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Inflation, Debt, and Default in a Monetary Union

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Abstract

Depending on the preferences of the central bank, countries in a monetary union tend to accumulate less debt. This reduces the need for fiscal criteria such as debt ceilings. In a monetary union with an independent central bank and a sufficiently large number of relatively small members, investors will begin rationing credit to the government more rapidly, and an equilibrium with no inflation and no default exists. However, highly-indebted countries are more likely to default once they join a monetary union.

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I. Introduction

Monetary unions, currency boards, or dollarization have recently been introduced in a number of countries. Theoretical and empirical analyses have shown that such a regime switch may limit inflation, lower risk premia, and have positive budgetary implications. However, the existing literature has often neglected the endogeneity of other variables, such as the default risk, to the monetary regime. In fact, default may under some circumstances replace inflation and therefore limit the beneficial effects of the new monetary regime. The main point of this paper is to define the conditions under which such a regime switch can have negative implications and to determine the impact of the regime shift on the dynamics of public debt.

A level of debt that is sustainable under one monetary regime may not be sustainable under another. The dynamics of the public debt are intimately linked to the institutional environment regulating the relationship between the central bank and the government, insofar as that relationship affects inflation. Altering this relationship through monetary integration, a fixed exchange rate regime, a currency board, dollarization, or increased central bank independence is likely to affect highly-indebted countries in several ways. First, the cost of servicing the debt may increase. Second, rolling over the debt can become difficult because the existing stock of debt may be unsustainable under the new monetary regime. In this case the government has three options: tax increases, default, or inflating the debt away. Two examples from very different countries and eras illustrate this point. In 1843, eight U.S. states defaulted after a period of increasing debt accumulation. The defaults were the consequence of an abrupt decline in inflation in 1839, followed by a long period of deflation.[1] And following Brazil's real stabilization program in 1995, many Brazilian states experienced a serious fiscal crisis because they could not adjust to the low-inflation environment achieved by the program.[2] In both cases unwillingness or inability to pay resulted in a row of default.

The design of European monetary integration also illustrates this point—and it is with European monetary integration that this paper primarily concerns itself. In setting up the monetary union, policymakers were concerned primarily with securing price stability and fiscal soundness in order to avoid pressuring the monetary authorities. Policymakers have used two approaches to prevent governments from resorting to some form of inflation financing. The first approach focuses on fiscal criteria as embodied in the Maastricht treaty, and the second on the creation of monetary institutions with a clear mandate to keep prices stable—and indeed the European Central Bank's primary objective is to ensure price stability. The no-bailout clauses prevent the central bank from financing government deficits.

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[1] See English (1996) for a complete discussion.

[2] See the discussion on the *Post-Real Fiscal Crisis in the Brazilian States* in Brazil – Recent Economic Developments, IMF (1998).

We present a two-period model based on Calvo (1988), in which inflation and default (partial or total) are endogenized to allow us to account for changes in institutional monetary arrangements. We focus on public debt denominated in domestic currency. The model assumes that a benevolent government must repay in period two debt accumulated in the first period. The government's ability to repay depends on its willingness to raise distortionary taxes and the central bank's monetary policy. But the alternative to tax increases is outright default (full or partial) on the debt. Default can also be seen as a tax on bond holders. Debt repudiation is costly: the costs are directly proportional to the amount being repudiated, resulting in a trade-off between the costs of default and the costs of distortionary taxes. The central bank wants to achieve price stability around its inflation target. If the government is expected to default, the central bank may ease its monetary policy, providing the government with additional resources. But such a bailout is not warranted because it conflicts with the objective of price stability.

We also consider a one-country and an *n*-country case. The n-country case can be seen as a monetary union with one central bank and several fiscally-independent countries. We show that countries in a monetary union accumulate less debt than a country in the one-country case, because the central bank is less likely to accommodate its monetary policy in case of a fiscal crisis. Beetsma and Bovenberg (1996) by contrast argue that monetary unification leads to excessive debt accumulation because the central bank has an incentive to boost output through unexpected inflation. Their argument goes as follows. The higher the level of public debt, the greater the incentive to increase the inflation rate. In order to achieve a lower inflation rate, in a one-country case the government will accumulate less debt. In a monetary union, however, inflation is a public good, reducing the incentive to limit debt accumulation, resulting in higher debt level.

In our framework the central bank has an incentive to avoid fiscal crises (default). In a monetary union a fiscal crisis in one country will trigger a diminished response (if any) from the central bank, which is concerned with the welfare of the entire union. Therefore the marginal benefit of inflation in a monetary union is reduced, resulting in a tighter budget constraint for the fiscal entities of the union.

Related works on debt and default include Alesina, Prati, and Tabellini (1990); Barro (1979); Calvo (1988); Giavazzi and Pagano (1990); Grossman and Van Huyck (1988). None of these works underline the trade-off between inflation and default we are interested in. An important literature has emerged around the European monetary integration that focuses on fiscal criteria and their impact on inflation. This literature includes Bayoumi and Masson (1995), Beetsma and Bovenberg (1995), Beetsma and Uhlig (1997), Eichengreen (1993), McKinnon (1996, 1997a, 1997b), Van Der Ploeg (1995), Von Hagen (1995) and Wyplosz (1991). The research focuses on the impact of monetary integration on public debt accumulation, budget deficits, or inflation, and the relevance of fiscal rules. However, these works do not analyze the implications of default. This paper addresses this issue as well.

In the next section we present the model. In sections III and IV we analyze the one-country case and the monetary union case respectively, and we conclude in section V.

II. The Model

The structure of the model is similar to Calvo (1988), with two periods and two agents: a representative individual and a benevolent government. In period 0, individuals can buy bonds b_0, with a gross interest factor of R_b. That is, in period 1 consumers receive R_b units of output per unit of bonds they hold (expressed in per capita units of output). They accumulate physical capital k_0 that yields R (the constant interest factor of holding capital k) and hold cash m_0 (money bears no interest). Money demand is constant (inelastic to the interest rate), so real cash holdings are given by $M_0/P_0 = m_0$. Assuming perfect foresight, consumers are indifferent between bonds and capital. Thus we have:

$$(1-\theta)(1-\pi)R_b = R \tag{1}$$

The return of bonds, adjusted for the expected inflation tax π and the expected share of the debt that is not repaid θ, equals the return of the risk-free asset.

The inflation rate $\hat{p}$ determines the inflation tax π and the seigniorage revenues. Seigniorage revenues s for the government are defined as the revenues from money growth. Let M_t be the money supply and P_t the price level. The amount of real resources that the government can obtain by increasing the money supply is:

$$\frac{M_1 - M_0}{P_1} = \frac{M_1}{P_1} - \frac{M_0}{P_0}\frac{P_0}{P_1},$$

so that seigniorage revenues s are equal to πm_0 with π equal to $\frac{\hat{p}}{1+\hat{p}}$.[3]

The government sets the tax rate τ and can default a share $\theta \in [0,1]$ of its bonds. The repudiation of one unit of real bond debt service incurs a cost to the government of $\alpha \in [0,1)$. The costs of outright default can be seen as some form of deadweight loss. The cost of default explicitly enters the government budget constraint, which is given by:

$$\tau\, y + \pi m_0 = g_1 + (1-\theta)(1-\pi)R_b b_0 + \alpha\theta(1-\pi)R_b b_0 \tag{2}$$

[3] π=1 corresponds to an infinite inflation rate, with the government appropriating all the possible revenue from seigniorage.

