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Devaluation, Debt, and Default in Emerging Economies

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Abstract

Motivated by the experiences of Mexico and Argentina, we explore a model intended to capture the interactions among exchange rate policy, fiscal policy, and default on foreign currency-denominated debt. Our objective is to examine how exchange rate policy affects the supply of short-term debt facing the government. We show that under a conventional soft peg, it can be optimal for the government to choose a level of the exchange rate that may result in partial or complete debt default, as in the Mexican case. Paradoxically, default may also be an equilibrium outcome under a hard peg, as in the case of Argentina, precisely because devaluation is *not* an option. Multiple equilibria may exist under a soft peg, with one equilibrium featuring a high domestic interest rate, an overvalued exchange rate, a low level of output, and a high default probability. Under a hard peg, however, there is a unique equilibrium.

[1] While absolving them from remaining errors, we would like to express our gratitude to Adolfo Barajas, Saleh Nsouli, and participants at an IMF Institute seminar for comments on an earlier draft.

In 1994, the government of Mexico undertook a devaluation that had been recommended to it by knowledgeable observers, in part to correct a real exchange rate overvaluation that appeared to be stifling growth in the country. A similar correction of the exchange rate had in fact resulted in an acceleration of economic growth a few years before in the UK and Italy when these countries decoupled their currencies from the ERM and allowed them to depreciate. Surprisingly, in Mexico the devaluation was followed not by an acceleration of growth, but by a debt crisis (a refusal of creditors to extend new loans) that resulted in a sharp contraction of economic activity.

Most observers have explained the emergence of the debt crisis as attributable to the significant worsening of the Mexican government's fiscal position created by the devaluation, in light of the large net stock of short-term dollar-denominated debt that the government had incurred during the course of 1994 through a combination of reserve depletion and refinancing of the government's peso-denominated debt. According to these observers, the increased peso value of the government's debt appears to have created the expectation of a potential default on the part of creditors.

This is somewhat puzzling, however, because in view of Mexico's relatively low ratio of public debt to GDP, its government's demonstrated record of fiscal adjustment, and the improved prospects for the Mexican economy as a result of the exchange rate adjustment, perceived insolvency of the Mexican government should not have been an issue. One problem, however, was that the short maturity of the existing debt signified a sharp deterioration in the government's *flow* fiscal position — an increase in its near-term borrowing requirements — implying the possibility that *if* creditors collectively withheld resources, the Mexican government would have found itself in a position in which it was forced to choose between defaulting on its short-term obligations or making a further fiscal adjustment. If creditors had reason to believe that the Mexican government would opt for default rather than fiscal adjustment under these circumstances, then it would indeed have been optimal for them to withhold funds.

In this paper, we investigate the conditions under which such an equilibrium is likely to arise. The objective of the paper is to better understand the relationship between exchange rate policy and a debt crisis (default) in emerging economies like Mexico. In particular, why should Mexico's creditors have converged on the expectation of default in the event of a "run" on government debt? Should a devaluation make a default more or less likely *ex post*?

These questions are particularly important because Mexico's circumstances in 1994 do not appear to be general. For example, during its 2002 crisis, investors in Argentina appear to have feared a default on public sector debt in part precisely because that country's currency-board arrangement made a devaluation of the Argentine peso *less* likely. This raises the question of what distinguishes these two cases from each other.

While the cases of Mexico and Argentina have received a substantial amount of attention, there is abundant evidence that debt and exchange rate policies are strongly linked in emerging economies more generally. Reinhart (2002), for example, finds that

84 percent of all default episodes in her 59-country sample over the period 1970–1999 are followed within 24 months by currency crises, while 66 percent of all currency crises in her developing-country subgroup are followed within 24 months by debt defaults.[2] It remains to understand why the link between the two phenomena should be so strong empirically, as well as why in some cases the two types of crisis tend to occur together while in others they do not. Our purpose is to attempt to identify the underlying characteristics of economies that help to explain the links between these phenomena.

