Revisiting Overborrowing and its Policy Implications

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Abstract

This paper analyzes quantitatively the extent to which there is overborrowing in a business cycle model for emerging market economies and discusses alternative policy regimes often advocated as second best policy responses to imperfect access to capital markets. We find that overborrowing can occur only under special circumstances. The main policy implication of the analysis is that there is no clear cut rationale to prefer ex ante or ex-post policies to minimize the likelihood or the severity of financial crises. Both type of policies have costs and benefits. It follows that policy should focus on trying to achieve first best outcomes by removing the underlying sources of financial friction.
1 Introduction

Economies with imperfect financial market access may experience crises that cause significant economic dislocation. These crises are characterized by the sudden stop of domestic or international credit flows and are associated with large declines in consumption, output, relative prices, and asset prices.

An important question for emerging-market economies is whether the likelihood and the severity of these crises is affected by excessive borrowing in normal times, when access to financial markets is unconstrained and plentiful. This question is important because the policy implications of alternative answers are very different. If in good times there is overborrowing, policy should be geared primarily toward addressing the ex ante inefficiencies that cause overborrowing. For example, imposing a tax on capital flows or other forms of capital controls to reduce borrowing.\(^1\) In this case, policy should be less concerned about mitigating the consequences of the crisis, when one occurs, and instead strengthen the incentives to borrow less in good times. If there is no overborrowing in good times, policy should be geared primarily toward designing efficient interventions during in bad times, trying to minimize the costs of the inevitable crises associated with imperfect access to financial markets.

A fast growing literature has examined this issue in related work. Lorenzoni (2008) and Korineck (2008a,b) explore the possibility of overborrowing qualitatively in stylized three-period economies, while Uribe (2006) and Bianchi (2009) have examined it quantitatively with mixed results. While Uribe (2007) finds no overborrowing, Bianchi finds that overborrowing may have significant welfare implications. As a result, Korineck (2008a,b) and Bianchi (2009) suggest that prudential policy may have scope for preventing and mitigating crises.

This paper analyzes quantitatively the extent to which there is overborrowing in a simple business cycle model with production for an emerging market economy and discusses alternative policy implications.

We investigate overborrowing in the framework originally proposed by Mendoza (2002) in which agents are subject to an international borrowing constraint that depends on their current income. There are two defining features of this environment. First the international borrowing constraint binds occasionally: the crisis, defined as the event in which the constraint binds, is an endogenous event that depends on agents’ decisions, the policy regime, and the state of the economy. Second, potential scope for policy intervention arises in this

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\(^1\)See for instance the recent introduction of a tax on international portfolio flows by Brazil, or Chile’s earlier experience with capital controls on foreign inflows.
environment because of the existence of a pecuniary externality in the model as agents fail to internalize the aggregate price implications of their own borrowing decision.\(^2\)

Our endogenous borrowing credit constraint is embedded in a standard two-sector (tradable and non-tradable good) small open economy (e.g., Obstfeld and Rogoff, 1996, Chapter 4) in which financial markets are not only incomplete but also imperfect, as in Mendoza (2002, 2009). The asset menu is restricted to a one period risk-free bond paying off the exogenously given foreign interest rate. In addition, we assume that access to foreign financing is constrained to a fraction of households’ total income. Foreign borrowing is denominated in units of the tradable good but it is leveraged on income generated at different relative prices (i.e. the relative price of non-tradeable good), a specification of the borrowing constraint that captures “liability dollarization” a key feature of emerging market capital structure (e.g., Krugman (2002)).\(^3\)

To investigate overborrowing quantitatively we compare the competitive equilibrium (CE) with the constrained efficient allocation (SP), solving them with global solution methods. That is, we solve for decision rules across both states of the world, when the constraint binds and when it does not. Such an approach enforces that the behavior away from the crisis periods is based on full knowledge of what the equilibrium will be when the economy enters the crisis state. This solution method, while computationally costly, is critical for understanding the interaction between different states of the world.\(^4\)

We find that overborrowing can occur only under special circumstances. In particular, we find that overborrowing due to pecuniary externalities is quantitatively relevant only for an endowment economy with specific assumptions about preferences and shocks—an endowment economy in which agents are more impatient than in our baseline model and shocks are larger than in our base model calibrated to Mexican data. When we move to an endowment economy with the same parameter values as in our baseline or to our baseline production economy, we do not find overborrowing in normal times. In this two cases, in the portion of the state space in which the credit constraint is not binding, the competitive equilibrium solution and the social planner solution coincide in the. Therefore, our analysis suggests that there is no strong quantitative ground for aggressive prudential policies in normal times. This is especially important in light of the fact that, in these models, the efficiency costs of the distortions associated with the implementation of the these policies

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\(^2\)See Benigno et al. (2009) and section 2 below for a more detailed discussion.

\(^3\)The latest wave of crises in emerging Europe and the corporate sector problems in Mexico and Brazil in the fourth quarter of 2008 represent striking evidence of the importance of such feature.

