

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

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  $\lambda_{t+1}^{SP}$  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  $\lambda_{t+1}^{SP}$  and  $f_B^{CE}(B_{t+1}, Y_{t+1}^N, Y_{t+1}^T)$ .

For general economies such as the production economy of Bianchi (2011), Bianchi and Mendoza (2011) or Benigno et al. (2012a, 2012b), the two social planner allocations differ, even though they coincide in the context of our endowment economy. To illustrate this point, Figures 1 and 2 show the policy functions for debt, tradable consumption, and the relative price of nontradables for the production of Benigno et

al. (2012) as well as the endowment economy studied by Bianchi (2011), respectively. The pictures plot the policy functions of the competitive and social planner equilibrium under both definitions of efficiency, with the two economies calibrated *exactly* as in Benigno et al. (2012a) and Bianchi (2011), respectively.

In the general case of a production economy, the definition of efficiency matters.<sup>14</sup> As Figure 1 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, and are stark: while the constrained efficient allocation has less borrowing than the competitive allocation (i.e., there is underborrowing in the jargon of this literature), with conditional efficiency there is less borrowing than in the competitive allocation (i.e., there is overborrowing). Thus, in the general case of a production economy, changing definition of efficiency might affect the conclusions of the normative analysis not only quantitatively but also qualitatively.

These differences are also reflected in the probability of a crisis and the welfare ranking between allocations, which are completely reversed when we change the definition of efficiency. With conditional efficiency we have a higher probability of crisis than in the competitive equilibrium (2.3 and 2 percent, respectively), while with constrained efficiency the probability is lower than 2 percent. 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).<sup>15</sup>

In contrast, in the special case of an endowment economy, the policy functions for tradable consumption and debt coincide under alternative definitions of efficiency, both in the constrained and unconstrained region (Figure 2). The policy function of the relative price of nontradables is different under constrained efficiency in the non-constrained region, but such a difference is immaterial in this case. Indeed, in the endowment economy, the difference in the policy function for  $P^N$  is irrelevant because prices do not affect the real allocation when the constraint is not binding. In fact, the Euler equation and the goods market equilibrium conditions are all that is needed to determine consumption of tradables and nontradables in this case.

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<sup>14</sup>In the production economy of Benigno et al. (2012a) the planner can manipulate not only the marginal rate of substitution between tradable and nontradable goods, but also their marginal rate of transformation.

<sup>15</sup>Welfare gains are generally small in this literature because financial crises are rare events.



In the case of the endowment economy, in the constrained region, the price of nontradables falls dramatically both in the competitive equilibrium and in the social planner allocation under both definitions of efficiency in the endowment economy. This decline sets off the so-called "Fisherian deflation" mechanism emphasized in the pecuniary externality literature—a decline in  $P^N$  that reduces the value of the collateral, tightening the borrowing constraint and reducing the consumption of tradables, which in turn again reduces  $P^N$ , and so on. As Figure 2 shows, however, this 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. It is thus evident that this particular feature of the endowment economy is not desirable, as it implies that crises are efficient events during which there is nothing that government should do—an implication that seems to be counterfactual.

## 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.<sup>16</sup> In the competitive equilibrium, the household's budget constraint becomes

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

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:

$$T_t = \tau_t^B B_{t+1}. \quad (18)$$

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  $\underline{B} \leq B_t$  for all  $t$ .

The competitive equilibrium allocation is then characterized by

$$u'(C_t) C_{CT} (1 + \tau^B) = \lambda_t + \beta (1 + r) E_t [u'(C_{t+1}) C_{CT}] \quad (19)$$

with

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

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<sup>16</sup>A recent example of the aggressive use of such a tax is Brazil. See Harris and Pereira (2012) for a detailed account of the Brazilian case.

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

along with the goods market equilibrium condition.

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

#### 4.1 Constrained-Efficiency

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

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

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

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

The following proposition then holds:

**Proposition 1.** *In an economy defined by (1), (3), and (4), with a tax on debt  $\tau^B$  as the government policy instrument, there exists policy for  $\tau^B$  under which the 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

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

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  $E_t[\lambda_{t+1}^{SP}\Sigma_{t+1}^{SP}] > 0$ , so that if the credit constraint is not currently binding but will bind with positive probability in the next period it,  $\tau^B$  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. ■

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. Note that the tax

is zero for any level of debt for which the constraint binds in the current period. It is only when the constraint does not bind today but will bind with a positive probability tomorrow 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 for  $\tau^B$  above is both Ramsey optimal and time consistent. However it does not achieve the 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 is 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. ■

In the special case of an endowment economy the tax policy rule that implements the constrained efficient allocation is also an optimal capital control policy in traditional Ramsey sense. In more general environments, however, this would not be the case.