where $(1-\theta)(1-\pi)R_b b_0$ is the total reimbursement net of default and the inflation tax. On the left-hand side of the budget constraint are the resources available to the government; expenditures are on the right. Using equation 2 total default on bonds is given by

$$\theta R_b b_0 = \frac{g_1 - \pi m_0 + (1-\pi)R_b b_0 - \tau y}{(1-\alpha)(1-\pi)} \tag{3}$$

In period 1 individuals consume all their wealth. The benevolent government maximizes their consumption:

$$c_1 = (1-\tau)y + Rk + (1-\theta)(1-\pi)R_b b_0 + (1-\pi)m_0 - z(\tau) - \Psi(\pi) \tag{4}$$

where y is the consumers' endowment of labor income in period 1. The second term represents the revenue from capital, and the third the cash holding net of the seignoriage tax. In this case τy represents tax paid to the government and $z(\tau)$ the deadweight cost of taxation. The welfare costs of inflation are represented by $\Psi(\pi)$. We assume that both $\Psi(\pi)$ and $z(\tau)$ are convex.[4,5]

The central bank's objectives are to stabilize inflation around its target and to promote the stability of the payment system.[6] The first objective is standard and aimed to limit the cost of inflation. A natural way to formalize the second objective is to have the central bank attach a cost to default in its objective function. The central bank loss function is given by:

$$\omega = \frac{a}{2}\left(\pi - \pi^*\right)^2 + \theta \tag{5}$$

[4] $\Psi(\pi)$ is such that $\Psi(0) = \Psi'(0) = 0$ and $\Psi''(\pi) > 0$ for all π.

[5] $z(\tau)$ is such that $z(0) = 0 = z'(0)$; $z''(\tau) > 0$ for all τ and $\lim_{\tau\to 1} z'(t) = \infty = -\lim_{\tau\to -1} z'(t)$

[6] Stability in the financial system appears to be a second major preoccupation for central bankers. In Capie and others (1994), Paul Volcker states "the concept of price stability is to be treasured and enshrined as the prime policy priority; that objective is inextricably part of a broader concern about the basic stability of the financial and economic system." Karl-Otto Pohl says nothing else when he states that "a central bank has to think more and more about the financial stability in a wider sense not only price stability but stability in the financial system." Jacques de Larosière pursues the same idea by stating that "preventing systemic risks has become one of the major concerns of any central banker" but he is "conscious that in some cases a multiplicity of objectives may lead to some contradictions."

where a is the weight attached to price stability relative to default. Such a formulation has several advantages. First, in the absence of a fiscal crisis the unique objective is to stabilize inflation.[7] When a fiscal crisis does occur, the central bank cannot ignore the possibility of default and may be forced to adjust its monetary policy. Second, the formulation formalizes the central bank's roles as lender of last resort and banker to the government. The term θ in the loss function also represents the idea that government default is a kind of risk that cannot be dealt with through prudential regulation or monitoring. Third, when the central bank's loss function is at its minimum, the welfare outcome is identical to the first-best outcome achieved in a model in which the government can pre-commit not to inflate and default.[8]

In a monetary union with n countries, the central bank loss function Ω is transformed so that each country is weighted according to its relative size γ_i in the union.[9] That is:

$$\Omega = \frac{a}{2}\left(\Pi - \Pi^*\right)^2 + \sum_{i=1}^{n} \gamma_i \theta_i \qquad (6)$$

Any deviation of the union inflation rate Π from the target Π^* is costly; a is the relative weight attached by the central bank to the price stability objective. Any deviation of θ_i from 0 is costly for the central bank.

The loss function shown in equation 6 internalizes some key issues related to European monetary integration. The main objectives of the European Central Bank are to achieve price stability and promote the smooth operation of the payments systems.[10] However to balance the kind of objectives embodied in equation 5 and 6, Articles 104 and 104a of the Maastricht Treaty ban direct central bank financing and access to favorable financing. Article 104b takes the constraint one step further, making each member responsible for servicing its own public debt, even in a fiscal crisis. If a member state fails to service its debt, neither the central bank nor other member states will bail the country out. The objective is to cut any potential link between the fiscal policy of a member state and the conduct of

[7] The literature traditionally assumes that the objective function of the central bank is to stabilize inflation and output around some potential level. In our model output is exogenous.

[8] Provided that the inflation target is equal to the first-best inflation rate. In the absence of a central bank, the government faces the standard time-inconsistency problem and will end up in the second-best equilibrium.

[9] γ_i can be defined by country i's GDP in the union's GDP or by the share of country i debt in the aggregate debt of the union.

[10] Per Article 105 of the Maastricht Treaty.

monetary policy. Whether these articles can credibly be enforced remains to be seen, but their existence justifies and supports the way we formalize the central bank's objective function.[11]

III. THE ONE-COUNTRY CASE

We look at Stackelberg equilibria, in which the government sets its fiscal policy after the central bank has implemented its monetary policy π. The government chooses τ to maximize c_1, subject to the budget constraint (2), taking R_b as given, and subject to $\theta \in [0,1]$. Therefore τ must satisfy:

$$\frac{1}{y} z'(\tilde{\tau}) = \frac{\alpha}{1-\alpha} \tag{7}$$

The optimal level of tax rate $\tilde{\tau}$ (derived from equation 7) determines the optimal fiscal policy $(\theta(\pi), \tau^*)$. That is:

$$\theta(\pi) = \begin{cases} 0 & \text{if} \quad \tilde{\tau} y \geq g_1 + (1-\pi) R_b b_0 - \pi m_0 & \tau^* = \dfrac{g_1 + (1-\pi) R_b b_0 - \pi m_0}{y} \\ 1 & \text{if} \quad \tilde{\tau} y \leq g_1 + \alpha (1-\pi) R_b b_0 - \pi m_0 & \tau^* = \tilde{\tau} \\ \theta^* & \text{otherwise} & \tau^* = \tilde{\tau} \end{cases} \tag{8}$$

where:

$$\theta^* = \frac{g_1 - \pi m_0 + (1-\pi) R_b b_0 - \tilde{\tau} y}{(1-\alpha)(1-\pi) R_b b_0} \tag{9}$$

Given (8) and (9), there exist π_L and π_H , so that for any inflation rate below π_L, $\theta(\pi)=1$. For any inflation rate above π_H, $\theta(\pi)=0$.[12] The first and second derivatives of $\theta(\pi)$ are respectively:

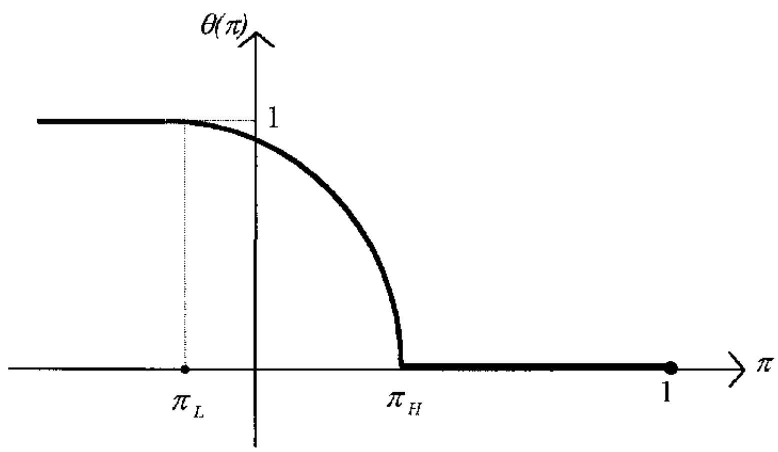
[11] The unique source of inflation in this model is fiscal.

