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

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Abstract

We argue that international lenders take into account that taxes (or subsidies) affect borrowers' income available for debt repayments. Using an endowment-economy model, we show that by incorporating this fact into the analysis of financial crises from the pecuniary externality perspective, ex-post interventions are completely ineffective to manage crises and, instead, ex-ante capital controls are useful for correcting the externality that stems from the underestimation of the social costs of decentralized debt decisions.

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

JEL Classification: H23, D62, F34, F41

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1 Introduction

In a recent strand of literature, based on a now common theoretical framework proposed by Mendoza (2002), financial crises are studied from a pecuniary externality perspective in which the negative effects arise from the combination of the fact that private agents do not internalize the contribution of their debt decisions to prices and the presence of an occasionally binding credit constraint.

The crisis of 2008 has brought a renewed interest among academics and policy makers on the benefits of macroprudential policies and restrictions on capital flows as a way to mitigate the effects of financial crises, specially in emerging economies. Most of the theoretical literature on this subject intends to give a welfare foundation to the role of capital controls and ex-ante interventions (e.g., Korinek, 2010, 2011; Bianchi, 2011). Benigno et al. (2013a), in the context of a production small open economy, find that both ex-ante and ex-post interventions are needed, although ex-post policies entail larger welfare gains than ex-ante policies do. Benigno et al. (2013b, 2014) discuss the effectiveness of ex-ante and ex-post interventions and show that a credible commitment to ex-post policies always welfare-dominates ex-ante interventions, as they can achieve the unconstrained allocation (i.e. crises can be avoided).

In this series of papers, the standard credit constraint is expressed in such a way that the amount that can be borrowed (D_t) is limited to a fraction (κ) of the borrower's current income (Y_t):

$$D_t \leq \kappa Y_t$$

This constraint can be motivated (e.g. Korinek, 2010) as an incentive compatibility constraint that avoids losses for lenders when financial markets are subject to moral hazard problems. If, for any reason, borrowers decided to default, international lenders could go to court; however, due to imperfect legal enforcement or, say, the existence of a non-seizable proportion of assets, lenders can recover at most a fraction (κ) of borrowers' income. As a consequence, domestic agents can borrow only up to the amount that lenders can be sure they would recover in case of default.

The standard credit constraint could be modified to take into account that, in practice, in assessing the borrowing capacity, lenders consider other variables[1] such as the expected future income or outstanding debt. These changes may introduce computational difficulties for solving models and therefore, in general, the credit constraint is kept in its standard form for the sake of simplicity or model tractability. However, in some scenarios, the form of this constraint is crucial to determine the effectiveness of a policy action.

As in the papers mentioned above, different policies have been analyzed in order to check whether or not the government can correct the externality or even to prevent crises. It has

[1] For instance, in a model in which borrowers may rationally choose not to repay debt, Eaton and Gersovitz (1981) show that the benefits of default increase with the size of outstanding debt.

been common practice to analyze the effect of these policies as if the financial constraint were immune to those policies. However, they often imply imposing taxes or subsidies, and therefore may affect disposable income and, in turn, debt repayment capacity. For instance, consider an economy in which the government subsidizes private consumption and finance this action through a lump-sum tax on private agents. The subsidy will have an effect on the borrowers' planned expenditure which in the end affects debt decisions. This effect is already incorporated into the standard constraint through changes in the level of debt D_t. However, this constraint does not consider the fact that the lump-sum tax reduces the disposable income of debtors. The lender knows that if he goes to court when a borrower defaults, he can recover a fraction of seizable income since taxes must be discounted to be paid to the government.

In this document, we show that by appropriately modifying the financial constraint so that it depends on disposable income, the exchange rate policy becomes ineffective to manage crises, and instead capital controls do implement the social planner allocation.

2 The Model and Results

We use a standard theoretical framework widely used for the analysis of financial crises and capital controls in a small open economy subject to an ocassionally-binding credit constraint.

A continuum of mass one of identical households maximize the utility function[2]

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

where β is the discount factor, $u\left(\cdot\right)$ 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. Households also have access to the international financial market 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, expressed 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 nontradable goods and the price of tradable goods has been normalized to one. $1/P_t^N$ can be interpreted as the real exchange rate.

