Macroprudential vs. Ex-post Policies: when Domestic Taxes are Relevant for International Lenders

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Keywords: financial crisis; credit constraint; capital controls; macroprudential tax; exchange rate policy.

JEL Classification: H23, D62, F34, F41

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1 Introduction

Recently, financial crises have been analyzed in the context of an open economy which faces an occasionally binding financial constraint. The negative effect on welfare stems from the feedback between the presence of this constraint and the underestimation of the social cost of debt.

The standard constraint in these models indicates that the individual could borrow up to a proportion of her current income. It can be motivated (e.g. Korinek, 2010) as an incentive compatibility constraint that avoids losses for lenders when credit markets are subject to moral hazard problems. If borrowers decided to default, lenders could go to court; however, due to the existence of a non-seizable proportion of assets, lenders can recover at most a fraction of borrowers' income, and hence they are unwilling to lend beyond this fraction.

The related literature shows that ex-ante or macroprudential policies solves the externality problem by increasing the private cost of debt and equalizing it to the social cost (e.g. Korinek, 2010, 2011; Bianchi, 2011). Other papers (e.g. Benigno et al. 2013b, 2014) find that ex-post or crisis-management policies may be even more effective because they completely avoid crises by having a positive effect on the collateral's price and, in turn, increasing debt capacity.

These results are found assuming that government policies do not modify the configuration of the financial constraint. However, such policies entail imposing taxes or subsidies, altering disposable income and, in the end, debt repayment capacity. For instance, take a subsidy on consumption financed by a lump-sum tax. The subsidy alters borrowers' planned expenditure, affecting ultimately debt decisions. This effect is captured by the standard constraint through changes in the debt level. However, the lump-sum tax reduces debtor's available income, a fact not captured by the standard constraint. By going to court, the lender recovers only a fraction of disposable income, since taxes must be paid to the government.

We analyze financial crises using a standard framework but modifying the financial constraint to consider that lenders incorporate the effect of taxes on debt capacity. As a result, we find that ex-post policies (e.g. exchange rate interventions) are ineffective to manage crises while macroprudential policies (e.g. a tax on debt) still correct the externality in a decentralized economy. Although an exchange rate intervention increases the price of collateral by subsidizing consumption, this subsidy is returned to the government by transfers and, in the end, does not affect borrowing capacity. Instead, a macroprudential tax, under the modified financial constraint, still increases the private cost of debt.

2 The Model and Results

A continuum of mass one of identical households maximize the utility function[1]

$$U = E_1 \left[\sum_{t=1}^{\infty} \beta^t u\left(C_t\right) \right] \tag{1}$$

where β is the discount factor, $u(\cdot)$ is the period utility function and C_t is the consumption index which aggregates tradable (T) and nontradable (N) goods

$$C_t = C\left(C_t^T, C_t^N\right) \tag{2}$$

Every period, each household receives a stochastic bundle of tradable and nontradable goods, Y_t^T and Y_t^N, and has access to international financial markets through one-period bonds B_{t+1} ($B_{t+1} < 0$ implies debt) at an interest rate r ($R \equiv 1 + r$). The budget constraint, in units of tradable goods, is:

$$C_t^T + P_t^N C_t^N - RB_t = Y_t^T + P_t^N Y_t^N - B_{t+1} \tag{3}$$

where P_t^N is the price of nontradables and the price of tradables has been normalized to one. $1/P_t^N$ is interpreted as the real exchange rate.

The first order conditions for the problem related to Equations (1)-(3), in the absence of a credit constraint (i.e. the 'never-constrained' economy), with respect to C_t^T, C_t^N and B_{t+1} are, respectively:

$$u'\left(C_t\right) \frac{\partial C_t}{\partial C_t^T} = \mu_t \tag{4}$$

$$u'\left(C_t\right) \frac{\partial C_t}{\partial C_t^N} = P_t^N \mu_t \tag{5}$$

$$\mu_t = \beta R E_t \left[\mu_{t+1}\right] \tag{6}$$

where μ_t is the budget constraint's Lagrange multiplier. The market-clearing conditions for nontradables and tradables are, respectively:

$$C_t^N = Y_t^N \tag{7}$$

$$C_t^T - RB_t = Y_t^T - B_{t+1} \tag{8}$$

Since C_t^N is determined by Equation (7), the solutions for the other endogenous variables of the never-constrained economy (denoted with the superscript $*$, i.e. C_t^{T*}, μ_t^*, B_{t+1}^* and P_t^{N*}) are obtained from the following system, given the state characterized by $\left\{B_t, Y_t^T, Y_t^N\right\}$:

[1] For notational clarity, we omit the subscript i but all choices are made at the household level.

$$\left[u'\left(C_t^*\right)\frac{\partial C_t^*}{\partial C_t^{T*}}\right]_{C_t^N=Y_t^N}=\mu_t^* \tag{9}$$

$$\mu_t^*=\beta R E_t\left[\mu_{t+1}^*\right] \tag{10}$$

$$B_{t+1}^*=Y_t^T-C_t^{T*}+RB_t \tag{11}$$

$$P_t^{N*}=\left[\frac{\partial C_t^*/\partial C_t^N}{\partial C_t^*/\partial C_t^{T*}}\right]_{C_t^N=Y_t^N} \tag{12}$$

where Equation (12) is derived from Equations (4) and (5). Notice that we can solve for C_t^{T*}, μ_t^* and B_{t+1}^* using Equations (9)-(11), and then for P_t^{N*} using Equation (12).

We now incorporate the standard financial constraint widely used in the literature, i.e. there is access to credit up to a fraction κ of current income:

$$-B_{t+1}\leq\kappa\left(Y_t^T+P_t^N Y_t^N\right) \tag{13}$$

With this additional restriction, we introduce λ_t, the associated Lagrange multiplier. For this model, the solution for C_t^T, μ_t, λ_t, B_{t+1} and P_t^N can be obtained (given $\left\{B_t,\, Y_t^T,\, Y_t^N\right\}$) from:

$$\left[u'\left(C_t\right)\frac{\partial C_t}{\partial C_t^T}\right]_{C_t^N=Y_t^N}=\mu_t \tag{14}$$

$$\mu_t=\lambda_t+\beta R E_t\left[\mu_{t+1}\right] \tag{15}$$

$$B_{t+1}=Y_t^T-C_t^T+RB_t \tag{16}$$

$$P_t^N=\left[\frac{\partial C_t/\partial C_t^N}{\partial C_t/\partial C_t^T}\right]_{C_t^N=Y_t^N} \tag{17}$$

$$\lambda_t\left(B_{t+1}+\kappa\left(Y_t^T+P_t^N Y_t^N\right)\right)=0 \tag{18}$$

If, in period t, the economy is unconstrained, $\lambda_t=0$ and hence, from Equation (18), $B_{t+1}\leq-\kappa\left(Y_t^T+P_t^N Y_t^N\right)$. If, instead, the economy is constrained, $\lambda_t\geq0$ and $B_{t+1}=-\kappa\left(Y_t^T+P_t^N Y_t^N\right)$.

As in the related literature, we interpret constrained periods as 'crisis' periods. The underestimation of the social cost of debt has distortionary consequences, and hence government intervention may improve social welfare.

2.1 Ex-post policy

Suppose the government imposes a subsidy $\tau_t<0$ (effective only when, in the absence of it, there would be crisis) on nontradable consumption, which is returned by the household through a lump-sum tax T_t. Similarly to Benigno et al. (2013b, 2014), we interpret this policy as an exchange rate intervention.

The new budget constraint is

$$C_t^T + P_t^N (1+\tau_t) C_t^N - RB_t = Y_t^T + P_t^N Y_t^N + T_t - B_{t+1} \tag{19}$$

There is a balanced-budget fiscal policy every period:

$$T_t = \tau_t P_t^N C_t^N \tag{20}$$

We show that, similarly to Benigno et al. (2014), τ_t allows the government to achieve the never-constrained allocation.