\(^4\)The technical challenge in solving such a model is that the constraint binds only occasionally and changes location in the state space of the model depending on the state of the economy.
are not present in the models.\footnote{See Nikolov (2009) for a quantitative analysis of this issue in which these costs, summarized by lower average growth, play an important role.}

In contrast, in our baseline production model, if the credit constraint is binding, there is a divergence between the CE and the SP allocations, with the CE curtailing borrowing much faster than the social planner because of the effect of the pecuniary externality, indicating the possibility that a policy intervention during a crisis may be beneficial. This stress the importance of global lending of last resort arrangements and reserve accumulation policies to help mitigate the effect of crises when they occurs, as in Benigno et (2009).\footnote{One important caveat to this analysis is that, like most of the literature above, the credit constraint is not microfounded. As we discuss at the end of the paper the specification of these microfundations could affect some of the results and their policy implications.} However, it is important to notice here that moral hazard considerations are also not present in the model. As a result, the case for ex post intervention policies may be also overstated.

In sum, the main policy implication of the analysis is that there is no clear cut rationale to prefer ex ante, or prudential policies, or ex-post policies that intervene after a crisis occurs. Indeed, the analysis and the discussion in the paper highlight that there is a very strong case for more fundamental policy actions geared toward ameliorating the underlying incentive problems of international borrowers and lenders so has to permit a smoother functioning of international capital markets without the necessity to impose tight credit constraints on borrowers or defaults on lenders to make up for the lack of commitment either on either side of the market.

The rest of the paper is organized as follows. Section 2 discusses the pecuniary externality that may give rise to overborrowing. Section 3 describes the model we use. Section 4 discusses its parametrization and solution. Section 5 illustrates the working of the model and its basic properties. Section 6 contains the main results of the paper, comparing the CE and the SP equilibria under alternative model specifications and parameter values. Section 7 concludes. Technical details about the computational methods can be found in Benigno et al (2009).

## 2 Overborrowing and Pecuniary Externalities

Before turning to the presentation of the model we discuss the source of the externality that may give rise to overborrowing. Overborrowing has been discussed extensively in the literature so our discussion of overborrowing and the pecuniary externality than may give rise to it is in the form of a review of the literature closely related to our paper.

There is an extensive literature that provides different explanations for why countries...
might overborrow. In an early contribution, Fernandez-Arias and Lombardo (1998) investigate analytically whether an economy with an aggregate debt limit tends to overborrow relative to an economy in which the debt limit is imposed at the level of the individual agent. They find that when agents fail to internalize the debt limit the economy tends to overborrow. Uribe (2007) investigates overborrowing quantitatively and finds that the amount borrowed is independent on foreign lenders basing their lending decisions on individual as opposed to aggregate variables. The models used in these early analyses are similar. The key difference among the two environments is that in Uribe (2007), when the constraint is binding, the domestic interest rate adjusts and induces agents to internalize the credit limit, while Fernandez-Arias and Lombardo (1998) assume that the domestic interest rate is equal to the world interest rate and agents fail to internalize the debt ceiling in their deterministic model. In both papers, however, there are two common ingredients. First, the debt ceiling is exogenously specified. Second, the economy is a one good economy, in which the pecuniary externality we focus on cannot arise (See Benigno et al, 2009, section 2 for details).

More recent work has considered richer environments in which there are multiple goods and the borrowing limit is endogenous. In this environments, the interaction between borrowing constraint and the dependence of the borrowing limit on a relative price generates a pecuniary externality that is not internalized in the competitive equilibrium allocation and might give rise to overborrowing. The social planner on the other hand takes into account the way the relative price is determined in the competitive allocation when choosing its optimal plan and chooses accordingly the amount to borrow. For instance, in a closed economy model, Lorenzoni (2008) shows that entrepreneurs do not take into account the effects of asset prices on the amount that they can borrow so that in the competitive equilibrium financial contracts result in excessive borrowing. Similar analysis has been conducted by Korinek (2009) and Bianchi (2009) in an open economy setting similar to our baseline model but without production in which the amount that individuals can borrow depends on income generated in both sectors of the economy and their relative price. Both papers conclude that there is overborrowing, with potentially significant welfare consequences, qualitatively (Korinek, 2009) and quantitatively (Bianchi, 2009). In contrast, Nikolov (2009), in a stochastic version of the Kiyotaki and Moore (1997) model, finds that these pecuniary externalities do not induce sizable divergence between the CE and the SP when a leverage ratio is a variable of choice.

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7 Uribe (2007) considers one extension in which the constraint is endogenous in the sense explained above. Indeed, in this case, he finds a small overborrowing.

8 Again, see Benigno et al (2009) for more details.
Interestingly, in Nikolov’s (2009) model, there is not only production but also firm heterogeneity. In this environment there is a trade off between the higher volatility associated with higher leverage ratio and the lower average growth associated with lower leverage ratios. So mandating lower regulatory leverage ratios may impose significant efficiency costs in terms of lower average growth.

3 Model

This section describes a standard two-sector (tradable and non-tradable good) small open economy in which financial markets are not only incomplete but also imperfect, as in Mendoza (2002, 2008). Key features of Mendoza’s model that we retain include an occasionally binding credit constraint and production of goods with a variable labor input. We simplify his model by considering only one disturbance, a shock to aggregate productivity in the tradable sector and an inelastic discount rate.