The first order conditions for the problem related to Equations (1)-(3), in the absence of a

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

credit constraint (and hence we refer to it as the 'never-constrained' economy), with respect to C_t^T, C_t^N and B_{t+1} are, respectively:

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

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

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

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

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

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

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

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

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

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

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

where Equation (12) was obtained 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 we can solve for P_t^{N*} using Equation (12).

To introduce the ocasionally-binding financial constraint we assume that access to international financial markets is imperfect, and therefore there is limited access to credit up to a fraction κ of current income:

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

This is the standard financial constraint widely used in the literature. With this additional restriction, we introduce an additional variable, λ_t, the Lagrange multiplier associated with

this constraint. For this model, the solution for C_t^T, μ_t, λ_t, B_{t+1} and P_t^N can be obtained from the following equation system (given $\left\{B_t,\, Y_t^T,\, Y_t^N\right\}$):

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

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

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

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

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

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 in that period, $\lambda_t\geq 0$ and $B_{t+1}=-\kappa\left(Y_t^T+P_t^N Y_t^N\right)$.

Like in the related literature, we interpret those periods in which the economy is constrained as 'crisis' periods. The presence of the financial constraint and the private underestimation of the social cost of debt decisions have distortionary consequences for the decentralized equilibrium, and hence the government intervention may improve social welfare. The government may adopt ex-post (crisis management) or ex-ante (macroprudential) policies.

2.1 Ex-post policy

Suppose that the government imposes a subsidy $\tau_t<0$ (which is only effective when, in the absence of such subsidy, 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

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

The government follows a balance-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), the government can use the subsidy on consumption 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 subsidy on nontradable consumption, τ_t, for every period t, such that the decentralized economy achieves C_t^{T*}, μ_t^* and B_{t+1}^* (and hence the economy is never constrained).

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

For the economy with financial constraint described in the proposition, the system of equations 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:

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

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

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

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

Notice that Equations (21)-(23) are the same as the original 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 $B_{t+1}=B_{t+1}^*$. Then, 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 in 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:

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

we find that any τ_t that satisfies this condition allows the decentralized economy to achieve the never-unconstrained allocation. ■

The above result implies not only that the government is able to avoid crises but also that if it were its purpose to maximize the debt capacity of the economy, it could do it without limit: from Equation (25) it follows that when the subsidy approaches -1, the debt capacity of the economy tends to infinity. This analysis implicitly assumes that international lenders

suffer from a sort of fiscal illusion since they do not take into account that at the moment of debt repayment households have to pay taxes and this reduces their income available for debt repayments. If lenders incorporate this fact, it seems more appropriate to consider the following financial constraint:

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

The next proposition shows that if the credit constraint is instead represented by Equation (26) the exchange rate intervention is then 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}, and hence the government cannot use such subsidy to implement the never-constrained allocation.*

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

With a financial constraint of the form in Equation (26), the exchange rate intervention not only cannot avoid crises but also does not affect the constrained economy at all.

2.2 Social Planner Equilibrium

Since private agents have an insignificant impact on the market, they make decisions taking prices as given. Instead, a benevolent Social Planner (SP) with restricted planning abilities

(i.e. the SP is subject to the same financial constraint as private agents) internalizes the effect of borrowing decisions on prices. By following the constrained-efficiency criterion[3], we assume that the SP is constrained by the same pricing rule of the competitive equilibrium, and therefore it takes into account the effect of his consumption decisions on Equation (17).

The first order conditions for the SP problem are (in addition to the pricing rule (17) and the market-clearing conditions (7) and (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 has shown (e.g. Bianchi, 2011; Korinek, 2011; Parra-Polania and Vargas, 2015), the SP improves social well-being by choosing a lower level of debt to enhance future levels of liquidity and borrowing capacity and therefore to mitigate the negative amplification effects of previous debt on the economy under crisis. The SP planner equilibrium can be implemented in a decentralized economy by means of a macro-prudential tax (i.e. only effective in normal times) on debt.

2.3 Macro-prudential Policy

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

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

The government follows a balance-budget fiscal policy every period:

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

The next proposition shows a standard result in the related literature when using the standard financial constraint: a macroprudential tax τ_t on debt implements the SP allocation in a decentralized economy.