Proposition 1 *If there exists a solution for a never-constrained economy described by Equations (1)-(3), then for an economy with financial constraint described by Equations (1), (2), (13), (19) and (20) there exists a value of τ_t, for every t, such that the economy achieves the never-constrained allocation.*

Proof. Suppose the statement is false, and hence it is not possible to find a value of τ_t consistent with the solution of the equation system of a never-constrained economy.

For the economy with financial constraint, the system that solves for C_t^T, μ_t, B_{t+1} and P_t^N when assuming that it will never be constrained thanks to the subsidy is:

$$\left[u'(C_t) \frac{\partial C_t}{\partial C_t^T} \right]_{C_t^N = Y_t^N} = \mu_t \tag{21}$$

$$\mu_t = \beta R E_t \left[\mu_{t+1} \right] \tag{22}$$

$$B_{t+1} = Y_t^T - C_t^T + RB_t \tag{23}$$

$$P_t^N = (1+\tau_t)^{-1} \left[\frac{\partial C_t / \partial C_t^N}{\partial C_t / \partial C_t^T} \right]_{C_t^N = Y_t^N} \tag{24}$$

Equations (21)-(23) are equivalent to the ones in the never-constrained economy, Equations (9)-(11). Since we can solve for C_t^T, μ_t and B_{t+1} independently of P_t^N, the solution implies that $C_t^T = C_t^{T*}$, $\mu_t = \mu_t^*$ and $B_{t+1} = B_{t+1}^*$. Therefore, for the proposition being false, any value of τ_t should be inconsistent with this solution, i.e. the financial constraint must be binding. However, by substituting the equation for P_t^N into the financial constraint (13):

$$-B_{t+1}^* < \kappa \left(Y_t^T + (1+\tau_t)^{-1} Y_t^N \left[\frac{\partial C_t^* / \partial C_t^N}{\partial C_t^* / \partial C_t^{T*}} \right]_{C_t^N = Y_t^N} \right) \tag{25}$$

and solving for τ_t:

$$\begin{aligned} \text{if } \kappa Y_t^T &> -B_{t+1}^*, \quad \tau_t > -1 \\ \text{if } \kappa Y_t^T &< -B_{t+1}^*, \quad \tau_t \in (-1, \widetilde{\tau}_t) \\ \text{where } \widetilde{\tau}_t &= -\left(1 + \frac{Y_t^N \left[\frac{\partial C_t^*/\partial C_t^N}{\partial C_t^*/\partial C_t^{T*}}\right]_{C_t^N = Y_t^N}}{Y_t^T + B_{t+1}^*/\kappa}\right) \end{aligned}$$

Any τ_t satisfying this condition allows the decentralized economy to achieve the never-constrained allocation. ■

This result implies not only that the government could avoid crises but also that it can boundlessly increase the economy's debt capacity: it tends to infinity when $\tau_t \to -1$ (from Equation (25)). This analysis implicitly assumes that lenders overlook that households have to pay taxes, which affects their debt repayment capacity. If, instead, lenders incorporate this fact, a more appropriate constraint is:

$$-B_{t+1} \leq \kappa \left(Y_t^T + P_t^N Y_t^N + T_t\right) \tag{26}$$

We show that when the financial constraint is (26), ex-post intervention is completely ineffective.

Proposition 2 *In the economy described by Equations (1), (2), (19), (20) and (26), a subsidy on nontradable consumption τ_t has no impact on the equilibrium values of C_t^T, μ_t, λ_t and B_{t+1}.*

Proof. Suppose the economy is initially constrained. The first three equations of the system, (14)-(16), remain the same. The financial constraint is binding, i.e. $-B_{t+1} = \kappa \left(Y_t^T + P_t^N Y_t^N + T_t\right)$ and the equation for P_t^N is

$$P_t^N = (1+\tau_t)^{-1} \left[\frac{\partial C_t/\partial C_t^N}{\partial C_t/\partial C_t^T}\right]_{C_t^N = Y_t^N} \tag{27}$$