#### 4.2 Conditional-Efficiency

Since the social planner problem under conditional efficiency delivers the same allocation as under constrained efficiency, it can immediately be shown that under the former definition of efficiency the same policy function for  $\tau_t^B$  as in (22) would implement the social planner equilibrium with the same properties.

## 5 Exchange Rate Policy

We now consider the use of alternative policy instruments. In the context of our endowment economy there are two alternative tax instruments that could be used: one is a tax on tradable consumption and the other is a tax on nontradable consumption. As we

shall see, both these policy tools have a direct effect on the relative price of nontradable goods,  $P_t^N$ , which in the context of this economy is a measure of the real exchange rate.

This interpretation is standard in the literature. For instance, Jeanne (2012), Korinek (2011), and Schmitt-Grohe and Uribe (2012) all use very similar small open economy models with tradable and nontradable goods and interpret the relative price of non-tradables as the real exchange rate. Therefore, consistent with the interpretation of  $P_t^N$  in the literature, we interpret these taxes as interventions in the real exchange rate, and we label the use of these taxes as "real exchange rate policy."

### 5.1 Tax on Nontradable Consumption

Let us 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

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

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 period by period:

$$T_t = \tau_t^N P_t^N C_t^N. \quad (24)$$

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

$$u'(C_t)C_{CT} = \lambda_t + \beta(1 + r) E_t [u'(C_{t+1})C_{CT}] \quad (25)$$

with

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

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

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 relative price  $P_t^N$ . In fact, the Euler equation and the goods market equilibrium conditions are all that is needed to determine consumption of tradables and nontradables. When the constraint binds, however, this tax is no longer neutral and can be used to affect the value of collateral in the borrowing constraint, 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 the equilibrium of our economy (i.e.,  $\lambda_t \equiv 0$  for all  $t$ ) via its impact on the relative price of nontradables.

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

*Proof.* For a given stochastic process of  $\{Y_t^N, Y_t^T\}$  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  $\tau_t^N$  such that  $\hat{P}_t^N(1 + \tau_t^N) \leq P_t^{N,uncon}$  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 optimally chooses the nontradables consumption tax. That policy is completely determined by the current state  $\{B_t, Y_t^T, Y_t^N\}$  and therefore it is time consistent. ■

Several remarks are in order here. First, this proposition establishes that there is a tax policy on nontradable consumption that replicates the unconstrained allocation, and hence dominates in welfare terms the tax on debt which is Ramsey optimal, but achieves only the constrained efficient allocation (i.e., a second best outcome).

But how does this policy work? This policy promises to relaxes the borrowing constraint by supporting the relative price of nontradables whenever the constraint binds, in such a way that the constraint never binds in equilibrium. Under this policy, during tranquil times, private agents behave as if the constraint does not exist. In doing so their consumption of tradable goods will be higher than in the competitive allocation and in the constrained social planner allocation. For a given endowment of nontradable goods, the allocation entails a higher relative price of nontradables during tranquil times (i.e., a relatively more appreciated real exchange rate), which in turn increases

the borrowing capacity of private agents, and makes the borrowing constraint never binding in equilibrium, completely eliminating the effects of the pecuniary externality.

The policy is not an actual intervention in crisis times but rather an *ex ante* announcement that averts the very need to intervene, i.e., a commitment to intervene *ex post* in the case of a crisis that removes *ex ante* the very need to intervene. Note that the above policy function for  $\tau^N$  is time consistent, and hence the promise to relax the borrowing constraint by supporting the relative price of nontradables whenever the constraint binds is fully credible. Thus, the *ex ante* commitment is a credible promise to intervene off the equilibrium path (i.e., when the constraint binds, which never happens in equilibrium).