[12] $\pi_L = \dfrac{\alpha R_b b_0 + g_1 - \tilde{\tau} y}{\alpha R_b b_0 + m_0}$ and $\pi_H = \dfrac{R_b b_0 + g_1 - \tilde{\tau} y}{R_b b_0 + m_0}$. Note that as α increases, π_L converges towards π_H.

$$\theta'(\pi)=\begin{cases} 0 & \text{if } \pi<\pi_L \\ 0 & \text{if } \pi>\pi_H \\ \dfrac{g_1-m_0-\tilde{\tau}y}{(1-\alpha)R_b b_0(1-\pi)^2}\le 0 & \text{if } \pi_L\le\pi\le\pi_H \end{cases} \quad \text{and} \quad \theta''(\pi)\begin{cases} =0 & \text{if } \pi<\pi_L \\ =0 & \text{if } \pi>\pi_H \\ \le 0 & \text{if } \pi_L\le\pi\le\pi_H \end{cases}$$

Figure 1 represents the default function with respect to inflation. Note that π_L and π_H depend positively on the cost of default, the stock of debt, and the interest rate on public debt. Remember that at this stage inflation is set by the central bank and given to the government.

Figure 1 : Default and Inflation



The intuition is that a too-tight monetary policy makes servicing and repaying the debt so costly that the optimal choice is to default, either partially or fully.

The central bank anticipates the government's strategy. It minimizes its loss function (5) with respect to π, given (8) and (9). The following first-order condition determines the optimal monetary policy:

$$a\left(\pi-\pi^*\right)=-\theta'(\pi) \tag{10}$$

Since $\theta'(\pi)$ is not positive, the optimal monetary policy is such that $\pi\ge\pi^*$. The following lemma summarize the results (for proofs, see the appendix).

Lemma 1: If total debt service is low, then the central bank sets inflation at its target and the government does not default.

Lemma 1 gives a clear condition on the size of the debt, so that the central bank does not implement inflationary policy and the government sets a sound fiscal policy.

Lemma 2: if total debt service is moderately high, the central bank accommodates its monetary policy and the government does not default. The central bank sets $\pi = \pi_H$ and the government sets $\theta^*=0$.

When the stock of debt is moderately high, the central bank prefers to relax its monetary policy in order to avoid default. The central bank adopts this strategy as long as deviating from its inflation target is not too costly. As the debt increases, an accommodating monetary policy simply increases the amount of deviation from the inflation target, up to the point at which

Lemma 3: if total debt service is high, the central bank stops accommodating its monetary policy to the government, and the government defaults. In this case the central bank sets $\pi=\pi^{CB}$ and the government sets $\theta^*>0$.

Above some level of debt service, the marginal gain of higher inflation is lower than its marginal cost. This result follows from the concavity of $\theta(\pi)$. The weight the central bank attaches to price stability is of paramount importance, since it determines the threshold level of debt above which the central bank refuses to accommodate its monetary policy. If the central bank attaches no weight to price stability, accommodation is the rule. This result compares with that of Phelps (1973), who shows that the central bank sets the flow of seigniorage revenue to balance the budget at the optimal level of tax. On the other hand, if the weight attached to price stability is infinite, the central bank always achieves price stability.

We now turn at the investors' decision to buy government bonds. Since default carries a cost, the stock of debt in equilibrium can be positive ($b_0 \geq 0$). We compare equilibria in which the central bank attaches no weight to price stability and an infinite weight to price stability, as well as the general case.

Case I: No commitment to price stability *($a = 0$)*

In this case the central bank provides sufficient seigniorage revenue to balance the budget given the optimal tax policy of the government. In equilibrium investors ask for a nominal interest rate that equates the real return of bonds $\Re$ to the risk-free rate. The real return is given by:

$$\Re = \begin{cases} \left(1-\pi^*\right)R_b & \text{if } R_b \leq R^1 \\ \left(1-\pi_H\right)R_b & \text{if } R_b > R^1 \end{cases} \tag{11}$$

where R^1 (see appendix) is the threshold factor rate below which central bank financing is not needed (and consequently the inflation target is the solution). In this case R^1 depends negatively on the debt service. Given the amount of bonds b_0, an increase in the factor rate R_b linearly increases the real return on bonds. At some point debt servicing becomes too costly and the central bank accommodates its monetary policy accordingly. The behavior of $\Re$ with respect to R_b has the following properties (see appendix for a technical discussion):

$$\frac{\partial \Re}{\partial R_b} > 0, \; \frac{\partial^2 \Re}{\partial R_b^2} < 0 \quad \text{and} \; \lim_{R_b \to \infty} \frac{\partial \Re}{\partial R_b} = 0$$

Proposition 1: Even if the central bank attaches no weight to price stability, a credit ceiling b_0^A exists above which the government cannot borrow. Below b_0^A a unique equilibrium exists in which the government never defaults.

Proof : see appendix.

The first part of the proposition is intuitive. Even if the central bank is accommodating, an infinite inflation rate can generate only a finite amount of real resources. Therefore investors will not lend indefinitely to the government, even at an infinite factor rate, and eventually the government finds that its credit has been rationed. The second part of the proposition derives directly from Lemma 2.

Case II: Commitment to price stability *($a = \infty$)*

In this case the optimal monetary policy is to set $\pi = \pi^*$. In equilibrium investors ask for a nominal factor rate R_b so that the real return on bonds $\Re$ equals the risk-free rate. As investors ask for higher R_b, the cost of debt servicing increases to the point at which it is optimal for the government to default. The real return is given by:

$$\Re = \begin{cases} \left(1-\pi^*\right)R_b & \text{if } R_b \le R^1 \\ \left(1-\theta\right)\left(1-\pi^*\right)R_b & \text{if } R_b > R^1 \end{cases} \tag{12}$$

Up to R^1 the real return increases linearly with interest factor R_b. Beyond R^1 the real return declines as the government defaults on an increasing share of its debt. When the risk-free rate R rises above the maximum real return $\Re$, there is no equilibrium. The following proposition summarizes the results.

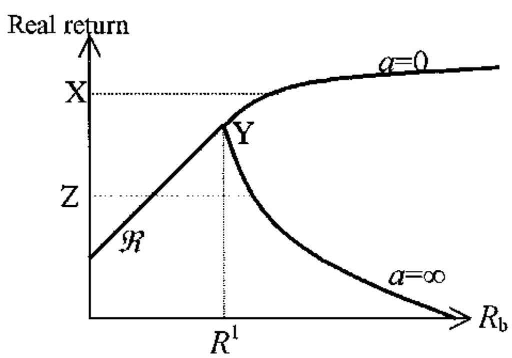
Proposition 2: If the central bank attaches an infinite weight to price stability, a debt ceiling b_0^B exists above which government credit is rationed. Below b_0^B two possible equilibria exist: one in which the interest rate is low and the government does not default, and another in which the interest rate is high and the government defaults.

Proof: see appendix

When the central bank is committed to a strong monetary rule, there is no inflation in equilibrium, however one equilibrium with default exists. A welfare comparison of the two equilibria shows that the equilibrium without default is pareto superior.[13]

In figure 2 we compare cases I and II. Suppose the government is willing to sell an amount b_0 of bonds. In case I a risk-free rate Z results in a unique equilibrium in which the government does not default and the central bank is not inflating the debt away. In case II two equilibria exist. The first exhibits a low factor rate and no default and the second a high factor rate and default.