Two separate strands of literature address this issue peripherally. One such strand is the literature on sovereign debt. Following the debt crises in the early 1980s, several authors focused on how a no-default debt equilibrium could be explained for sovereign borrowers (see Eichengreen, 1991 for a review), using models based on reputation (Grossman and Van Huyck, 1988) or sanctions (Bulow and Rogoff, 1989). Some early empirical work associated with this literature (e.g., Edwards (1984), Cline (1983)) attempted to link sovereign default to exchange rate policy, by considering how the exchange rate regime prevailing prior to a debt crisis would influence the occurrence of such crises. The central idea was that the willingness to use the exchange rate as a means of adjustment could have the effect of reducing the likelihood of a crisis. However, this literature produced neither formal models nor systematic empirical evidence supporting such views.

[2] There were no defaults among industrial countries in Reinhart's sample.

A second strand is the second-generation variant of the currency crisis literature (e.g., Obstfeld, 1996), which examines the factors that influence an optimizing government's choice to alter (or not) an existing exchange rate peg. But this literature does not typically consider such a choice as part of a wider menu of policies that also includes a fiscal instrument and a debt default option. This paper can thus be perceived as addressing gaps in both the debt and the currency crisis literatures by simultaneously looking at the interaction among exchange rate policy, fiscal policy and default on external debt.

The structure of the paper is the following: in the next section, we will describe a simple model that can be used to explore how a benevolent government chooses between fiscal adjustment and default on debt. In Section II we use this model to analyze the behavior of a government that exercises discretion in making this choice — i.e., one that is not bound in its debt-servicing decisions by its previous promises to pay, which is the standard framework adopted in the analysis of sovereign debt. Section III considers how this government's fiscal as well as debt-servicing decisions are affected by the level of the exchange rate, and considers the application of our analysis to the case of Argentina. In Section IV we analyze the conditions under which devaluation-cum-default would be a rational choice by a welfare-maximizing government, with an application to the case of Mexico. Finally, Section V considers some complications to the analysis that arise in the form of multiple equilibria, and considers how the likelihood of such equilibria is affected by the exchange rate regime. The final section summarizes our results.

I. THE MODEL

We explore a model intended to capture the interaction among exchange rate policy, fiscal policy and outright default on foreign-currency denominated debt. The model contains a representative agent and a benevolent government. The government has three policy instruments at its disposal — a fiscal policy, an exchange rate policy, and a debt default policy, consisting of the option to default either partially or totally on its contractual debt service. In specifying the fiscal policy, we will assume that the government chooses an optimal rate of taxation, given the level of public expenditure. Thus, the rate of taxation determines the government's fiscal policy. The exchange rate is fixed, but adjustable. We will consider separately the cases of "hard" (as in a monetary union or a currency board) and "soft" pegs. Given the domestic price level, the level of the nominal exchange rate affects real output in the economy, because it determines the extent of real exchange rate misalignment. We interpret misalignment as a relative price distortion that reduces the level of output below its optimal value, regardless of the direction of misaligment. Because the government's debt is denominated in foreign currency, the nominal exchange rate also affects the domestic-currency value of the government's debt service obligations. While the government can repudiate a part or the totality of its debt, it is costly for it to do so, because debt repudiation adversely affects the welfare of the representative agent.

At the beginning of the period, the government inherits a stock of long-term foreign-currency debt d_L from the past.[3] For simplicity, we will assume that this debt has infinite maturity (i.e., we take it to be consol debt). The total service due on this debt in period 1 is thus $R_L\, d_L$, where R_L is the contracted interest rate on long-term debt. At the beginning of the period, the government faces a market supply curve for short-term debt. Since we ultimately want to ask why short-term creditors converge on a no-lending equilibrium, our interest is precisely in understanding what determines the shape of this curve, and how the curve is affected by changes in the exchange rate.

At the beginning of the period risk-neutral investors decide the terms on which they are willing to extend short-term debt d_S to the government. They have access to an alternative, risk-free asset whose rate of return is denoted R. At the end of the period, the government has the option of defaulting on some or all of its debt. As we will see, the inability of the government to credibly commit to repaying its debt gives rise to a classical time-inconsistency problem: in formulating its fiscal plans, the government takes the short-term interest rate as given; however, in this perfect foresight framework, investors anticipate the government's future actions and adjust their lending rate accordingly. This means that in a discretionary equilibrium the interest rate may turn out to be higher than the risk-free rate, depending on the incentives the government faces to default (at least partially) on its outstanding debt. If neither long-term nor short-term debt has seniority status, when the government undertakes a partial default it will default

[3] It is straightforward to extend the model to the case in which some portion of the pre-existing long-term debt is denominated in domestic currency. This changes some of the details of the derivations, but none of the model's essential features.

on the same share (say θ) of all of its outstanding debt service obligations (this can be seen as an *ex post* tax on all bondholders).