3.1 Households

There is a continuum of households $j \in [0, 1]$ that maximize the utility function

$$U^j \equiv E_0 \sum_{t=0}^{\infty} \left\{ \exp \left( -\theta_t \right) \frac{1}{1 - \rho} \left( C_{j,t} - \frac{H^\delta_j t}{\delta} \right)^{1-\rho} \right\},$$

(1)

with $C_j$ denoting the individual consumption basket and $H_j$ the individual supply of labor. For simplicity we omit the $j$ subscript for the remainder of this section, it is understood that all choices are made at the individual level. The elasticity of labor supply is $\delta$, while $\rho$ is the coefficient of relative risk aversion. In (1) the preference specification follows from Greenwood, Hercowitz and Huffman (1988): in the context of a one-good economy this specification eliminates the wealth effect from the labor supply choice. Here, in multi-good economy the sectoral allocation of consumption will affect the labor supply decision through relative prices. The consumption basket, $C_t$, is a composite of tradable and non-tradable goods:

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

(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

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9This is the same base model used by Benigno et al (2009) and Bianchi (2009).
utility function. The discount factor, $\theta_t$, is endogenous and evolves as:\footnote{Note that all computations in the paper assume a inelastic discount rate.}

\[
\theta_t = \theta_{t-1} + \beta \ln \left( 1 + C_t - \frac{H^\delta_{t\delta}}{\delta} \right)
\]

\[
\theta_0 = 1.
\]

We normalize the price of traded goods to 1. The relative price of the nontraded good is denoted $P^N$. The aggregate price index is then given by

\[
P_t = \left[ \omega + (1 - \omega) \left( P^N_t \right)^{1-\kappa} \right]^{\frac{1}{1-\kappa}},
\]

where 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 tradeable consumption. The constraint each household faces is:

\[
C^T_t + (1 + \tau^N_t) P^N_t C^N_t = \pi_t + W_t H_t - B_{t+1} - (1 + i) B_t - P^N_t T^N,
\]

where $W_t$ is the real wage, $B_{t+1}$ denotes the foreign lending at the end of period $t$ with gross real return $1 + i$, $\tau^N_t$ is a distortionary taxes on non-tradables consumption, and $T^N$ is lump sum taxes of non-tradables. Households receive profits, $\pi_t$, from owning the representative firm. Their labor income is given by $W_t H_t$.

International financial markets are incomplete and access to them is also imperfect. The asset menu includes only a one period bond denominated in units of tradable consumption. This captures the effects of liability dollarization since foreign borrowing is denominated in units of tradables. In addition, we assume that the amount that each individual can borrow internationally is limited by a fraction of his current total income:

\[
B_{t+1} \geq -\frac{1 - \phi}{\phi} \left[ \pi_t + W_t H_t \right].
\]

The constraint (9) depends endogenously on the current realization of profits and wage income. We don’t derive explicitely the credit constraint as the outcome of an optimal credit contract between lenders and borrowers.\footnote{As emphasized in Mendoza (2002), this form of liquidity constraint shares some features, namely the endogeneity of the risk premium, that would be the outcome of the interaction between a risk-averse borrower and a risk-neutral lender in a contracting framework as in Eaton and Gersovitz (1981). It is also consistent with anecdotal evidence on lending criteria and guidelines used in mortgage and consumer financing. However, it is not derived as the outcome of an optimal credit contract.} We could interpret this constraint as the
outcome of the interaction between lenders and borrowers in which the lenders is not willing to permit borrowing beyond a certain limit. This limit depends on $\phi$ that measures the tightness of the borrowing constraint and current gross income that could be used as a good proxy of future income. \(^{12}\)

Households maximize (1) subject to (3) and (4) by choosing $C^N_t, C^T_t, B_{t+1}$, and $H_t$. The first order conditions of this problem are the following:\(^{13}\)

\[
\frac{C^N_t}{C^T_t} = (1 + \tau^N_t) P^N_t, \tag{5}
\]

\[
u C_t C^N_t = \mu_t, \tag{6}
\]

\[
\mu_t + \lambda_t = \theta_t (1 + i) E_t [\mu_{t+1}], \tag{7}
\]

and

\[
z_H(H_t) = C^T_t W_t \left[ 1 + \frac{\lambda_t}{\mu_t} \frac{1 - \phi}{\phi} \right]. \tag{8}
\]

$\mu_t$ and $\lambda_t$ are the multipliers on the budget and liquidity constraint. Equation (5) determines the optimal allocation of consumption across tradable and nontradable goods by equating the marginal rate of substitution between $C^N_t$ and $C^T_t$ with the relative price of non-tradable and distortionary taxation in the nontradable sector. The presence of the tax in this equation makes it clear that policy will be aimed at altering the households choice of consumption basket through its affect on relative prices. Equation (6) determines the multiplier $\mu_t$ in terms of the marginal utility of tradable consumption. Equation (7) determines the optimal choices of foreign bonds and thus saving. Note that when the the credit constraint is binding ($\lambda_t > 0$), the standard Euler equation incorporates effects that can be interpreted as arising from a country-specific risk premium on external financing. The extent of this affect is governed by the degree of risk aversion. Moreover in this frame-

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\(^{12}\)A constraint expressed in terms of future income which could be the outcome of the interaction between lenders and borrowers in a limited commitment environment would introduce further computational difficulties that we are avoiding at first pass. Namely this type of constraint implies that a decision made tomorrow that is conditional on states not realized yet – alters the constraint set of choices today. As a result, the problem would become not recursive.