Figure 2 : Equilibrium Factor Rates



[13] A welfare comparison of the two equilibria yields:

$$c^A - c^B = \frac{\theta^B}{1-\theta^B} R b_0 > 0$$

where c^A is consumption under the equilibrium with no default and a low interest rate, and c^B is the equilibrium with default and a high interest rate. This positive value represents the deadweight loss of outright default.

For a higher risk-free rate (say at X), no equilibrium exists in case II. An equilibrium can be reached only if the government reduces the amount it wants to borrow.[14] In case I, however, an equilibrium exists in which the factor rate is high, the central bank is accommodating, and the government does not default.

Case III: The general case ($0 < a < \infty$)

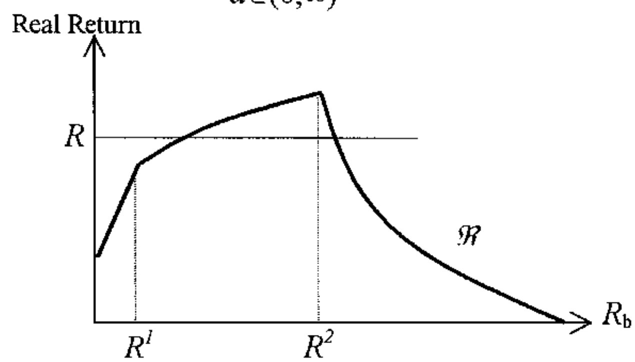
The central bank often has some room to accommodate its monetary policy to the government's needs. The expected real return $\mathfrak{R}$ with respect to the bond factor rate is given by:

$$\mathfrak{R} = \begin{cases} (1-\pi^*)R_b & \text{if } R_b \le R^1 \\ (1-\pi_H)R_b & \text{if } R^1 \le R_b \le R^2 \text{ [15]} \\ (1-\theta)(1-\pi^{CB})R_b & \text{if } R_b > R^2 \end{cases} \tag{13}$$

As investors ask for a higher factor rate, the real return on bonds increases linearly to the point at which the central bank finds it optimal to relax its monetary policy in order to accommodate the higher cost of debt servicing. At some point the central bank stops being accommodating, the government starts to default, and the real return begins to decline (figure 3).

Figure 3 : Equilibrium Interest Rates

$a \in (0, \infty)$



[14] Reducing b_0 causes point Y to move up and to the right.

[15] R^1 and R^2 are given in the appendix.

Proposition 3:If the central bank attaches a positive and finite weight to price stability, a debt ceiling b_0^C exists above which the government's credit is rationed. Below b_0^C there are two possible equilibria: one characterized by a low or moderate interest rate and no default, and another characterized by a high interest rate and default.

Proof: see appendix

In this case multiple equilibria arise. The higher the tolerance of the central bank for inflation, the higher the inflation can be in the equilibrium with no default.

In all three cases, there are credit-rationed equilibria. The higher the tolerance of the central bank for inflation, the higher the debt ceiling. The debt ceilings in the three cases can be ranked as follows:

$$b_0^B < b_0^C \leq b_0^A .$$

Maximum debt accumulation can be the highest under an accommodating central bank. Under a strict monetary rule, debt accumulation will be the lowest.

IV. THE *N*-COUNTRY CASE

The central bank assigns each country in the union a weight according to its relative size γ_i (an alternative is to assign weights by the relative size of each country's debt). The objective function of the central bank as derived from equation 6, is:

$$\Omega = \frac{a}{2}\left(\Pi - \pi^*\right)^2 + \sum_{i=1}^{n} \gamma_i \theta_i$$

For simplicity, we suppose that the stock of public debt is held entirely by domestic investors.[16] Solving backward we see that each government maximizes the welfare of its consumers. With identical default costs across countries, fiscal policy is still defined by equations 7 and 8. The central bank then minimizes the function in equation 5 subject to those in equations 7 and 8. The first-order condition is:

$$\Pi = \pi^* - \frac{1}{a}\sum_{i=1}^{n} \gamma_i \frac{\partial \theta_i}{\partial \Pi} \tag{14}$$

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[16] Relaxing this simplification does not change the results. But it does make default less costly, since foreign bond holders bear a portion of the welfare loss.

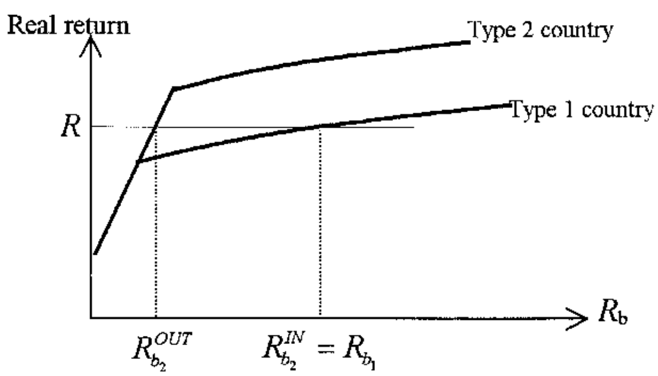
To further simplify the discussion, suppose there are two types of countries. Type 1 includes fiscally weak countries (defined by a high level of debt), and type 2 incorporates fiscally strong countries. Their respective weights in the union are given by γ_1 and γ_2 and $\gamma_1 + \gamma_2 = 1$. Outside the union, the central banks of type 2 countries would never set their inflation rates above their targets.

Following the lines of the discussion in section III, we look at three cases: one in which a=0, one in which a is infinite, and the general case a>0. In the first case if the union's central bank attaches no weight to price stability (***a*=0**), then the optimal monetary policy is given by:

$$\pi^{CB} = Max\left(\pi_{H_1}, \pi_{H_2}, \pi^*\right) = \pi_{H_1} \tag{15}$$

where π_{H_1} and π_{H_2} are the minimum inflation rates necessary to avoid default. In this case the most indebted countries determine the union's inflation rate. Given the poor fiscal performance of type 1 countries, type 2 countries must finance their debt at a higher nominal factor rate. In figure 4 we compare the equilibrium inside and outside the union for the two types of countries.

Figure 4 : Equilibrium Factor Rates In and Outside the Union
(a=0)



The fiscally weak type 1 countries have negative externality effects on the other countries through the central bank. In this case fiscally strong type 2 countries' welfare is higher outside a monetary union whose central bank attaches a limited weight to price stability.

In the second case, where a=∞, the optimal monetary policy is completely independent of fiscal policies, and the analysis is comparable to that in section II. Investors' decisions are independent across countries, so fiscally weak countries reach the debt ceiling, and investors do not allow governments to build up the kind of debt that would be possible outside the union.

The intermediate case, in which $a>0$, is more complex. The relative size of each of the two types of countries in the union is a key parameter. We first define the optimal monetary policy and then look at the possible equilibrium. Given type 2 sound fiscal policy, the first-order condition of the central bank's optimization problem simplifies to:

$$a\left(\pi-\pi^{*}\right)=-\gamma_{1}\frac{\partial\theta_{1}}{\partial\pi} \tag{16}$$

The central bank's monetary policy depends on the relative weight of type 1 countries in the monetary union. The greater the number of type 1 countries, the more accommodating the central bank will be. If the union includes few type 1 countries, the central bank sets the inflation rate close to its target.

Investors' expectations of default in one country depend on outcomes in other countries. Determining possible equilibria is complex. But by assuming that type 2 countries have sound fiscal policies, we can restrict the analysis to equilibria in which type 2 countries do not default. We then compare the equilibrium factor rates for each type of country inside and outside the union. (We base the discussion on figure 5 and place all technical details in the appendix.)