These assumptions allow us to determine the terms on which the government will be able to incur new short-term debt. When θ is the expected rate of default on short-term debt, risk-neutral investors set the nominal rate R_S on new government short-term debt so as to satisfy the no-arbitrage condition:

$$(1 + R_S) = (1 + R)/(1 - \theta) \tag{1}$$

The next step is to link the default rate • to the government's behavior. The government is assumed to be benevolent. It sets its policies so as to maximize the utility of a representative agent. We express utility as linear in consumption, and write it as $u(c_t) = c_t$. The representative agent's consumption is given by:

$$c_1 = (1 - t - z(t))y_1 - a\theta D\, e_1 - \psi/2\, (e_1 - e_0)^2 \tag{2}$$

where $D = R_L d_L + (1 + R_S)d_S$ denotes the government's contractual debt service obligations, t is the (proportional) tax rate, and $z(t)$ represents the deadweight cost of taxation, with $z' > 0$ *and* $z'' > 0$.[4] e is the nominal (and real) exchange rate, defined as the

[4] Debt service on short-term debt takes the form of $(R_S + 1)d_S$ because, by definition, all of this debt has to be repaid by the end of the period.

value of the foreign currency expressed in units of national currency.[5] The second term represents the cost to the representative domestic agent of a partial default by the government on the service of its dollar-denominated debt, both long-term and short-term. This cost is assumed to be proportional to the size of the default — i.e. to the magnitude of the shortfall of debt service paid from the contracted amount, with the parameter *a* denoting the factor of proportionality.[6] Finally, $\psi/2(e_1 - e_0)^2$ represents the costs associated with exchange rate changes during the government's planning period. These can be interpreted, for example, as costs to the representative agent caused by changes in the real value of foreign currency-denominated private debt.[7]

We express real output as the sum of two elements:

$$y_1 = y^* - \alpha/2(e^* - e_1)^2 \tag{3}$$

The first term can be interpreted as the undistorted level of real output. The second term measures the effects on real output of distortions arising in the form of deviations of the real effective exchange rate from its equilibrium level (i.e., it captures the effect of real

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[5] Since we are taking the domestic price level to be constant, we can set the domestic and foreign price levels both equal to unity. In that case, *e* can also be interpreted as the real exchange rate.

[6] The more effective foreigners are in penalizing domestic residents for default, the larger is *a*.

[7] See, for example, Calvo and Reinhart (2000).

exchange rate misalignment on real output). Real output is taken to be a decreasing function of such deviations, whether the real exchange rate is over- or undervalued.[8]

Finally, the budget constraint of the government is given by:

$$ty_1 \geq g_1 + (1 - \theta)\, De_1 \tag{4}$$

The government cannot spend more than its revenue, but it has the possibility of partially or completely reneging on its debt-service obligations.

II. The Supply of Short-Term Debt under a "Hard" Exchange Rate Peg

Our objective is to examine the determinants of the supply of short-term debt available to the government, given creditors' awareness that the government may choose to exercise the option to default on some part of this debt in the future rather than raise the fiscal resources to service it fully. In particular, we wish to examine how the supply of short-term debt facing the government is affected by the factors that influence the government's fiscal decisions. In this section, we examine the determinants of the supply of short-term debt conditioned on a given value of the exchange rate. In the section that follows, we will consider how the level of the exchange rate affects the supply curve. Subsequently, we will examine whether it can ever be optimal for the government to

[8] Since we will be working only with cases of overvaluation, all we actually require is that the level of real output be a differentiable convex function of the level of misalignment in the range where $e^* > e_1$. Equation (3) is just a tractable function that meets this requirement.

choose a level of the exchange rate that would be likely to result in a debt crisis (a foreseen default).