Moreover further complications might be introduces as the lender will condition his lending behavior on the worst possible state.

Despite this technical/computational issue as we discussed in the context of our two-period example the nature of the policy problem is very similar if we consider current or future income as a collateral for lending decisions.

\(^{13}\)We denote with $C^N_t$ the partial derivative of the consumption index $C$ with respect to non-tradable consumption. $\nu C$ denotes the partial derivative of the period utility function with respect to consumption and $z_H$ denotes the derivative of labor disutility with respect to labor.
work there is an intertemporal effect coming from the possibility that the constraint might be binding in the future: this effect is embedded in the term $E_t [\mu_{t+1}]$ and implies that consumption of tradeable goods would be lower compared to the unconstrained case. Finally, (8) determines the optimal supply of labor as a function of the relevant real wage and the multipliers. Again, it is important to note here that a binding international credit constraint increases the marginal benefit of supplying one unit of labor since this improves households’ borrowing capacity. Consumption, saving, equilibrium labor effort, and output are therefore distorted by the presence of a binding credit constraint in a manner that depends on the interaction between the two effects highlighted above.

### 3.2 Firms

The firms are endowed with a stochastic stream of tradable goods, $\exp(\varepsilon_T^t)Y^T_t$, where $\varepsilon_T^t$ is a stochastic process, and produces non-tradable goods, $Y^N_t$. Unlike Mendoza (2002), we assume that $\varepsilon^T_t$ follows an autoregressive process of the first order (AR(1) for accuracy). We abstract from other sources of macroeconomic uncertainty, such as shocks to the technology for producing non-tradables, the world interest rate, and the tax rate.

Firms produce non-tradables goods, $Y^N_t$, with a variable labor input and Cobb-Douglas technology

$$Y^N_t = AH_t^{1-\alpha},$$

where $A$ is a scaling factor. The firm’s problem is static and current-period profits ($\pi_t$) are:

$$\pi_t = \exp(\varepsilon_T^t) Y^T_t + P^N_t AH_t^{1-\alpha} - W_tH_t.$$

The first order condition for labor demand is:

$$W_t = (1 - \alpha) P^N_t AH_t^{-\alpha},$$

so the value of the marginal product of labor is set equal to the real wage ($W_t$).

### 3.3 Government

For ease of comparison with the model used by Benigno et al (2009), here we discuss also a government sector, but in the results reported in this draft of the paper there is no government policy at work.\(^{14}\) So, in our model, the SP could potentially implement a

\(^{14}\)We plan to discuss implementation issues by means of second best government distortions in the next draft of the paper.
constrained efficient allocation by means of a distortionary tax rate $\tau_t^N$ on private domestic non-tradables consumption. The tax rate can be negative, in which case the government is subsidizing nontraded consumption. We focus on this as our policy tool is because it is possible to interpret this instrument as an intervention on the real exchange rate (i.e., as exchange rate policy). The government runs a balanced budget in each period. Changes in the policy variable $\tau^N$ are financed by lump-sum taxes/transfers on nontradables, $T_t^N$. The government budget constraint is then given by

$$\tau_t^N P_t^N C_t^N = -P_t^N T_t^N.$$  

Lump sum financing of the optimal policy is a simplifying assumption that allows us to abstract from other distortions that may arise with alternative financing arrangements. Our interpretation of the lump sum taxation is that the government has accumulated reserves, and once accumulated, these reserves can be used for an intervention at no new cost.

### 3.4 Aggregation and equilibrium

Combining the household budget constraint, government budget constraint, and the firms’ profits, we have the aggregate resource constraint:

$$C_t^T + P_t^N C_t^N + B_{t+1} = \exp(\varepsilon_t^T) Y_t^T + P_t^N Y_t^N + (1 + i) B_t.$$  

All goods produced in the nontraded sector are consumed, the price of the nontraded good adjusts to ensure that this happens in the competitive equilibrium. The output of the traded good is either consumed or used to pay off interest on debt:

$$C_t^T = Y_t^T - B_{t+1} + (1 + i) B_t. \quad (10)$$  

High levels of debt then, imply lower consumption of the traded good. This equation shows the evolution of the net foreign asset position as if there were no international borrowing constraint. Note finally that, in the model, using the definitions of firm profits and wages, the liquidity constraint implies that the amount that the country as a whole can borrow is constrained by a fraction of the value of its GDP:

$$B_{t+1} \geq -\frac{1 - \phi}{\phi} \left[ \exp(\varepsilon_t^T) Y_t^T + P_t^N Y_t^N \right]. \quad (11)$$
4 Parameter values and solution method

In this section we discuss the parameter values chosen and briefly describe the global solution method that we use in the numerical computations. The solution method and the choice of most parameter values follow Benigno et al (2009) and details on the computations can be found in that paper.