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

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

Proof. First, notice that when the economy is constrained ($\lambda_t \geq 0$, $\tau_t = 0$), we can solve for $C_t^{T,SP}$ and B_{t+1}^{SP} from Equations (31) and (8). These are exactly the same as those values of C_t^T and B_{t+1} that solve the system (16)-(18), for a given state $\left\{B_t, Y_t^T, Y_t^N\right\}$. This shows that, 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 normal (unconstrained) periods ($\lambda_t = 0$), if there were no tax, although Equations (29), (30) and (8) (for the SP) 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 implement the SP allocation in the decentralized economy, we introduce a tax τ_t on debt such that:

$$(1+\tau_t)\left[u'\left(C_t\right)\frac{\partial C_t}{\partial C_t^T}\right]_{C_t^N = Y_t^N} = \lambda_t + \beta R E_t\left[u'\left(C_{t+1}\right)\frac{\partial C_{t+1}}{\partial C_{t+1}^T}\right] \tag{35}$$

(from (14) and (15)) becomes equal to:

$$\left[u'\left(C_t^{SP}\right)\frac{\partial C_t^{SP}}{\partial C_t^{T,SP}}\right]_{C_t^N = Y_t^N} + \lambda_t^{SP}\psi_t^{SP} = \lambda_t^{SP} + \beta R E_t\left[u'\left(C_{t+1}^{SP}\right)\frac{\partial C_{t+1}^{SP}}{\partial C_{t+1}^{T,SP}} + \lambda_{t+1}^{SP}\psi_{t+1}^{SP}\right] \tag{36}$$

(from (29) and (30)). It can be verified that the expression for such tax is[4]

$$\tau_t = \frac{\lambda_t\psi_t - \beta R E_t\left[\lambda_{t+1}\psi_{t+1}\right]}{u'\left(C_t\right)\frac{\partial C_t}{\partial C_t^T}} \tag{37}$$

■

Now we show that if lenders take into account the effect of taxes on income available for debt repayments, the expression for the macroprudential tax τ_t that implements the SP allocation in a decentralized economy does not change.

Proposition 4 *In the economy described by Equations (1), (2), (26), (32) and (33) the government can implement the SP allocation in the decentralized economy by imposing a*

[4] Take into account that $\psi_t^{SP} = \psi_t$, $\lambda_t^{SP} = \lambda_t$ and $\lambda_{t+1}^{SP} = \lambda_{t+1}$ because τ_t is equalizing the equilibria.

macroprudential tax on debt that satisfies (37).

Proof. Notice that the only change in this economy, with respect to the one in the previous proposition, is the inclusion of $T_t = \tau_t B_{t+1}$ in the financial constraint. As $\tau_t = 0$ during crises, there is neither change in the corresponding equation system in those periods nor in the probability of crisis.[5] In normal times, the financial constraint is different, but it is not a relevant equation for the corresponding system. ■

3 Conclusion

Previous literature has studied financial crises in the context of an open economy which faces an occasionally binding financial constraint. When the constraint is binding, limited access to credit forces agents to reduce consumption. The negative effect on welfare becomes greater due to the feedback between the presence of the constraint and the fact that private agents do not internalize the contribution of their debt decisions to prices. Under such circumstances, there may be room to improve social welfare by government interventions.

Some papers (e.g. Korinek, 2010, 2011; Bianchi, 2011; Parra-Polania and Vargas, 2015) show that ex-ante or macroprudential policies (e.g. a tax on debt in normal times) can correct the externality that arises from the underestimation, by private agents, of the social cost of debt. A macroprudential tax increases the private cost of debt and makes it equal to the social cost. Other papers (e.g. Benigno et al. 2013b, 2014) also find that ex-post or crisis-management policies (e.g. an exchange rate intervention) may be even more effective because they completely avoid crises rather than only preventing the greater impact that results from the abovementioned externality. An exchange rate intervention has a positive effect on the price of collateral and, in turn, increases debt capacity.

The above results are found under the assumption that government policies do not alter the configuration of the financial constraint. However, such policies imply imposing taxes or subsidies which affect disposable income, and thus debt repayment capacity. If a borrower defaults, the lender knows that if he goes to court he will recover a fraction of seizable income because taxes must be discounted to be paid to the government.