For now, we assume that the economy operates a fixed exchange rate in the form of a "hard" peg, so that the government has recourse only to the fiscal instrument.[9] This allows us to characterize optimal fiscal policy and to examine the determinants of default conditioned on the exchange rate. We relax this assumption subsequently. Given the fixed peg, we have that $e_1 = e_0$. Equation (2) thus becomes:

$$c_1 = (1 - t - z(t))y_1 - a\theta De_1, \tag{5}$$

with y_1 and e_1 both taken as given by the government.

A. The Discretionary Solution

When the government exercises discretion, it chooses the tax ratio and the rate of default so as to maximize the utility of the representative consumer, taking the interest rate on short-term debt R_S as given. However, its budget constraint (4) implies that it cannot choose these independently. Thus it determines t^* and θ so as to maximize (5) subject to (3) and (4), taking D as given. To find the optimal value of t chosen by the government, first isolate θ in (4). This yields the following constraint:

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[9] In other words, we assume that ψ is sufficiently large as to preclude the possibility of devaluation by an optimizing government. We will turn to the more general case in Section V.

$$\theta \geq 1 - \frac{(ty_1 - g_1)}{De_1}, \tag{6}$$

where $1 \geq \theta \geq 0$. Note that for c_1 to be at its optimal value, (6) must hold as an equality, since default rates over and above those required by the government's budget constraint would serve only to diminish private consumption, according to (5). Substituting the resulting form of (6) into (5), the first order condition for optimal tax policy simplifies to:

$$1 + z'(t^*) = a \tag{7}$$

This equation sets the marginal cost of a change in the tax rate in the form of reduced consumer income, given by $(1 + z'(t^*))y_1$, equal to its marginal benefit in the form of a reduced default penalty, given by ay_1. To understand the latter, notice that an increase in the tax rate, by supplying the government with revenue, reduces the default *rate* (θ) at the margin by $y_1/D\, e_1$, and it reduces the *size* of the default at the margin by y_1. When default incurs a utility penalty of a per unit, therefore, the marginal benefit to the representative agent amounts to the utility penalty per unit of default times the reduction in the size of the default, or ay_1.

The tax rate determined by (7) is positive as long as default is costly, because levying taxes yields income for the government with which to service debt and avoid default. If default were costless, taxation would yield no benefits, and an increase in the tax rate would have a marginal cost of $(1 + z'(t))y_1$, which is increasing in t. Thus the government would maximize the welfare of the representative individual by setting the tax rate such as to minimize the marginal cost of taxes — i.e., at the corner solution with $t^* = 0$, and would set the default rate θ at the residual value required to satisfy its budget constraint. When default is penalized, however, raising the tax rate provides a marginal benefit to the representative consumer, in the form of a reduced default penalty. Indeed, since $z'' > 0$, we can verify from (7) that the optimal tax rate increases with the size of the penalty *a*.

An important point to notice about the preceding analysis is that the optimal tax rate given by (7) is not affected by the government's budgetary needs as measured, say, by the size of any budgetary gap $De_1 - (ty_1 - g_1)$ that would need to be closed in order to assure full debt servicing. The reason is that, at the margin, the impact of a change in the tax rate on the budgetary gap depends only on the tax base y_1. Because a given change in the tax rate has the same effect on the government's budgetary resources whether the budgetary gap is large or small, the size of that gap is irrelevant for the determination of the optimal tax rate. This property of our model is an important one, since it implies that the government has no incentive to alter its fiscal policy in response to an emergence of a budgetary gap.

Given the optimal tax rate t^*, the default strategy is given trivially by:

$$0 \leq \theta^* = 1 - \frac{t^* y_1 - g_1}{De_1} \leq 1 \qquad (8)$$

The interpretation of this equation is straightforward. Given the exogenous values of y_1 and g_1, the optimal tax rate derived from (7) determines the government's primary surplus $t^*y_1 - g_1$. These are the resources that the government is willing to commit to debt service. If the optimal value of the primary surplus is nonpositive, the government must default completely on its debt (i.e., $\theta = 1$), since even after taking the utility cost of default into account, its optimal tax policy does not generate any resources for the service of debt. As t^* increases from a position of primary balance, the default rate falls because the resources transferred to creditors represent an increasing share of the government's (fixed) contractual debt service obligations. When the value of t^* reaches the critical level $t^* = (De_1 + g_1)/y_1$, the government honors all of its contractual debt-service obligations.