4.1 Parameter values

The parameter values we use are reported in Table 1. As in Benigno et al (2009) these values are set following the work of Mendoza (2002, 2008) and Kim and Ruhl (2008) to the extent possible, but also to facilitate the convergence of the numerical solution procedure.

We set the world interest rate to $i = 0.0159$, which yields an annual real rate of interest of 6.5 percent; a value that is between the 5 percent of Kehoe and Ruhl (2008) and the 8.6 percent of Mendoza (2008). The elasticity of intratemporal substitution between tradables and nontradables follows from Ostry and Reinhart (1992) who estimates a value of $\kappa = 0.760$ for developing countries.\footnote{There is considerable debate about the value of this parameter. The estimate we use is consistent with Kehoe and Ruhl (2005) who set this parameter to 0.5.} The value of $\delta$ is set to 1.193 to yield a steady state value for hours of 0.33 and implying a Frisch elasticity of labor of 2. For simplicity, the elasticity of intertemporal substitution is unitary ($\rho = 1$).

For simplicity, the labor share of production in the non-tradable sector is also assumed to be unitary ($\alpha = 1$). We then normalize steady-state tradable output to one (i.e., $Y_T = 1$) and set $\omega$ and $A$ to obtain a steady-state ratio of tradable to non-tradables output of 0.75 (slightly higher than Mendoza, 2002) and a unitary relative price of non-tradables in steady state (i.e., $P^N = 1$).

The tax rate on non-tradable consumption is fixed at $\tau = 0$ as a benchmark to compare the two allocations (CE and SP). Government spending and lump sum taxes are also set to zero.

We set $\beta = 0.98$ (implying an annual value of 0.92237) to obtain a foreign borrowing to GDP ratio of 50 percent on average in the stochastic simulations. This ratio is defined as total debt in a quarter divied by annual GDP.

The value of the credit constraint parameter ($\phi$) determines the probability of a sudden stop. We set this parameter to 0.7, which makes the constraint binding in the deterministic steady state and yields a realistic probability of sudden stop, as typically defined in the empirical literature. In the competitive equilibrium the unconditional probability of being
in a sudden stop is 2.8 percent. For this calculation a sudden stop is defined as the event in which the constraint becomes binding.

Finally, in our analysis, we focus on the behavior of the economy subject to only one stochastic shock, to the endowed tradeable output, which we model as an AR(1) process. Specifically, the shock process for tradable GDP is,

$$\varepsilon_t^T = \rho \varepsilon_{t-1}^T + v_t,$$

(12)

where $v_t$ is an iid $N(0, \sigma^2_\varepsilon)$ innovation. The parameters of this process are set to $\rho = 0.55^4$ and $\sigma_\varepsilon = 0.59^4$, which are the first autocorrelation and the standard deviation of total GDP reported by Mendoza (2008), respectively.

As parameterized, as Benigno et al (2009) show, the model produces a sharp reversal in capital flows, a large drop in output and consumption, and a large real exchange rate depreciation (proxied by the fall in the relative price of non-tradable goods) that is typical of a sudden stop. In this sense, our model is quantitatively capturing the sudden stop phenomena we observe in the data.

### 4.2 Solution

The solution to the competitive equilibrium follows from Benigno et al (2009). Here we summarize their solution procedure and explain how we compute the solution to the social planner problem.

The equilibrium of the model can be represented as a recursive dynamic programming problem summarized by the following Bellman equation:

$$V(b_t, B_t, \varepsilon_t^T, \tau) = \max_{B_{t+1}} \left\{ u(G_t - z(H_t)) + \exp(-\theta_t) E \left[ V(b_{t+1}, B_{t+1}, \varepsilon_{t+1}^T, \tau) | \varepsilon_t^T \right] \right\}. $$

(13)

The value function, $V(b_t, B_t, \varepsilon_t^T, \tau)$, depends on three state variables: individual borrowing ($b$), aggregate borrowing ($B$), and the stochastic shock to the tradable endowment ($\varepsilon_t^T$), as well as the value the policy instrument ($\tau$). In equilibrium, individual and aggregate borrowing must coincide, but from the perspective of the representative agent of our model the borrowing constraint is imposed at the individual level, taking relative prices as given. Our solution explicitly accounts for this feature of the model specification by treating aggregate and individual debt separately in the value function. Note that the value function also depends on the tax rate, $\tau$, but there is no active policy in the decentralized equilibrium, but rather a fixed value that, as we noted already, is set to $\tau = 0$. 

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A solution for the decentralized equilibrium defined above will be given by (i) a value function \( V(B_t, \varepsilon_T, \tau) \) and (ii) a set of laws of motion (hereafter, also called decision rules or policy functions) for aggregate borrowing \( (B = G^n_B(B, \varepsilon_T, \tau)) \), aggregate employment \( (H = G^n_H(B, \varepsilon_T, \tau)) \), and the relative price of the non-tradable good basket \( (P^N = G^n_{p,N}(B, \varepsilon_T, \tau)) \), and for government transfers \( (T = G^n_T(B, \varepsilon_T, \tau)) \) that satisfy the Bellman equation above. Note that while the value function depends on both individual and aggregate borrowing, the decision rules for all other endogenous variables only depend on aggregate borrowing. Since we set \( \tau = 0 \), the transfer function is also zero in the decentralized equilibrium.\(^{16}\)

Benigno (2009) provides a detailed description of the algorithm we use to solve for the competitive equilibrium. A key ingredient is a transformation of the system of Kuhn-Tucker conditions into a standard system of nonlinear equations that is due to Garcia and Zangwill (1981). The transformed system can then be solved using standard nonlinear equation solution methods.