Second, the proposition shows that the normative prescriptions obtained by comparing the social planner allocation with the competitive equilibrium is sensitive to the way the key relative price in the borrowing constraint is determined in the social planner problem. In this sense, the proposition above shows that conducting the normative analysis of this class of models by computing the optimal policy problem conditional on the set of available instruments chosen is more robust than computing the social planner problem and then discussing its implementation with an arbitrary choice of instruments separately, as is usually done in the related literature. In fact, in the optimal policy approach, the pricing equation is part of the set of relations describing the private sector's behavior and is always taken into account in the optimal policy problem.

This explains why the Ramsey allocation achieves higher welfare than the social planner allocation defined in Section 3 in our model. This counterintuitive result is due to the fact that the *social planner* problem is constrained by the pricing rule as defined in (8). In contrast, the *optimal policy* problem in which the policy tool is the tax on nontradable consumption is constrained by (26). Our Ramsey planner can manipulate the relative price of nontradables directly with the tax on nontradable consumption so as to undo the constraint completely without creating further distortions, and hence can use the instrument assigned to remove completely the constraint.

Third and finally, because of our interpretation of the instruments analyzed, the proposition above implies that real exchange rate policy dominates capital control policy discussed in Section (4) in welfare terms. Under the exchange rate policy defined above the probability of a financial crisis is zero and the economy replicates the unconstrained allocation. In contrast, capital controls can achieve only a second best allocation.

## 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:

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

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

$$T_t = \tau_t^T C_t^T. \quad (29)$$

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

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

with

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

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

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 consumption tax policy.

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

*Proof.* Let the optimal nontradable consumption tax be  $\tau_t^N$ . 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 also affects 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, that 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  $\tau_t^T$  so that

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

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, the nontradable price has a strictly positive lower limit. Therefore there exists  $\underline{\tau}^T$  such that the borrowing constraint (4) is always satisfied for any  $\tau^T \geq \underline{\tau}^T$ . Thus, any constant tax policy of the form  $\tau_t^T \equiv \tau^T \geq \underline{\tau}^T$  is an optimal policy such that the competitive equilibrium replicates the first best unconstrained allocation. ■

### 5.3 Discussion

Is the optimal exchange rate policy implied by the propositions above realistic? For a given endowment of nontradable goods, the optimal exchange policy implied by the propositions above entails a more appreciated relative price of nontradables than under capital controls or no policy intervention, which in turn increases the borrowing capacity of private agents, and makes the borrowing constraint never binding in equilibrium, completely eliminating the effects of the pecuniary externality. This policy is consistent with experiences during the emerging market crises of the 1990s and the 2000s, in which a key policy action was the defense of the exchange rate from excessive depreciations via interest rate increases or other liquidity tightening measures such as higher reserve requirements.

For instance, the defense of the exchange rate was a crucial component of the adjustment programs supported by the IMF in Indonesia, South Korea, and Brazil during the period 1997-1999 even after the initial exit from the respective currency pegs (IMF Independent Evaluation Office, 2003).<sup>17</sup> In the specific case of Brazil, faced with the prospect of a new financial crisis ahead of the 2002 presidential election, "the authorities ... responded ... proactively, announcing in June an increased primary surplus target for 2002-2003 and ... maintained a firm monetary policy to limit the inflationary impact of the weakening real" (IMF, 2002). To support these policies, the IMF

<sup>17</sup>From a theoretical perspective on this, Braggion, Christiano and Roldos (2009), among several others, show that the optimal interest rate policy response to a financial crisis is an increase in the interest rate that leads to an appreciation of the relative price of nontradables.



approved a US\$30.4 Billion Standby Credit in September 2002, which was the largest loan ever to that date.<sup>18</sup>

More broadly, in the context of the recent US and European financial crises, the policy above can be interpreted as price support intervention that avoids the collapse of asset prices when a crisis does occur. In this sense, the proposition above not only rationalizes the need to set a floor under the exchange rate as in the emerging market crises of the 1990s and the 2000s, but also recent policy interventions during the European crisis aimed at supporting asset prices to contain the "fire sales" and the asset deflation spirals. Most recently, for example, the ECB President Mario Draghi's verbal intervention that promised unlimited intervention in sovereign debt markets marked a turnaround in the situation in Europe without actual financial intervention.<sup>19</sup>

## 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 constrained 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 an optimal policy problem in which the government takes as given the behavior of private agents for given policy tools. Our main result is that a commitment to support the real exchange rate in crisis times always dominates prudential capital controls in welfare terms. We also show that this policy commitment is time consistent and thus fully credible, and it delivers the 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, under the optimal policy, the proper policy tool (i.e., the consumption tax) can directly manipulate the key relative

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<sup>18</sup>The 2002 loan turned out so successful that it eventually was not fully drawn and was repaid well ahead of schedule by the Brazilian authorities.