B. Perfect Foresight Equilibrium

The solution for θ^* given by (8) is not necessarily a perfect foresight equilibrium, since the optimal default rate θ^* chosen by the government may not be consistent with the value of θ expected by creditors when they set R_S through equation (1). Thus, to find the perfect foresight equilibrium we need to solve equation (6) for θ while imposing the condition that $(1 + R_S) = (1 + R)/(1 - \theta)$.

Doing so yields the result that under perfect foresight the default rate is given by:

$$0 \leq \theta^* = 1 - \frac{(t^*y_1 - g_1) - (1 + R)\, d_S\, e_1}{R_L\, d_L\, e_1} \leq 1 \qquad (9)$$

To interpret this condition, note that under perfect foresight the government's payments to its short-term creditors are not affected by a partial debt default, since the rate of default is foreseen by the creditors and they can thus adjust the contractual interest rate to offset their expected losses from partial defaults, leaving then with the same *ex post* return that they would have received on the safe asset, $(1 + R)\ d_S\, e_1$. In effect, short-term creditors acquire effective "senior" status by being able to negotiate their contractual debt payment after observing the parameters of the government's decision problem.

The actual default rate is thus determined by the payments that the government can make on its long-term debt relative to the contractual value of those payments. In turn, the payments that the government can make on its long-term debt amount to the excess of its primary surplus over its short-term debt service — that is, $(t^* y_1 - g_1) - (1+R) d_S\, e_1$. To the extent that this amount falls short of its contractual long-term debt service obligations $R_L\ d_L\ e_1$, the government at least partially defaults.

How much short-term debt can the government incur at the beginning of the period under these circumstances? Note first that if the optimal tax rate implies that the government will run a primary budget deficit during the period, there will be insufficient resources available to pay *any* portion of the debt service due -- either on short- or long-term debt. Thus, in this case the government defaults completely, and consequently it will be unable to borrow short-term at the beginning of the period. This means that if a is sufficiently small and the costs of default are therefore low enough, there is no equilibrium with positive values of short-term debt. Investors will simply not extend new short-term loans to the government, because they know that if they do so they will not be repaid. Under discretion, therefore, a positive level of short-term debt can be supported only if default is sufficiently painful for the government.

Alternatively, if the optimal tax rate allows the government to run a primary surplus, then a perfect foresight equilibrium with positive short-term debt exists. In this equilibrium, the government's debt may or may not be serviced fully. To derive the supply curve of short-term debt, relating the amount of such debt offered by creditors to the contractual interest rate R_S that they demand, we thus proceed in two steps:

a. From equation (9), we derive the effects of changes in the stock of short-term debt d_S on the optimal default ratio θ^*.
b. From equation (1), we derive the effects of the optimal default ratio on the contractual interest rate on short-term debt R_S.

To see what the resulting supply curve looks like, suppose that we define:

$$d_S^* = \frac{(t^* y_1 - g_1) - R_L d_L e_1}{(1 + R) e_1}, \tag{10a}$$

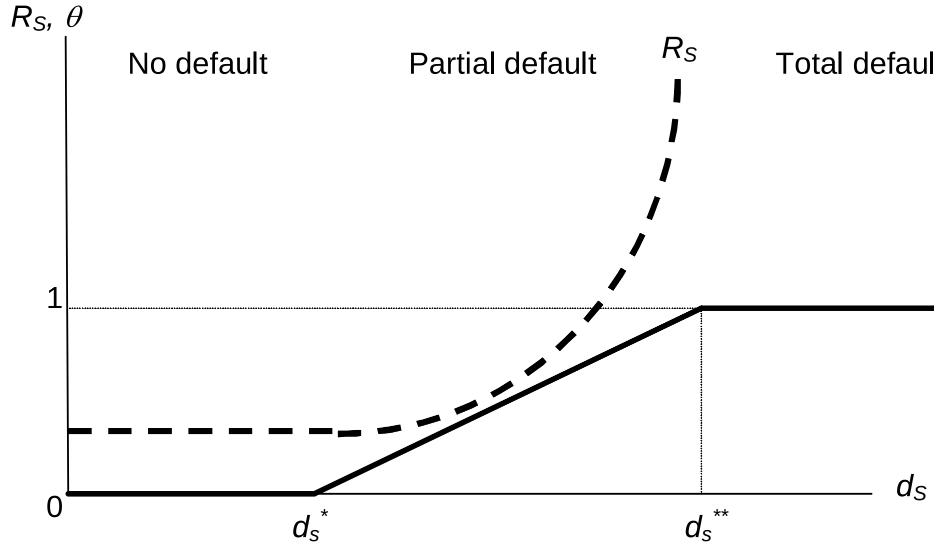
and:

$$d_S^{**} = \frac{t^* y_1 - g_1}{(1 + R) e_1} = d_S^* + \frac{R_L d_L}{(1 + R)} \tag{10b}$$

As can be verified from (9), for values of d_S such that $d_S \leq d_S*$, we must have $\theta = 0$. That is, for small enough levels of short-term debt, the government will be able to service its debt fully. This means that it will be able to borrow short-term up to $d_S = d_S*$ and, by (1), will be able to do so at the risk-free interest rate. On the other hand, for values of d_S that satisfy $d_S* < d_S < d_S**$, equation (9) implies that the government will partially default on its debt (i.e., $0 < \theta* < 1$). In this case, since creditors can protect themselves from partial default by adjusting the contractual interest rate, the government can still borrow short-term. However, since equation (9) implies that the default rate is increasing in the stock of short-term debt outstanding, equation (1) implies that in this range the government's contractual borrowing rate increases with the amount of short-term debt incurred. The maximum amount of short-term debt that the government can undertake, however, is d_S**. Beyond this point, it is impossible for short-term creditors to set an interest rate for their claims on the government that would yield them a market return, given the resources expected to be at the government's disposal. Consequently, they are unwilling to extend new loans to the government.

The supply curve for short-term debt is illustrated in the form of the dashed curve in Figure 1. As long as $d_S < d_S*$, the government can borrow short-term at the risk-free interest rate R. For values of d_S that exceed d_S*, θ becomes positive and the government can engage in short-term borrowing, but only by paying the higher interest rate $R_S = (1 + R)/(1 - \theta) - 1$. As d_S approaches d_S**, however, creditors become unwilling to extend short-term loans at any contractual interest rate.

Figure 1: Short-Term Debt Supply Curve



Notice from equations (10a) and (10b) that the critical values d_S* and d_s** depend on variables such as the size of the primary surplus, the contractual debt service payments due on long-term debt, the risk-free interest rate, and the exchange rate. Thus, changes in these variables will induce shifts in the position of the supply curve for short-term debt. As long as the position of the curve is such that $d_s* > 0$, the government has the option of borrowing without incurring even a partial default. If $d_s* = 0$, any level of short-term borrowing implies at least a partial default. If the position of the curve is such that $d_s** = 0$, however, the government must be in full default. Thus, default arises when the supply curve for short-term debt shifts sufficiently to the left. The next two sections explore how such shifts can come about.

III. DEBT SUSTAINABILITY AND THE EXCHANGE RATE

As mentioned at the end of the last section, the exchange rate is one of the variables that can affect the critical values d_s* and d_s**.[10] This raises the question of the role of exchange rate policy in influencing the government's default decision, and thus its ability to engage in short-term borrowing. We consider that issue in this section.

A. Exchange Rates and Short-Term Debt

We are interested in identifying the effects of exchange rate changes on the credit supply curve depicted in Figure 1. To address this issue, we can simply differentiate d_S* with respect to e_1. Recall that d_S* is given by:

$$d_S* = \frac{t*y_1 - g_1 - R_L\, d_L\, e_1}{(1 + R)\, e_1}.$$

Using equation (3), this becomes:

$$d_S* = \frac{t*[y* - \alpha/2(e* - e_1)^2] - g_1 - R_L\, d_L\, e_1}{(1 + R)\, e_1}.$$

$$= \frac{t*[y* - \alpha/2(e* - e_1)^2] - g_1}{(1 + R)\, e_1} - \frac{R_L\, d_L}{1 + R}.$$

[10] As can be verified from equations (10a) and (10b), d_S* and d_S** depend on the exchange rate, but the *difference* between them does not.