The top panel of figure 5 shows the real return to type 1 bonds with respect to their factor rate R_{b_1} for a given level of bonds b_0. The dotted lines represent the real return outside a monetary union, as described in section III. Assuming the union's central bank has the same preferences as each country's central bank, the range of debt servicing for which the central bank is accommodating is restricted by the relative size of type 1 countries in the union, in which case R^2 moves closer to R^1. As a consequence the debt ceiling is lower inside the union than outside.[17] If the risk-free rate is greater than X, no equilibrium exists inside the union. However an equilibrium with inflation exists outside the union. Debt accumulation in a monetary union depends on two factors: the relative size of highly indebted countries in the union, and the weight the central bank attaches to price stability.

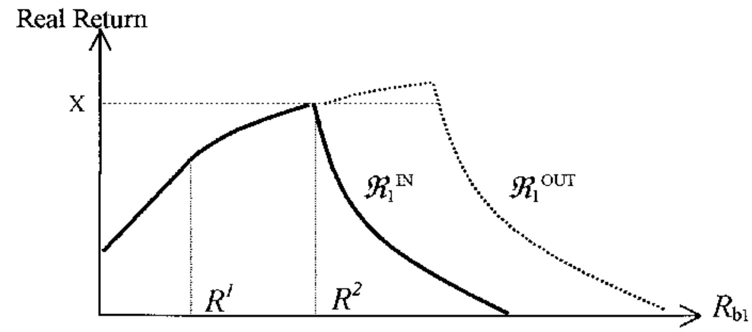
Panel b in figure 5 shows the real return on type 2 bonds with respect to R_{b_1}. The straight line represents the return on bonds outside the union. The bold lines represent the return inside the union: investors in type 2 bonds need to take into account the expectations of investors in type-1 bonds. The result is that a type 2 government is likely to finance its debt at a higher nominal factor rate than it would if it was outside the union. This result occurs when the central bank is only weakly committed to price stability and type 1 countries are members of the union. The smaller the weight of type 1 countries in the union, or the higher the weight

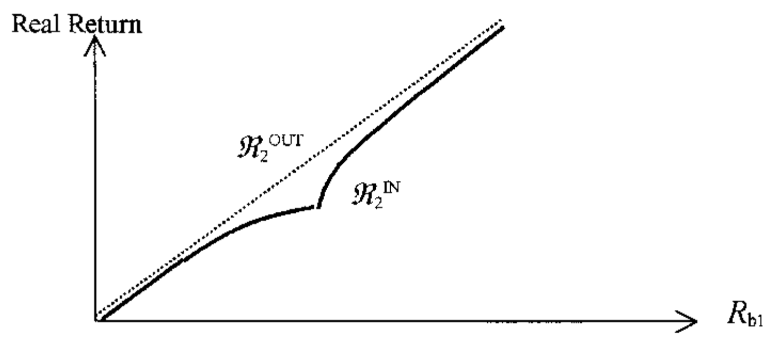
[17] If a central bank outside the union has looser preferences regarding price stability, the debt ceiling would be even greater.

the central bank attaches to price stability, the smaller the deviation of the bold and straight lines.

Figure 5 : Yields on Type 1 and 2 Countries

(a) : Type 1 countries, in and outside a monetary union





(b) : Type 2 countries, in and outside a monetary union

Note : Yields are with respect to type 1 factor rates in and outside the Union.

In a monetary union, then, the budget constraint is tighter (all other things being equal). Fiscally loose governments cannot rely on central bank financing as they can outside the union. Debt accumulation depends on the monetary environment and can be highest when the central bank attaches no weight to price stability. When the central bank commits to price stability, debt accumulation is minimal and fiscally weak countries default with no welfare impact on the other countries (unless investors in the rest of the union hold bonds from a defaulting country). For fiscally strong countries, the impact of default on their welfare is nil (unless investors of fiscally strong countries hold bonds of fiscally weak countries); however higher inflation would have a negative impact on their welfare.

V. Conclusion

In this paper we develop a model of public debt repudiation. Public debt can be either inflated away or repudiated. The government is benevolent and coexists with an independent central bank. Investors are risk neutral and invest either in government bonds or in a risk-free asset.

In the one-country case, three kinds of equilibria emerge: one with no default and no inflation, one with no default but high inflation, and one with default. Depending on the commitment to price stability, either no equilibrium, one equilibrium, or two equilibria exist. The weaker the commitment to price stability, the more investors will lend to the government, as loose monetary policy generates additional real resources. When the commitment to price stability increases, credit to the government will be rationed more rapidly, reducing debt accumulation.

In a monetary union the budget constraint hardens, depending on the central bank's preferences. The central bank is less likely to accommodate a government in a bad fiscal position by revising its monetary policy to provide additional resources, especially when the country is small. Maximum debt accumulation in countries belonging to a monetary union is lower than in countries that are not in a union, and debt ceilings are unnecessary. Ex ante however, ceilings imposed on would-be participants in a monetary union determine the composition of fiscally-weak and fiscally-strong countries in the union.

The institutional framework influences debt accumulation. A level of debt that is sustainable under one regime may not be sustainable under another. For this reason fiscal criteria are necessary to ensure an equilibrium without inflation before the monetary integration. However, a monetary union with fiscally-weak countries and with a less than perfectly credible central bank may require fiscal criteria and penalties once the integration is achieved.

Future research should analyze the pertinence of fiscal criteria and penalties inside a monetary union as incentive devices. The need for such studies is reinforced as potential candidates are queuing at the doors of the EU and the EMU.

Future research should also focus on analyzing the fiscal dimension of the soft budget constraint. In this paper we take a monetary approach to the issue. A fiscal entity faces a hard budget constraint in the presence of monetary and fiscal separation (McKinnon and Nechyba 1997). Monetary separation means that a fiscal entity does not have access to the central bank. When this monetary separation is ambiguous, the capital market realizes that outright default is unlikely. In any national currency, then, investors see central government bonds as the safest financial instrument, irrespective of the fiscal situation (McKinnon and Nechyba 1997). With respect to European integration, the most important issues are the extent to which national governments lose access to the European Central Bank and the extent to which the Pact for Stability and Growth can help prevent situations that require central bank financing.

Still, securing monetary separation is not sufficient to ensure a hard budget constraint if fiscal separation is not guaranteed. If it is not the soft budget constraint is transmitted to local governments. If European integration is to deepen, fiscal federalism should be designed to remove the conflicting objectives of the European Central Bank. The Brazilian experience shows how unconditional bailouts can jeopardize a disinflation program. Future research should unify these issues.

Proof of lemma 1

If $\pi_H \leq \pi^*$, then we have $\pi_H = \dfrac{R_b b_0 + g_1 - t^*(\alpha)}{R_b b_0 + m_0} \leq \pi^{*}$[18], which implies that

$R_b b_0 \leq \dfrac{\pi^* m_0 + t^*(\alpha) - g_1}{(1-\pi^*)}$, the case for a country with a relatively low debt level

($R_b b_0$ represents the total reimbursement). In this case, given that for any $\pi > \pi_H$ default is zero, the central bank sets $\pi = \pi^*$ in order to minimize its loss function.
Assume that $[\pi=\pi'; \theta^*(\pi')=\theta']$ is another equilibrium in which $\pi' \neq \pi^*$. Then if $\pi' > \pi^*$, $\theta(\pi')=0$, since in that case $\pi' > \pi_H$. But given the central bank's loss function (5), $\omega(\pi') > \omega(\pi^*)=0$. Therefore π' does not minimize the loss function. If $\pi_H < \pi' < \pi^*$, $\theta(\pi')=0$, but $\omega(\pi') > \omega(\pi^*)=0$. If $\pi' < \pi_H$, $\theta(\pi')$ is positive, increasing the loss function ω. In this case π' is even further from the central bank's target, and again $\omega(\pi') > \omega(\pi^*)=0$. Thus $[\pi=\pi^*; \theta^*(\pi)=0]$ is the unique Stackelberg equilibrium. ■

Proof of lemma 2 and lemma 3

The first-order condition can be written in the form $(\pi-\pi^*)=\dfrac{k}{(1-\pi)^2}$, where

$k = \dfrac{t^*(\alpha) + m_0 - g_1}{a(1-\alpha)R_b b_0} > 0$. Since $\dfrac{k}{(1-\pi)^2}$ is strictly convex in $(-\infty, 1)$ and $(\pi-\pi^*)$ is linear, they will intersect at 0, 1, or 2 points. Tangency between the straight line and the curve occurs if $k = \dfrac{4}{27}(1-\pi^*)^3$ in which case the point of contact is $\left(1-\sqrt[3]{2k}, \dfrac{\sqrt[3]{2k}}{2}\right)$.