Substituting Equations (7) and (20) into (26) yields

$$-B_{t+1} = \kappa \left(Y_t^T + (1+\tau_t)\, P_t^N Y_t^N\right) \tag{28}$$

By substituting Equation (27) into (28) we obtain:

$$-B_{t+1} = \kappa \left(Y_t^T + Y_t^N \left[\frac{\partial C_t/\partial C_t^N}{\partial C_t/\partial C_t^T}\right]_{C_t^N = Y_t^N}\right)$$

which is equivalent to the equation that results from (17) and (18), when the economy is constrained. Therefore, the equilibrium values of C_t^T, μ_t, λ_t and B_{t+1} for this economy are exactly the same as those obtained from the model without τ_t, Equations (14)-(18). ■

With the financial constraint being (26), exchange rate interventions not only cannot avoid crises but also leave completely unaltered the constrained economy.

2.2 Social Planner Equilibrium

Since private agents have an insignificant impact on the market, they take prices as given. Instead, a benevolent Social Planner (SP), subject to the same financial constraint, internalizes the effect of borrowing decisions on prices. By following the constrained-efficiency criterion[2], we assume that the SP is constrained by the same pricing rule of the competitive equilibrium, and therefore it acknowledges the effect of consumption decisions on Equation (17).

The first order conditions for the SP problem are (in addition to the pricing rule (17) and conditions (7), (8)):

$$\left[u'\left(C_t^{SP}\right)\frac{\partial C_t^{SP}}{\partial C_t^{T,SP}}\right]_{C_t^N=Y_t^N}+\lambda_t^{SP}\psi_t^{SP}=\mu_t^{SP} \tag{29}$$

$$\mu_t^{SP}=\lambda_t^{SP}+\beta R E_t\left[\mu_{t+1}^{SP}\right] \tag{30}$$

$$\lambda_t^{SP}\left(B_{t+1}^{SP}+\kappa\left(Y_t^T+\left[\frac{\partial C_t^{SP}/\partial C_t^N}{\partial C_t^{SP}/\partial C_t^{T,SP}}\right]_{C_t^N=Y_t^N}Y_t^N\right)\right)=0 \tag{31}$$

where $\psi_t^{SP}\equiv\frac{\partial\left(\left[\frac{\partial C_t^{SP}/\partial C_t^N}{\partial C_t^{SP}/\partial C_t^{T,SP}}\right]_{C_t^N=Y_t^N}\right)}{\partial C_t^{T,SP}}\kappa Y_t^N$.

As previous literature shows (e.g. Bianchi, 2011; Korinek, 2011; Parra-Polania and Vargas, 2015), the SP improves social well-being by choosing a lower level of debt, enhancing future borrowing capacity and therefore mitigating the negative amplification effects of previous debt on the economy under crisis.

The SP planner equilibrium is implemented in a decentralized economy using a macro-prudential tax (i.e. triggered in normal times only) on debt.

2.3 Macro-prudential Policy

Suppose the government, in the decentralized economy, imposes a macroprudential tax $\omega_t < 0$ on debt ($\omega_t = 0$ when the economy is constrained), which is returned to the household through a lump-sum transfer T_t. The budget constraint in financially unconstrained periods is

$$C_t^T+P_t^N C_t^N-RB_t=Y_t^T+P_t^N Y_t^N+T_t-B_{t+1}\left(1+\tau_t\right) \tag{32}$$

[2] See Kehoe and Levine (1993) and Lorenzoni (2008).

Theres is a balanced-budget fiscal policy every period:

$$T_t = \omega_t B_{t+1} \tag{33}$$

We show a common result in the related literature when using the standard financial constraint: ω_t implements the SP allocation in a decentralized economy.