<sup>19</sup>"The speech in London on 26 July was such a moment. If you look at the verbatim, it doesn't say anything that's outside our mandate. But indeed it's an especially strong speech that makes a firm statement on the preservation of the Euro." (Edited transcript of Mario Draghi's interview with the *Financial Times*, December 11, 2012).

price that enters the borrowing constraint and hence undo the constraint by supporting this key market price.

From a methodological point of view, our analysis shows that in this class of models there is no general equivalence between the constrained social planner problem and the Ramsey problem. In the case of the endowment economy on which we focus in this paper the equivalence is conditional on the policy tool: when the policy tool is given by the tax on debt the constrained social planner coincides with the Ramsey policy problem. However, when the policy tool is given by a consumption tax, the Ramsey planner can replicate the unconstrained equilibrium and achieve a higher welfare than the constrained efficient social planner problem. In this sense our analysis suggests 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 abstracting from the complications of an optimal policy approach, it is not informative on the relative merit of alternative policy tools to do so.

Finally, we have shown that the specification of the constrained social planner problem might be sensitive to the definition of efficiency adopted, possibly biasing the normative analysis significantly, both qualitatively and quantitatively. For instance, in the case of a production economy, we show that changing the definition of efficiency completely changes 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 an optimal policy approach which is fully transparent in terms of the constraints imposed on the normative analysis.

## References

- [1] Benigno, G., and L. Fornaro. 2012. “The Financial Resource Curse.” London, United Kingdom: London School of Economics. Mimeographed document.
- [2] Benigno, G. et al. 2012a. “Financial Crises and Macro-Prudential Policies.” *Journal of International Economics*. Forthcoming.
- [3] Benigno, G. et al. 2012b. “Optimal Policy for Macro-Financial Stability.” CEPR Discussion Paper 9223. London, United Kingdom: Centre for Economic Policy Research.
- [4] Bianchi, J. 2010. “Credit Externalities: Macroeconomic Effects and Policy Implications.” *American Economic Review* 100(2): 398-402.
- [5] Bianchi, J. 2011. “Overborrowing and Systemic Externalities in the Business Cycle.” *American Economic Review* 101(7): 3400-3426.
- [6] Bianchi, J., and E.G. Mendoza. 2010. “Overborrowing, Financial Crises and ‘Macro-Prudential’ Taxes.” NBER Working Paper 16091. Cambridge, United States: National Bureau of Economic Research.
- [7] Blanchard, O., and J. Ostry. 2012. “The Multilateral Approach to Capital Controls.” Available at: <http://www.voxeu.org/article/multilateral-approach-capital-controls>
- [8] Braggion, F., L.J. Christiano and J. Roldos. 2007. “Optimal Monetary Policy in a ‘Sudden Stop.’” *Journal of Monetary Economics* 56(4): 582-595.
- [9] Caballero, R., and G. Lorenzoni. 2009. “Persistent Appreciations and Overshooting: A Normative Analysis.” Cambridge, United States: Massachusetts Institute of Technology. Unpublished manuscript.
- [10] Caballero, R.J. 2010. “Sudden Financial Arrest.” *IMF Economic Review* 58(1): 6-36.
- [11] Christiano, L., and D. Ikeda. 2012. “Government Policy, Credit Markets and Economic Activity.” Evanston, United States: Northwestern University. Mimeographed document. Available at: <http://faculty.wcas.northwestern.edu/~lchrist/research/jekyll/manuscript.pdf>
- [12] Costinot A., G. Lorenzoni and I. Werning. 2012. “A Theory of Capital Controls as Dynamic Terms-of-Trade Manipulation. Cambridge, United States: Massachusetts Institute of Technology. Mimeographed document.