<u>**Remark 1**</u>: when $\dfrac{k}{(1-\pi)^2} > (\pi-\pi^*)$, $\omega'(\pi)<0$, i.e., the central bank loss function is decreasing.

The reverse applies if $\dfrac{k}{(1-\pi)^2} > (\pi-\pi^*)$, $\omega'(\pi)>0$, and the loss function is increasing.

[18] To simplify notation, τy is represented by t_1.

Therefore :

1. If $k = \frac{4}{27}\left(1-\pi^*\right)^3$, the first-order condition has a unique solution: $\tilde{\pi} = \frac{1}{3}\left(1+2\pi^*\right)$. Given remark 1, the optimal monetary policy is therefore $\pi = \bar{\pi}$. Taking the monetary policy as given, the government responds with $\theta^*(\bar{\pi})=0$.

2. If $k > \frac{4}{27}\left(1-\pi^*\right)^3$, the first-order condition is never satisfied. Since $\frac{k}{(1-\pi)^2} > (\pi-\pi^*)$, given remark 1 the unique minimum is set at $\pi = \bar{\pi}$. The government responds with $\theta^*(\pi_H)=0$.

3. If $k < \frac{4}{27}\left(1-\pi^*\right)^3$, the first-order condition has two real solutions in $(-\infty,1)$ and one in $(1, \infty)$. Rewriting the first-order condition, we have:

$$\pi^3 + \pi^2\left(-\pi^* - 2\right) + \pi\left(1+2\pi^*\right) - \pi^* - k = 0 .$$

Using Cardan's solution of cubic equations[19], we substitute $\pi = y + \frac{\pi^*+2}{3}$, so that the squared term disappears. Therefore the first-order condition becomes $y^3 \underbrace{- \frac{1}{3}\left(\pi^* - 1\right)^2}_{p} y \underbrace{- \frac{2}{27}\pi^{*3} + \frac{2}{9}\pi^{*2} - \frac{2}{9}\pi^* + \frac{2}{27} - k}_{q} = 0$, and $q = \frac{2}{27}\left(1-\pi^*\right)^3 - k$. Since the coefficients are real numbers, and we have three real roots, we know that the roots are given by:

$$\pi^{(1)} = \frac{2}{3}\left(1-\pi^*\right)Cos\rho + \frac{\pi^*+2}{3},$$

$$\pi^{(2)} = \frac{2}{3}\left(1-\pi^*\right)Cos\left(\rho + \frac{2.Pi}{3}\right) + \frac{\pi^*+2}{3}, \text{ and}$$

$$\pi^{(3)} = \frac{2}{3}\left(1-\pi^*\right)Cos\left(\rho + \frac{4.Pi}{3}\right) + \frac{\pi^*+2}{3},$$

with ρ solving $Cos3\rho = \frac{27}{2}\frac{k}{\left(1-\pi^*\right)^3} - 1$. Since $3\rho \in [0,Pi]$, $\rho \in [0,Pi/3]$, then $\pi^{(1)} > 1 > \pi^{(3)} > \pi^{(2)}$.

[19] Borofsky, Samuel, 1950, "Elementary Theory of Equations," Macmillan, pp. 114-127.

With respect to our problem, and given remark 1, a local minimum exists at $\pi^{(2)}$, and a local maximum at $\pi^{(3)}$. We can derive the range for these two solutions. Given that Cos(Pi/3)=1/2, it is easy to show that:

$$\pi^{CB} = \pi^{(2)} \in (\pi^*, \frac{1+2\pi^*}{3}) \text{ and } \pi^{(3)} \in (\frac{1+2\pi^*}{3}, 1),$$

where π^{CB} is the optimal response for the central bank. The government responds with $\theta^*(\pi^{CB})>0$. If the debt level is very high, $\pi = \pi_H$ may be the minimum for the central bank, although the local minimum is π^{CB}. Let that equilibrium be called the *inflation trap equilibrium*. In this case the central bank sets $\pi = \pi_H$, and the government responds with $\theta(\pi_H)=0$. ■

Remark 2: In the low-inflation equilibrium $[\pi=\pi^{CB}; \theta^*(\pi^{CB})>0]$ a positive shock on g_1 (or a rising debt b_0) decreases k, therefore increasing ρ and decreasing π^{CB}. The economic argument is that in this case we are at equilibria where the marginal costs of increasing inflation are not matched by marginal gains in terms of a lower level of default.

To sum up, as far as the debt service satisfies $R_b b_0 \le \dfrac{t^*(\alpha)+m_0-g_1}{4a(1-\alpha)\left(\dfrac{1-\pi^*}{3}\right)^3}$ (points 1 and 2), there is no default and the central bank is accommodating. When debt servicing exceeds this threshold value, the central bank is no longer accommodating, and default occurs.

Proof of Proposition 1

When α=0, the real return is :

$$\Re = \begin{cases} (1-\pi^*)R_b & if \ \ R_b \le R^1 \\ (1-\pi_H)R_b & if \ \ R_b > R^1 \end{cases} \quad \text{with } R^1 = \frac{\pi^* m_0 + t^*(\alpha) - g_1}{(1-\pi^*)b_0}.$$

When $R_b > R^1$, the real return is $\Re = \dfrac{m_0 + t^*(\alpha) - g_1}{b_0 R_b + m_0} R_b$. The real return exhibits a horizontal asymptote equal to $\dfrac{m_0 + t^*(\alpha) - g_1}{b_0}$. If the risk-free rate R is greater than that value, there is no equilibrium, and the government is rationed out.

If the risk-free rate is lower than that value, the equilibrium is unique, since the real return $\Re$ is monotonically increasing and concave. Put differently, the maximum amount of debt the government is able to borrow is $b_0^A = \dfrac{m_0 + t^*(\alpha) - g_1}{R}$. ■

Proof of Proposition 2

When $a=\infty$, the real return is :

$$\Re=\begin{cases}\left(1-\pi^*\right)R_b & if\ \ R_b\le R^1\\ (1-\theta)\left(1-\pi^*\right)R_b & if\ \ R_b>R^1\end{cases}\quad \text{with}\quad R^1=\frac{\pi^*m_0+t^*(\alpha)-g_1}{\left(1-\pi^*\right)b_0}.$$

When $R_b>R^1$, the real return is:

$$\frac{\partial\Re}{\partial R_b}=\frac{g_1-\pi^*-t^*(\alpha)}{(1-\alpha)\left(1-\pi^*\right)b_0R_b^2}<0\text{ and }\frac{\partial^2\Re}{\partial R_b^2}>0.$$

Moreover, there is a value of R_b above which the real return is zero and then becomes negative. When $R_b\le R^1$, the real return is increasing linearly.