To solve for the social planning problem we solve a dynamic programming problem. The programming problem is written as an optimization of the value function subject only to the resources constraints and borrowing constraints. In the problem, the planner chooses all quantities directly. Specifically the problem can be written as:

\[
\begin{aligned}
  v(B, e) = \max_{c_T, c_N, h, p, B'} \left\{ \frac{1}{1 - \rho} \left( (\omega c_T^\kappa + (1 - \omega) c_N^\kappa) \frac{1}{\kappa} - h^\delta \right)^{1 - \rho} + \beta E^e v(B', e') \mid e \right\} \\
  \text{subject to} \\
  c_T = (1 + r) B + e - B' \\
  c_N = Ah \\
  B' \geq -\frac{1 - \varphi}{\varphi} (e + pAh) \\
  p = \frac{1 - \omega}{\omega} \left( \frac{c_N}{c_T} \right)^{\kappa - 1}.
\end{aligned}
\]

We compute a solution to this problem numerically. The methods are standard. In particular, we use cubic splines to approximate the value function and we then solve the maximization problem using a feasible sequential quadratic programming routine.

\(^{16}\)For simplicity we will suppress the tax notation in describing the solution to the competitive equilibrium.
5 Competitive Equilibrium

The working of the competitive equilibrium is fully explained by Benigno et al (2009). Here we briefly present some of the same Figures with the slightly different calibration reported above.

We begin with the policy function for $B_t$, which is plotted in Figure 1. In this figure, each solid line depicts the policy function for $B_t$ conditional on a particular state of the tradable shock. For illustrative purposes, we report the decision rule for the worst state (State 1), and progressively better ones together with the 45 degree line (dashed black line) and the values of $B_t$ that satisfy the constraint exactly for each state (dashed colored lines). The figure shows that there are two ways for the constraint to bind strictly. First, if a bad state is received perpetually the economy would end up intersecting the 45 degree line at a point in which the constraint binds strictly. The economy remains at this point thereafter. Second, if the economy is currently at the intersection between the decision rule for a good state and the 45-degree line and receives a bad shock, the constraint can bind strictly on impact as the economy jumps to the corresponding new decision rule.

Figure 2 contains the policy rules for all other variables as a function of the endogenous state, $B_t$. The other relevant state is the shock. The policy function is drawn for the continued realization of the worst shock. All variables ($P_t^N$, $C_{N,t}$, $C_{T,t}$, $H_t$), follow a similar pattern. Before the constraint binds (to the right of the vertical line) the economy behaves in a seemingly linear manner as the negative shocks continue realize. Far from the constraint, a negative shock leads to a decrease in consumption and an increase in debt. Once the constraint is reached, the recession rules are driven by the need to meet the now binding constraint. The constraint forces tradable and non-traded consumption to drop dramatically as the relative price of non-tradable goods collapses. This is the sudden stop and the associated debt deflation.

An alternative way to see how the model works is to look at simulated data near a sudden stop. In Figure 3 we plot the average value (across 100,000 simulations) of debt, the relative price of non-traded goods, non-traded consumption, employment and total GDP, before and after the beginning of a sudden stop episode. As the economy approaches the sudden stop period, the amount foreign borrowing continues to increase to smooth consumption. But once the constraint binds, borrowing decreases suddenly and sharply. Associated with the sudden stop the model produces a dramatic fall in employment, traded and non-traded consumption, and the relative price of non-tradable goods.

The distribution of debt in the stochastic steady state of the model is an important part of understanding its properties and working. In Figure 4, we plot the ergodic distribution
of debt for economies with and without the constraint. For the economy with the constraint
the debt pdf is clearly to the right on the unconstrained version. That is, agents in this
model want to borrow much more than they can. They choose to live near the borrowing
constraint because this brings them closer to the debt they would have in an unconstrained
world (the first best scenario). As a benchmark for our welfare calculation, the gains of
removing completely the constraint in the benchmark economy are very large at 2.1 percent
of average lifetime consumption.

6 Quantifying Overborrowing

We can now compare the competitive equilibrium (CE) with the allocation chosen by a
social planner (a social planner equilibrium or SP for brevity), under alternative model
specifications and parameter assumptions.

Figure 5 plots the decision rule for $B_t$. This Figure shows that there is no overborrowing
before the constraint binds in the base model. If the constraint is not binding, the two
allocations essentially coincide. The comparison implies that the pecuniary externality
at work has a significant impact on the CE allocation only when the constraint binds. If
instead the constraint is binding, for each value of the endogenous state $B_t$, $B_{t+1}$ is always
smaller in the CE than in the SP.