Proposition 3 *In the economy described by Equations (1), (2), (13), (32) and (33) there exists a value of ω_t, such that the SP allocation is implemented in the decentralized economy.*

Proof. When the economy is constrained ($\lambda_t \geq 0$, $\omega_t = 0$), we solve for $C_t^{T,SP}$ and B_{t+1}^{SP} from Equations (31) and (8). Solutions are exactly equal to those of C_t^T and B_{t+1} that solve the system (16)-(18) for a given state $\{B_t, Y_t^T, Y_t^N\}$. Consequently, when the economy is financially constrained, the SP allocation coincides with the decentralized-economy allocation ($C_t^{T,SP} = C_t^T$ and $B_{t+1}^{SP} = B_{t+1}$). However, the valuation of liquidity differs: by comparing Equations (29) and (14),

$$\mu_t = \mu_t^{SP} - \lambda_t^{SP} \psi_t^{SP} \tag{34}$$

and hence the SP valuation of liquidity, under crisis, is greater: $\mu_t^{SP} \geq \mu_t$. In unconstrained periods ($\lambda_t = 0$), if there were no tax, although Equations (29), (30) and (8) are of the same form as those for the decentralized economy, (14)-(16), they do not produce the same equilibrium, due to the difference in the valuation of liquidity during crisis, i.e. $E_t\left[\mu_{t+1}^{SP}\right] \neq E_t\left[\mu_{t+1}\right]$. To equalize these equilibria, we introduce a tax ω_t on debt such that

$$\frac{E_t\left[\mu_{t+1}\right]}{1+\omega_t} = E_t\left[\mu_{t+1}^{SP}\right] \tag{35}$$

Let ρ_t^{SP} denote the crisis probability[3] for the SP. Since ω_t implements the SP allocation, the crisis probability will be equal for both cases, i.e. $\rho_t = \rho_t^{SP}$. Hence

$$E_t\left[\mu_{t+1}\right] = \left(1 - \rho_{t+1}^{SP}\right) \mu_{t+1}^{UE,SP} + \rho_{t+1}^{SP} \mu_{t+1}^{CE} \tag{36}$$

where the superscript UE refers to the unconstrained economy and CE to the constrained economy and we have also taken into account that ω_t makes $\mu_{t+1}^{UE} = \mu_{t+1}^{UE,SP}$ (since τ_t equalizes both equilibria, in normal times). The relation between μ_{t+1}^{CE} and $\mu_{t+1}^{CE,SP}$ is expressed by

[3] Each period, given a value of B_t^{SP}, there is a desired value of B_{t+1}^{SP} and $C_t^{T,SP}$, for each pair (Y_t^T, Y_t^N). Therefore ρ_t^{SP} represents the probability that $-B_{t+1}^{SP}(Y_t^T, Y_t^N) > \kappa\left(Y_t^T + Y_t^N\left[\frac{\partial C_t^{SP}(Y_t^T, Y_t^N)/\partial C_t^N}{\partial C_t^{SP}(Y_t^T, Y_t^N)/\partial C_t^{T,SP}(Y_t^T, Y_t^N)}\right]_{C_t^N = Y_t^N}\right)$.

Equation (34). Using Equations (30) and (34)-(36) we find that

$$\omega_t = -\frac{\rho_{t+1}^{SP}\lambda_{t+1}^{SP}\psi_{t+1}^{SP}}{E_t\left[\mu_{t+1}^{SP}\right]} = -\frac{\beta R\rho_{t+1}^{SP}\lambda_{t+1}^{SP}\psi_{t+1}^{SP}}{\mu_t^{SP}} \tag{37}$$

makes the decentralized equilibrium equal to that of the SP, in normal times, and hence implements the SP allocation in the decentralized economy. ■

This result still holds when lenders consider the effect of taxes on available income:

Proposition 4 *In the economy described by Equations (1), (2), (26), (32) and (33), the SP allocation is implemented in the decentralized economy by imposing a macroprudential tax on debt satisfying (37).*

Proof. The only change in this economy, relative to the one in Proposition (3), is the inclusion of $T_t = \omega_t B_{t+1}$ in the financial constraint. As $\omega_t = 0$ during crises, there is neither change in the corresponding equation system in those periods nor in the crisis probability (see the definition in footnote 3). In normal times, the financial constraint is different, but it is not a relevant equation for the corresponding system. ■

3 Conclusion

We modify the financial constraint, in an otherwise standard framework, to consider that lenders incorporate the effect of taxes on debt capacity. As a result, we find that ex-post policies are ineffective for managing crises while macroprudential policies preserve their ability to correct the underestimation of the social cost of debt.

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