- [13] De Paoli, B., and A. Lipinska. 2012. "Capital Controls: A Normative Analysis." New York, United States: Federal Reserve Bank of New York. Mimeographed document.
- [14] Fahri, E., and I. Werning. 2012. "Dealing with the Trilemma: Optimal Capital Controls with Fixed Exchange Rates." Cambridge, United States: Harvard University and Massachusetts Institute of Technology. Mimeographed document. Available at: Fahri, E., and I. Werning. 2012. "Dealing with the Trilemma: Optimal Capital Controls with Fixed Exchange Rates." Cambridge, United States: Harvard University and Massachusetts Institute of Technology. Mimeographed document. Available at: <http://www.crei.cat/conferences/ief-workshop/Werning.pdf>
- [15] Gertler, M., N. Kiyotaki and A. Queralto. 2012. "Financial Crises, Bank Risk Exposure and Government Financial Policy." *Journal of Monetary Economics* 59(Supplement): S1-S78.
- [16] Gorton, G.B., and G. Ordóñez. 2012. "Collateral Crises." NBER Working Paper 17771. Cambridge, United States: National Bureau of Economic Research.
- [17] Harris, R. and L. Pereira da Silva. 2012. "Sailing through the Global Financial Storm: Brazil's Recent Experience with Monetary and Macroprudential Policies to Lean against the Financial Cycle and Deal with Systemic Risks." Working Paper 290. Brasilia, Brazil: Central Bank of Brazil.
- [18] International Monetary Fund (IMF). 2002. "IMF Approves US\$30.4 Billion Stand-By Credit for Brazil." Press Release 02/40, <http://www.imf.org/external/np/sec/pr/2002/pr0240.htm>. Washington, DC, United States: IMF. September 6.
- [19] IMF Independent Evaluation Office. 2003. "The IMF and Recent Capital Account Crises: Indonesia, Korea, and Brazil." Evaluation Report. Washington, DC, United States: IMF, Independent Evaluation Office.
- [20] IMF. 2012. "The Liberalization and Management of Capital Flows: An Institutional View." IMF staff paper. Washington, DC, United States. Available at: <http://www.imf.org/external/np/pp/eng/2012/111412.pdf>.
- [21] Jeanne, O. 2012. "Capital Flow Management." *American Economic Review* 102(3): 203-206.

- [22] Jeanne, O., and A. Korinek. 2011a. “Excessive Volatility in Capital Flows: A Pigouvian Taxation Approach.” *American Economic Review* 100(2): 403-407.
- [23] Jeanne, O., and A. Korinek. 2011b. “Managing Credit Booms and Busts: A Pigouvian Taxation Approach.” Unpublished manuscript.
- [24] Jeanne, O., A. Subramanian and J. Williamson. 2012. *Who Needs to Open the Capital Account?* Washington, DC, United States: Peterson Institute for International Economics.
- [25] Kehoe, T.J., and D. Levine. 1993. “Debt-Constrained Asset Markets.” *Review of Economic Studies* 60(4): 865-888.
- [26] Korinek, A. 2011. “The New Economics of Prudential Capital Controls.” *IMF Economic Review* 59(3): 523-561.
- [27] Krugman, P. 1999. “Balance Sheets, the Transfer Problem, and Financial Crises.” *International Tax and Public Finance* 6(4): 459-472.
- [28] Lorenzoni, G. 2008. “Inefficient Credit Booms.” *Review of Economic Studies* 75(3): 809-833.
- [29] Magud, N.E., C.M. Reinhart and K.S. Rogoff. 2011. “Capital Controls: Myth and Reality—A Portfolio Balance Approach.” NBER Working Paper 16085. Cambridge, United States: National Bureau of Economic Research.
- [30] Mendoza, E.G. 2002. “Credit, Prices, and Crashes: Business Cycles with a Sudden Stop.” In: S. Edwards and J.A. Frankel, editors. *Preventing Currency Crises in Emerging Markets*. Chicago, United States: University of Chicago Press and National Bureau of Economic Research.
- [31] Mendoza, E.G. 2010. “Sudden Stops, Financial Crises and Leverage: A Fisherian Deflation of Tobin’s Q.” *American Economic Review* 100(5): 1941-1966.
- [32] Ostry, J., A. Ghosh and A. Korinek. 2012. “Multilateral Aspects of Managing the Capital Account.” IMF Staff Discussion Note 12/10. Washington, DC, United States: International Monetary Fund.
- [33] Pereira da Silva, L.A., and R. E. Harris. 2012. “Sailing through the Global Financial Storm: Brazil’s Recent Experience with Monetary and Macroprudential Policies to Lean Against the Financial Cycle and Deal with Systemic Risks.” Central Bank of Brazil WP 290. Brasilia, Brazil: Central Bank of Brazil.