Figure 6 compares the behavior of the other endogenous variables for the worst value
of the exogenous state $\varepsilon_t$ like in Figure 2. Consistent with Figure 5, the CE is uniformly
close to the SP when the constraint does not bind. When the constraint binds, instead,
employment and non-tradable consumption are higher in the CE than in the SP, while
tradable consumption and the relative price on tradable goods is lower. This shows that
the pecuniary externality at work has a significant impact on the CE allocation only when
the constraint binds. Key to the understanding of this is endogenous labor supply. As we
can see from equation (8), a binding constraint (or the expectation of a binding constraint
in the future) induces household to supply more labor than socially efficient. Agent supply
more labor to alleviate the constraint, but don’t internalize that higher labor supply implies
lower relative price, a tighter constraint, and hence a lower consumption. As a result,
employment (consumption of tradeable goods) in the competitive equilibrium allocation is
higher (lower) than the socially efficient level.

Figure 7 compares the ergodic distributions of $B_t$ in the two equilibria. It shows that
precautionary saving is higher in the CE than in the SP. The difference, however, is not

\[A \text{ small underborrowing appears also far away from the constraint. As we can see from Figure 7 below,}
\text{however, this is in a region of the state space that is not visited frequently in the stochastic steady state.}\]
large in terms of average level of debt as a ratio to annual GDP, at -0.53891282 in the CE and -0.56606002 in the SP, respectively. Despite the small difference in average borrowing, under the two distributions, the probability of having the constraint binding strictly is 2.8 percent of the simulated quarters in the CE, while in the SP it is only 0.7 percent. In the CE, in which agents do not internalize the impact of their decisions on the relative price, the value of the collateral is smaller, and hence the constraint is met more frequently. Consistent with this, the Figure also shows that the SP meets the constraint at a higher level of $B_t$, despite the larger precautionary saving in the CE.

Figure 8 compares the sudden stop dynamics in the CE and the SP. The fall in the relative price of non-tradable goods is much larger in the CE than in the SP because employment fall much less in the SP equilibrium. Note, however, that tradable consumption and output behave similarly in the two equilibria. As a result, the difference in the unconditional probability of a sudden stop, which is higher in the CE than in the SP does not have a large welfare impact, at about 0.01 percent of average lifetime consumption.

Consider now an endowment economy under alternative parameter values. Figure 9, Panel A compares the decision rule for $B_t$ in the CE and the SP when labor supply is exogenous, i.e., in a endowment economy, with parameter values that are the same as in the baseline production economy above, to the extent possible. As we can see, for these parameter values, there is essentially no difference between the CE and the SP allocation, either before or after the constraint binds, once we shut off endogenous labor supply. Figure 10, Panel A, indeed confirms that the two ergodic distributions are very close to each other. In an endowment economy with more impatient agents and larger shocks, the probability of sudden stop is about the same in the two economies, at 10.4 percent in the CE and 10.2 percent in the SP equilibrium respectively.

In Figure 9, Panel B, we consider the same endowment economy with a different parametrization in which agents are more impatient (i.e., the discount factor is lower at 0.91) and the shocks are larger, similarly to the assumptions made by Bianchi (2009). In this case, the decision rule for $B_t$ shows evidence of over-borrowing in the intermediate region of the state space. Consistent with this finding, Figure 10, Panel B shows that, in this particular case, overborrowing in normal times can indeed arise. In this endowment economy, the probability of sudden stop is much higher in the CE than in the SP, at 7 percent and 3 percent, respectively. In both economies these probabilities are lower because of the higher self insurance in the form of precautionary saving.

In sum, the analysis shows that overborrowing in the more general case of a production economy we consider is not present when the constraint does not bind. Only in an endowment economy with more impatient agents and larger shocks we find over borrowing when
before the credit constraint binds. We conclude from these experiments that overborrowing is a quantitative matter. In the next section we shall focus on the policy implications of this main finding.

7 Policy Implications

The analysis in the previous section has important policy implications. A recent literature reviewed in section 2 has focused on the theoretical and quantitative possibility of overborrowing, and strongly recommended prudential policies, such as a Tobin tax on capital inflows, to curtail it.

While consistent with a theoretical second best view of the world, that policy approach in practice is problematic. First, overborrowing is a quantitative matter and it is not clear that overborrowing is a relevant feature of emerging economies. Recommending taxation of financial transactions based on uncertain quantitative properties of models is not prudent. Such taxes are distortionary and should be avoided unless there is a very clear cut case that overborrowing is quantitatively relevant. As Nikolov (2009) has pointed out, in this environment there is a trade off between the higher volatility associated with higher leverage ratios and the lower average growth associated with lower leverage ratios. So mandating lower regulatory leverage ratios may impose significant efficiency costs in terms of lower average growth.

Second, the pros and cons of alternative policy regimes should be evaluated quantitatively in models that fit the data well, as it has been the case for more standard monetary policy rules. But rich models with occasionally binding financial frictions are not easily amenable to be analyzed quantitatively with the same ease with which standard macroeconomic stabilization issues are addressed. We need to recognize that the models are not yet ready to provide clear cut policy recommendations. But at the same time, we should also appreciate the enormous progress that is taking place in the academic literature on these issues and welcome the debate.