When $R_b=R^1$ the real return is maximized and equal to $\frac{\pi^*m_0+t^*(\alpha)-g_1}{b_0}$. If the risk-free rate is above that value, there is no equilibrium. If it is below that value, there are two equilibrium factor rates, one that is less than R^1 and the another that is more than R^1. Credit rationing occurs when $b_0>\frac{\pi^*m_0+t^*(\alpha)-g_1}{R}=b_0^B$ ■

Proof of Proposition 3

When a is some positive number, the real return is:

$$\Re=\begin{cases}\left(1-\pi^*\right)R_b & if\ \ R_b\le R^1\\ \left(1-\pi_H\right)R_b & if\ \ R^1\le R_b\le R^2\\ (1-\theta)\left(1-\pi^{CB}\right)R_b & if\ \ R_b>R^2\end{cases}\quad \text{with } R^2=\frac{m_0+t^*(\alpha)-g_1}{4a(1-\alpha)\left(\frac{1-\pi^*}{3}\right)^3b_0}.$$

When $R_b>R^2$, the real return is:

$$\frac{\partial\Re}{\partial R_b}=\frac{1}{(1-\alpha)}\left(-\alpha(1-\pi)b_0+\left(\alpha R_bb_0+m_0\right)\frac{\partial\pi^{CB}}{\partial R_b}\right)<0\ \text{ as }\ \frac{\partial\pi^{CB}}{\partial R_b}<0.$$

The other cases are similar to the one analyzed in proposition 1 and 2. The real return is maximum when $R_b=R^2$ and is equal to $\frac{m_0+t^*(\alpha)-g_1}{b_0+\frac{m_0}{R^2}}$ (17). When $R_b\le R^2$ the real return increases. It decreases when $R_b>R^2$. Therefore as long as the risk-free rate is below (17), two equilibria emerge, one with a high nominal rate and no default (but possibly inflation), and another with high real returns and default. If the risk-free rate is above (17), there is rationing and the government is not able to borrow b_0.

The maximum level of debt the government is able to borrow before being rationed out is found by manipulating (17). If the risk-free rate is above (17), the government is rationed out. Isolating b_0, we find that the government is rationed out when :

$$b_0 > \frac{b_0^A}{1+\dfrac{4a(1-\alpha)\left(\dfrac{1-\pi^*}{3}\right)^3 m_0}{m_0+t^*(\alpha)-g_1}} = b_0^C .$$

■

An N-Country Monetary Union : A Technical Appendix

We assume that type 2 countries have sound fiscal policies and never default so that, only type-1 countries generate negative externalities on type-2 countries.

1. First, we show there is less debt accumulation in a monetary union. We show that the threshold value R^2 inside the union is smaller than it is outside. In the union, we find that for type 1 countries:

$$R_1^2 = \frac{\gamma_1}{b_{0_1}}\left[\frac{t_1^*(\alpha)+m_{0_1}-g_{1_1}}{ca(1-\alpha)-\gamma_2\ell_2}\right],$$

   where $c = 4\left(\dfrac{1-\pi^*}{3}\right)^3$ and $\ell_2 = \dfrac{t_2^*(\alpha)+m_{0_2}-g_{1_2}}{R_{b_2}b_{0_2}}$. Note that by assumption $\ell_2 = 1$ (type 2 countries never default). Recall that, all else being equals, outside the union $R^2 = \dfrac{t_1^*(\alpha)+m_{0_1}-g_{1_1}}{ca(1-\alpha)b_{0_1}}$. Therefore:

$$R_1^2 < R^2 \Leftrightarrow a > \frac{1}{c(1-\alpha)}.$$

   That is, if the central bank attaches a sufficient weight to price stability, a type 1 country accumulates less debt. In the text we assume a is sufficiently high.

2. Second, we compare the impact of fiscal policy in a type 1 country with the equilibrium factor rate of a type 2 country. We justify the shape of the bond return in figure 7(b).

   The real return of a bond in a type 2 country depends on the union's monetary policy and therefore on the fiscal policy of type 1 countries. We then have

$$\Re_2 = \begin{cases} \left(1-\pi^*\right) R_{b_2} & \text{if } R_{b_1} \leq R_1^1 \\ \left(1-\pi_{H_1}\right) R_{b_2} & \text{if } R_1^1 \leq R_{b_1} \leq R_1^2 \\ \left(1-\pi^{CB}\right) R_{b_2} & \text{if } R_{b_1} > R_1^2 \end{cases}.$$

Moreover, we can show that, using results from the proofs of Lemma 2 and 3:

$$\frac{\partial \Re_2}{\partial R_{b_1}} \begin{cases} = \left(1-\pi^*\right) & \text{if } R_{b_1} \leq R_1^1 \\ > 0 & \text{if } R_1^1 \leq R_{b_1} \leq R_1^2 \\ > 0 & \text{if } R_{b_1} > R_1^2 \end{cases} \quad \text{and} \quad \frac{\partial^2 \Re_2}{\partial R_{b_1}{}^2} \begin{cases} = 0 & \text{if } R_{b_1} \leq R_1^1 \\ < 0 & \text{if } R_1^1 \leq R_{b_1} \leq R_1^2 \\ > 0 & \text{if } R_{b_1} > R_1^2 \end{cases}.$$

As a consequence, given a risk-free-rate R, a type 2 government might be in the position of needing to finance its debt at a higher factor rate than it would have to outside the union.

References

Alesina, Alberto, and others, 1992, "Default Risk on Government Debt in OECD Countries," *Economic Policy: A European Forum,* Vol. 15, (October), pp. 428–63.

Alesina, Alberto, Alessandro Prati, and Guido Tabellini, 1990, "Public Confidence and Debt Management: A Model and a Case Study of Italy," in *Public Debt Management: Theory and History*, ed. by Rudiger Dornbusch and Mario Draghi, (Cambridge: Cambridge University Press).

Atkeson, Andrew, 1991, "International Lending with Moral Hazard and Risk of Repudiation," *Econometrica,* Vol. 59(4), pp. 1069–89.

Barro, Robert J., 1979, "On the Determination of the Public Debt," *The Journal of Political Economy*, Vol. 87(5), pp. 940–71.

Bayoumi, Tamin, and Paul Masson, 1995, "Fiscal flows in the United States and Canada: Lessons for Monetary Union in Europe," *European Economic Review*, Vol. 39(2), pp. 253-74.

Beetsma, Roel, and A. Lans Bovenberg, 1995, "Does Monetary Unification Lead to Excessive Debt Accumulation?" CEPR Discussion Paper No. 1299, (London: Centre for Economic Policy Research).

Beetsma, Roel, and Harald Uhlig, 1997, "An Analysis of the Stability Pact," CEPR Discussion Paper No. 1669, (London: Centre for Economic Policy Research).

Begg, David, and others, 1991, "The Making of Monetary Union: Macroeconomic Issues," in *The Making of Monetary Union, Monitoring European Integration*, ed. by Centre for Economic Policy Research, (London: Centre for Economic Policy Research).

Buiter Willem, Giancarlo Corsetti, and Nouriel Roubini, 1993, "Excessive Deficits: Sense and Nonsense in the Treaty of Maastricht," *Economic Policy: A European Forum,* Vol. 16, (April), pp. 57–90.

Buiter, Willem, 1999, "The Fallacy of the Fiscal Theory of the Price Level," NBER Working Paper No. 7302, (Cambridge, Massachusetts: National Bureau of Economic Research).