[34] Schmitt-Grohe, S., and M. Uribe. 2012. "Prudential Policy for Peggers." New York, United States: Columbia University. Manuscript.

Figure 1: Endowment Economy Decision Rules

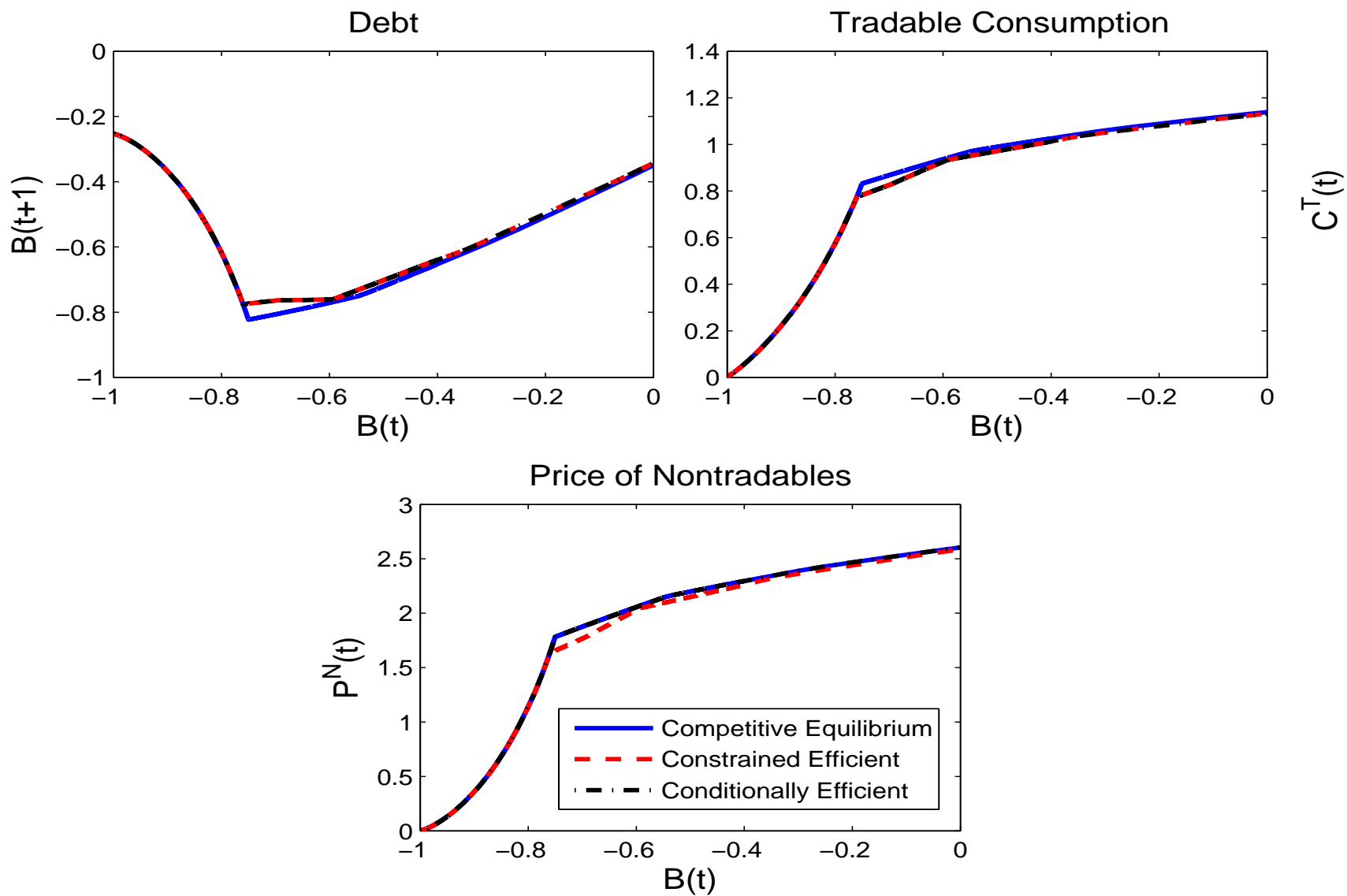


Figure 2: Production Economy Decision Rules

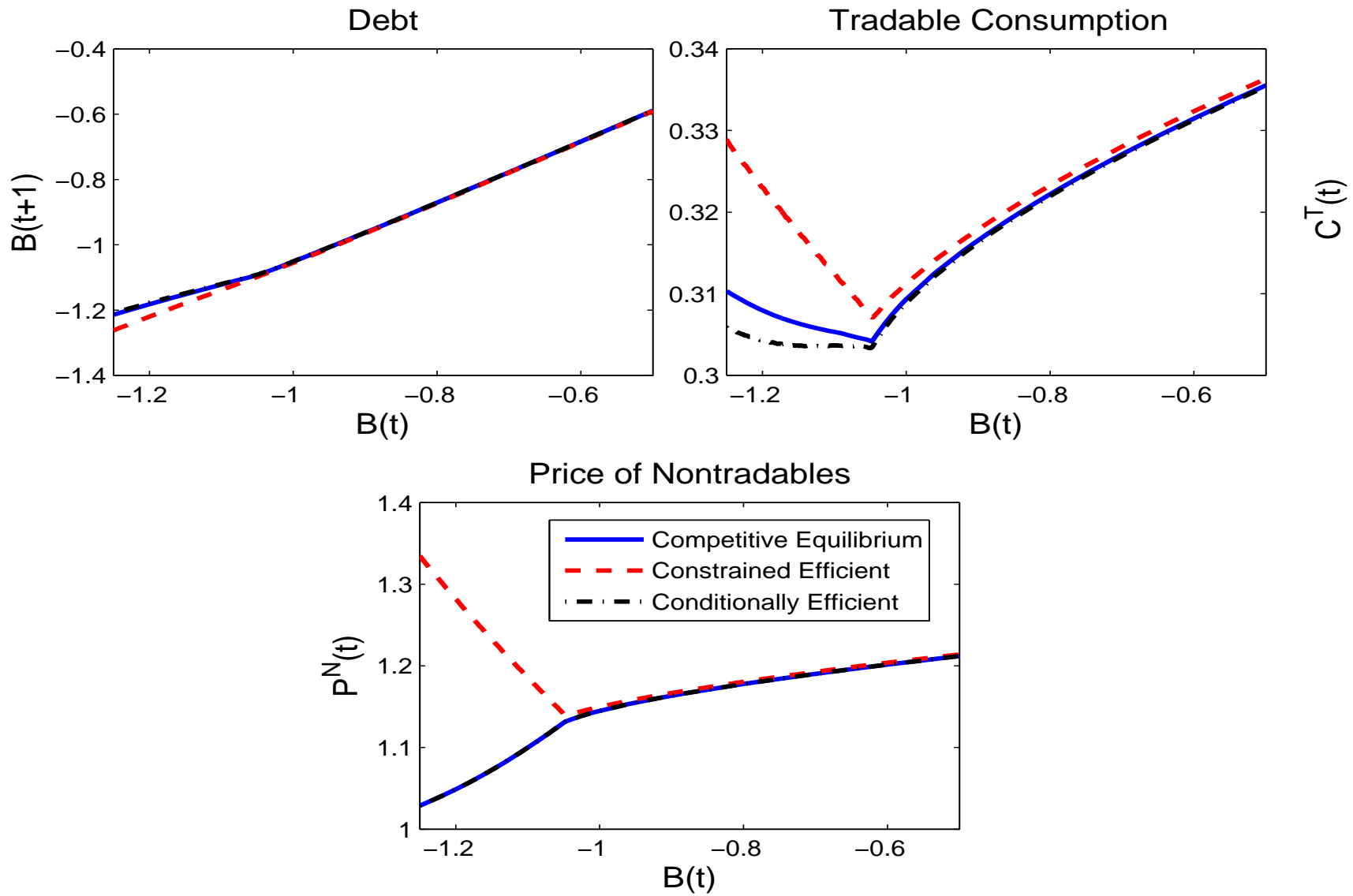




Figure 3: Production Economy Ergodic Distribution of Debt