Third, the recommendation of ex-ante prudential policies is predicated on the basis of standard second best considerations. As such, a comparison with first best outcomes is necessary. Caballero (2009), for instance, argues that prudential policies may have some value but it does not substitute for policies to intervene ex post in response to the inevitable accidents. As Caballero (2009) notes the acute concern for the potential moral hazards associated with those policies has pushed the debate too far away from the question of what to do at the sudden stop. Not only may ex-post policies bring greater welfare gains, but ex-ante policies do not eliminate sudden stops, they may just lower their severity their
severity, but not necessarily their likelihood as our analysis highlights. Even with prudential policies in place, we would still need to design policies that can be implemented in response to sudden stops.

In Benigno at al (2009), we study optimal policy for intervening on the exchange rate before and after a possible sudden stop. The optimal policy problem set up explicitly allows for both ex-ante and ex-post intervention, as we search for an optimal policy rule for all states of the world. What we find in that analysis is that it is optimal, in Ramsey sense, to wait until the crisis hits before intervening with a distortionary tax instrument that can be interpreted as an intervention in the foreign exchange market. When the constraint is not binding, policy should not intervene. An important implication of this result is that stabilization policy in an economy with intermittent access to capital markets should be set as if the friction were not present when this is not binding, even though the constraint does potentially distort private sector behavior in the non-binding state. When the credit constraint is binding, optimal policy is to intervene to subsidize the price of non-tradable consumption and hence support the exchange rate. This subsidy increases demand for nontradable goods and the relative price of non-tradable goods. The increase in income increases collateral and alleviates the effects of the binding borrowing constraint. The intuition for these results is that the pecuniary externality that creates potential scope for policy action has no quantitatively sizable impact on the CE allocation if the constraint does not bind. As a result, our Ramsey planner does not intervene before the sudden stop occurs.

One important implication is that capital controls (as recently implemented by Brazil and advocated in some parts of the international policy community) may be welfare reducing. Ex post interventions, as predicated in Beningno et al (2009), seem preferable, based on the results of this analysis based on a more realistic production model.

A more difficult, but safer, avenue to follow for policy is to try to address the underlying source of financial friction. In the specific case of our model, this means strengthening domestic policies (more sustainable external positions, higher official reserve cushions) and institutions to allow foreign creditors to impose looser debt constraints.

But the details of the micro fundations may matter for the policy conclusions. In particular, there are no moral hazard concerns in our set up. Using these models for positive purposes, to describe the cycle or the crisis, or both, the micorfundations of financial friction matter less. For policy analysis, they can make a difference. For instance, moral hazard considerations may surface in a microfunded specification of our constraint. Once moral hazard of ex post policies is considered, the implication may be reversed and ex ante policies may become more clearly preferable. For instance, if one considers two-sided
commitment problems in models of default, such as in Cavallo, Chang, and Velasco (2009), the recommendation would be to adopt policies that facilitate creditors’ commitment to borrowers to alleviate the consequences of the credit friction. In practice, this means policies that facilitate the smooth functioning of international capital markets such as the defunct sovereign debt restructuring mechanism, the collective action clauses, and the international corporate debt restructuring mechanism that we should be talking about in light of the recent experience. That is, policy should be geared toward improving the stability of the international markets, rather than the climate in the receiving country. Both sets of policies should therefore be pursued at the same time. Indeed, studying overborrowing with fully micro-funded financial frictions is an important area of future research.

8 Conclusions

In this paper we study overborrowing in a production small open economy subject to an occasionally binding borrowing constraint that gives rise to a pecuniary externality. We found that while the competitive equilibrium is not constrained efficient, differences in allocations with respect to a socially planned equilibrium are small when the constraint does not bind. Significant differences when the constraint does not bind can arise only for endowment economies with specific parameter values. As we discuss in the paper, this finding has important policy implications and suggest the policy debate should focus on policy actions that can move the economy closer to the first best.
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Figure 1: Decision Rule For Foreign Borrowing (Competitive Equilibrium)
Figure 2: Decision Rules For Relative Prices, Consumption, Labor (Competitive Equilibrium)
Figure 3: Simulated Data (Competitive Equilibrium)

- **Output**: Graph showing output over time (t-4 to t+4).
- **Relative Prices**: Graph showing relative prices over time (t-4 to t+4).
- **Labor**: Graph showing labor over time (t-4 to t+4).
- **Non-Traded Consumption**: Graph showing non-traded consumption over time (t-4 to t+4).
Figure 4. Constrained and Unconstrained Economy
Figure 5: Decision Rule For Foreign Borrowing (Competitive Equilibrium and Social Planner)
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Figure 7: Ergodic Distribution For Foreign Borrowing (Competitive Equilibrium and Social Planner)
Figure 8: Simulated Data (Competitive Equilibrium and Social Planner)

Traded Consumption

Relative Prices

Non-Traded Consumption

Labor

- CE
- SP
Figure 9: Endowment economies: Decision Rule For Foreign Borrowing

Panel A. Base calibration

Panel B. Alternative calibration
Figure 10: Endowment Economies: Ergodic Distributions for Foreign Borrowing
Panel A. Base calibration

Panel B. Alternative calibration