Calvo, Guillermo, 1988, "Servicing the Public Debt: The Role of Expectations," *American Economic Review*, Vol. 78(4), pp. 647–61.

Calvo, Guillermo, and Pablo E. Guidotti, 1990, "Indexation and Maturity of Government Bonds: An Exploratory Model," in *Public Debt Management: Theory and History*, ed. by Rudiger Dornbusch and Mario Draghi, (Cambridge: Cambridge University Press).

Capie, Forrest, and others, eds., 1994, *The Future of Central Banking: The Tercentury Symposium of the Bank of England*, (New York: Cambridge University Press).

Chari, V. V., and Patrick Kehoe, 1993, "Sustainable Plans and Debt," *Journal of Economic Theory*, Vol. 61, (December), pp. 230–61.

______, 1998, "Models of Sovereign Debt: Partial versus General Reputations," *International Economic Review*, Vol. 39(1), pp. 55–70.

Cukierman, Alex, 1992, *Central Bank Strategy, Credibility, and Independence: Theory and Evidence*, (Cambridge, Massachusetts: MIT Press).

De Grauwe, Paul, 1994, *The Economics of Monetary Integration*, (Oxford: Oxford University Press).

______, 1996, "Reforming the Transition to EMU," in *Making EMU Happen, Problems and Proposals: A Symposium*, ed. by Peter Kenen, (Princeton: Essays in International Finance).

______, 1998, "The Risk of Deflation in the Future EMU: Lessons of the 1990s," CEPR Discussion Paper No. 1834, (London: Centre for Economic Policy Research).

Dewatripont, Mathias, and others, 1995, *Flexible Integration: Towards a More Effective and Democratic Europe*, (London: Centre for Economic Policy Research).

Dornbusch, Rudiger, 1997, "Fiscal Aspects of Monetary Integration," *American Economic Review, Papers and Proceedings*, Vol. 87(2), pp. 221–23.

Dornbusch Rudiger, Carlo Favero, and Francesco Giavazzi, 1998, "Immediate Challenges for the European Central Bank," NBER Working Paper No. 6369, (Cambridge, Massachusetts: National Bureau of Economic Research).

Drudi, Francesco, and Alessandro Prati, 1999, "Signaling Fiscal Regime Sustainability," IMF Working Paper 99/86, (Washington: International Monetary Fund).

Eichengreen, Barry, 1990, "The Capital Levy in Theory and Practice," *Public Debt Management: Theory and History*, ed. by Rudiger Dornbusch and Mario Draghi, (Cambridge: Cambridge University Press).

______, 1993, "European Monetary Unification," *Journal of Economic Literature*, Vol. 31, (September), pp. 1321–57.

Eichengreen, Barry, and Charles Wyplosz, 1998, "The Stability Pact: More than a Minor Nuisance?" *Economic Policy: A European Forum*, Vol. 26, (April), pp. 67–113.

English, William, 1996, "Understanding the Costs of Sovereign Default: American State Debts in the 1840s," *American Economic Review*, Vol. 85(1), pp. 259–75.

Favero, Carlo, Luigi Spaventa, and Francesco Giavazzi, 1997, "High Yields: The Spread on German Interest Rates," *Economic Journal*, Vol. 107, (July), pp. 956–85.

Freixas, Xavier, and Jean-Charles Rochet, 1997, *Microeconomics of Banking*, (Cambridge, Massachusetts: MIT Press).

Giavazzi, Francesco, and M. Pagano, 1990, "Confidence Crises and Public Debt Management," in *Public Debt Management: Theory and History*, ed. by Rudiger Dornbusch and Mario Draghi, (Cambridge: Cambridge University Press).

Giovannini, Alberto, and Gustavo Piga, 1992, "Understanding the High Interest Rates on Italian Government Securities," CEPR Discussion Paper No. 720, (London: Centre for Economic Policy Research).

Gros, Daniel, 1993, "Seigniorage and EMU: The Fiscal Implication of Price Stability and Financial Market Integration," *European Journal of Political Economy*, Vol. 9, (November), pp. 581–601.

Grossman, Herschel I. and John B. Van Huyck. 1988. "Sovereign Debt as a contingent Claim: Excusable Default, Repudiation, and Reputation," *American Economic Review*, Vol. 78 (5), pp. 1088-97.

IMF Staff Country Reports, 1998, Brazil—Recent Economic Developments No. 98/24, (Washington: International Monetary Fund).

Kenen, Peter B, 1997, "Preferences, Domains, and Sustainability," *American Economic Review, Papers and Proceedings*, Vol. 87(2), pp. 217–20.

Mussa, Michael, 1997, "Political and Institutional Commitment to a Common Currency," *American Economic Review, Papers and Proceedings*, Vol. 87(2), pp. 227–29.

McKinnon, Ronald, 1996, "Monetary Regimes, Government Borrowing Constraints, and Market-Preserving Federalism: Implication for EMU," paper presented at the conference "The Nation State in Global/Information Era: Policy Challenges," Ontario, 1996.

______, 1997a, "EMU as a Device for Collective Fiscal Retrenchment," *American Economic Review, Papers and Proceedings*, Vol. 87(2), pp. 227–29.

______, 1997b, "Market-Preserving Fiscal Federalism in the American Monetary Union," in *Macroeconomic Dimensions of Public Finance: Essays in honour of Vito Tanzi*, ed. by M.I. Blejer and T. Ter-Minassian, (New York: Routledge).

McKinnon, Ronald, and Thomas Nechyba, 1997, "Competition in Federal Systems: the Role of Political and Financial Constraints," in *The New Federalism: Can the States Be Trusted?*, ed. by J. Ferejohn and B.R. Weingast, (Stanford: Hoover Institution Press).

Obstfeld, Maurice, and Kenneth Rogoff, 1996, *Foundations of International Macroeconomics*, (Cambridge, Massachusetts: MIT Press).

Phelps, Edmund S. 1973, "Inflation in the Theory of Public Finance," *Swedish Journal of Economics*, Vol. 75, (March), pp. 67–82.

Prati, Alessandro, 1991, "Poincaré's Stabilization: Stopping a Run on Government Debt," *Journal of Monetary Economics*, Vol. 27(2), pp. 213–39.

Sargent, T., and N. Wallace. 1981. "Some Unpleasant Monetarist Arithmetic," *Quarterly Review of the Federal Reserve Bank of Minneapolis*, Vol. 5, (Fall), pp. 1–17.

Sibert, Anne C, 1994, "Allocation of Seigniorage in a Common Currency Area," *Journal of International Economics,* Vol. 37, (August), pp. 111–22.

Van der Ploeg, Frederick, 1995, "Political Economy of Monetary and Budgetary Policy," *International Economic Review*, Vol. 36(2), pp. 427–39.

Von Hagen, Jürgen, 1995, "Reciprocity and Inflation in Federal Monetary Unions," CEPR Discussion Paper No. 1297, (London: Centre for Economic Policy Research).

Wildasin, David, 1997, *Externalities and Bailouts: Hard and Soft Budget Constraints in Intergovernmental Fiscal Relations*, (Washington: World Bank Development Research Group).

Woodford, Michael, 1996, "Control of the Public Debt: A Requirement for Price Stability?" NBER Working Paper No. 5684, (Cambridge, Massachusetts: National Bureau of Economic Research).

Wyplosz, Charles, 1991, "Monetary Union and Fiscal Policy Discipline," CEPR Discussion Paper No. 488, (January), (London: Centre for Economic Policy Research).