Differentiating this expression with respect to e_1, we have:

$$dd_S^*/d\,e_1 = \frac{t^*\,\alpha(e^* - e_1)}{(1 + R)\,e_1} - \frac{t^*y_1 - g_1}{(1 + R)\,e_1}$$

$$= (1/(1 + R)\,e_1)\{\,t^*\,\alpha(e^* - e_1) - (t^*y_1 - g_1)\} \qquad (11)$$

Thus, an exchange rate depreciation has two effects on d_S^*, shown on the right-hand side of (11):

i. A change in the exchange rate affects the magnitude of exchange rate misalignment, and through this channel influences domestic output and tax revenue. This effect is captured by the first term above. For example, if the currency is initially overvalued ($e^* > e_1$), an exchange rate depreciation increases real output, which increases government revenues and thus makes it possible for the government to sustain a larger burden of short-term debt, causing d_S^* to increase. If it is undervalued, on the other hand, an exchange rate depreciation aggravates the extent of misalignment, thus reducing real output and tax revenues, thereby *reducing* the volume of short-term debt that the government's fiscal resources can support.

ii. At the same time, exchange rate depreciation reduces the foreign-currency value of the government's primary surplus. This unambiguously *decreases* the amount of foreign currency-denominated debt that the primary surplus can support. This effect is larger the larger the initial value of the primary surplus, and is captured by the second term.

Thus, the key factors in determining the net result of these two effects are the sign and magnitude of real exchange rate misalignment $(e^* - e_1)$, the sensitivity of real output to such misalignment (α), and the magnitude of the government's initial capacity to service debt (its initial primary surplus). If the extent of overvaluation of the currency is substantial, the effects of misalignment on real output are very powerful, and the domestic-currency component of the primary surplus is small — specifically, if $t^*\alpha(e^* - e_1) > (t^*y_1 - g_1)$ -- then an exchange rate depreciation will increase both d_S * and d_S **. In that case, the loan supply curve of Figure 1 will shift to the right. If this condition is reversed, on the other hand, the curve will shift to the left. This condition turns out to be critical in interpreting the contrasting experiences of Mexico and Argentina.

B. Argentina

The application of the results of this section to the Argentine case is straightforward. At the time of its crisis in 2002, Argentina maintained a hard peg in the form of a currency board that had gained substantial credibility after having survived the "tequila" effects associated with the Mexican crisis in early 2005. Prior to the ultimate collapse of the currency board, however, the Argentine government had been forced to pay high premiums to renew its short-term debt. These high premiums did not reflect currency risk, but rather default risk.[11] Our model points to exchange rate overvaluation as a likely culprit for these premia. Notice first that differentiating d_S* with respect to the equilibrium real exchange rate e^* yields:

$$dd_S^*/d\,e^* \;=\; -\; \frac{t^*\,\alpha(e^* - e_1)}{(1+R)\,e_1} \;<0 \;\text{if}\; (e^* - e_1) > 0.$$

That is, starting from a position of overvaluation, an appreciation of the equilibrium real exchange rate shifts the loan supply curve to the left. Many observers have concluded that the cumulative inflation since the adoption of the currency board in 1991left the Argentine peso substantially overvalued by the mid-1990s. The combination of cumulative Argentine current account deficits, the appreciation of the U.S. dollar in the second half of the 1990s, the effect of the Asian financial crisis on world commodity prices, and the depreciation of the Brazilian currency that was associated with the currency crisis in that country at the beginning of 1999, would all have contributed to a substantial depreciation of the country's equilibrium real exchange rate e^* , culminating in a very large overvaluation of the Argentine peso — i.e., a very high value of $(e^* - e_1)$ – by 2001-2002.[12]

The Argentine case can thus be interpreted as one in which the loan supply curve was displaced sharply to the left by a severe pre-existing overvaluation of the currency.

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[11] The premia in question were on dollar-denominated Argentine government obligations. See Serven and Perry (2004).

[12] Alberola, Lopez, and Serven (2004) for example, estimated that the Argentine peso was overvalued by about 44 percent in 2001, while both Gay and Pellegrini (2003, as well as Serven and Perry (2004), estimated the magnitude of overvaluation to be over 50 percent for the same year.