The present paper analyzes financial crises in the context of a standard framework but modifies the financial constraint to consider that, in assessing debt capacity, lenders take into account that taxes affect the seizable income of borrowers. As a result of this change, we find that ex-post policies are totally ineffective while macroprudential policies preserve their ability to correct the externality in a decentralized economy. Although an exchange rate intervention

[5] 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 the probability of crisis is the probability that $-B_{t+1}^{SP}(Y_t^T, Y_t^N) > \kappa\left(Y_t^T + Y_t^N\left[\frac{\partial C_t^{SP}(Y_t^T,Y_t^N)/\partial C_t^N}{\partial C_t^{SP}(Y_t^T,Y_t^N)/\partial C_t^{T,SP}(Y_t^T,Y_t^N)}\right]_{C_t^N=Y_t^N}\right)$ occurs.

increases the price of collateral by subsidizing consumption, this subsidy is returned to the government by transfers and, in the end, there is no effect on borrowing capacity. Instead, a macroprudential tax on debt, under the modified financial constraint, is still able to increase the cost of debt for private agents.

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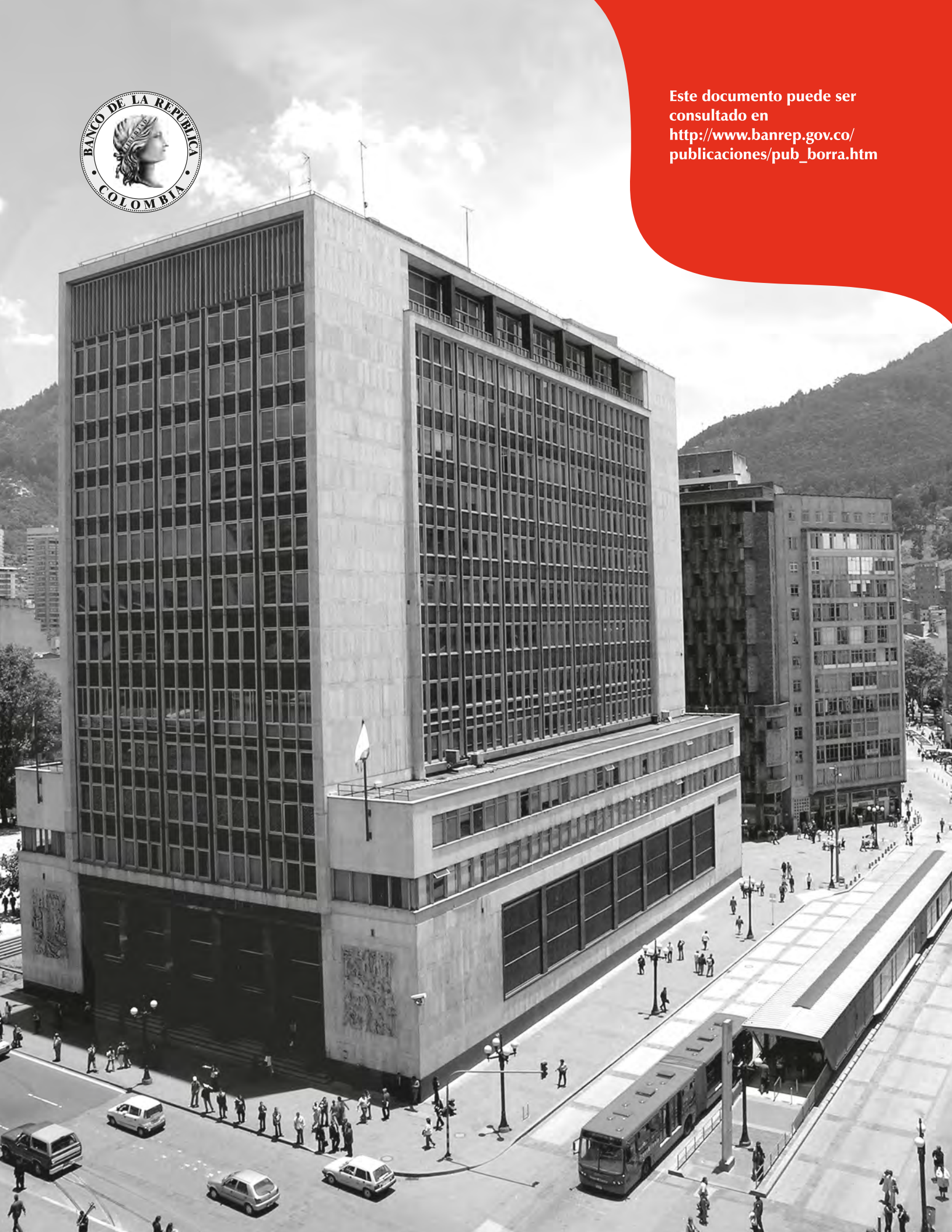

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