Given this severe overvaluation, and the relatively lax fiscal policies that Argentina pursued during the 1990s (according to Serven and Perry (2004), its consolidated primary surplus averaged 0.1 percent of GDP during 1998-2001), our model suggests that the inability to devalue the exchange rate may have played a critical role in the Argentine debt crisis, since under these conditions an exchange rate devaluation – if it could have been implemented -- would have provided the means to shift the supply curve back to the right. Thus, default risk may have emerged in the Argentine case precisely *because* the currency board made the exchange rate peg credible, at least in the short run.

In short, the depressing effects of severe overvaluation on economic activity and tax revenue in Argentina, combined with the commitment to the exchange rate peg, implied that d_S * and d_S ** were relatively low, implying the possibility of a default even without an exceptionally large preexisting debt burden (Argentina's debt/output ratio was approximately 50 percent of GDP in 2001). Thus, default became a possibility in Argentina precisely because devaluation was not.

But why should creditors take the government's tax effort as given under these circumstances? Could they not expect the government to make a larger fiscal effort in this case? The answer is no, because as indicated in the discussion of equation (7), the government's optimal tax rate in period 1 is not a function of the degree of exchange rate overvaluation. The optimal tax rate that yields the probable default scenario already takes into account the social costs of default. The government therefore cannot precommit to applying the tax rate that would be required to yield a sufficiently large volume of resources in period 1 to service its debt fully. Because the government always has the incentive to levy the tax rate implied by (7) and default on the excess of its debt service obligations over its primary surplus, it would not be rational for its creditors to expect it to levy a tax rate other than t^*.

This leaves another question, however. Just as is the tax rate, the exchange rate is a policy instrument that can at least potentially be chosen by the government. Could a default scenario such as Argentina's ever emerge in the absence of the very large costs of exchange rate adjustment that we have assumed in this section? Another way of putting this is as follows: if the costs of altering the exchange rate are *not* prohibitive, would it ever be optimal for the government to choose a value for e_1 that places its short-term debt in the partial-default range to the right of d* or in the full default range above d^{**}? The next section takes up that question.

IV. THE SUPPLY OF SHORT-TERM DEBT UNDER A SOFT EXCHANGE RATE PEG

Although we have argued that in the Argentine case a more depreciated exchange rate would have shifted the supply curve of short-term debt to the right, we have seen that there exist circumstances under which, if creditors anticipate more depreciated values of the exchange rate, they would demand a higher default risk premium from the government or refuse to extend short-term debt at all. That is, a more depreciated exchange rate could also shift the supply curve of short-term debt to the *left*. The question now is: is it ever rational for the government to implement an exchange rate that would induce its creditors to behave in this way? In particular, given the use of the exchange rate as a policy instrument, can it ever be optimal for the government to choose a level of the exchange rate that would result in partial or complete debt default? If the answer is yes, then devaluation-cum-debt crisis can be an equilibrium outcome under a soft peg.

A. Optimal Exchange Rate Policy

Suppose, then, that the government simultaneously chooses the exchange rate, tax rate, and default rate on debt. That is, it chooses t^*, e_1 , and θ so as to maximize:

$$c_1 = (1 - t - z(t))(y^* - \alpha/2(e^* - e_1)^2) - a\theta De_1 - \psi/2(e_1 - e_0)^2, \tag{12}$$

subject to its budget constraint (6). Since the effects of changes in the tax rate on (12) are not a function of the exchange rate, the solution for t^* remains unchanged and continues to be given implicitly by equation (7). The first-order condition for the optimal value of the exchange rate is given by:

$$e_1 = e^* - \frac{aD + \psi(e^* - e_0)}{\alpha(1 - t^* - z(t^*) + at^*) + \psi}. \tag{13}$$

This equation determines the optimal exchange rate under discretion. As can be verified from (13), in setting the optimal exchange rate, the government does not necessarily seek to eliminate misalignment entirely. While misalignment is indeed costly (it results in reduced output and an associated loss in consumption given by $\alpha(1 - t^* - z(t^*) + at^*)$), the government is discouraged from eliminating it entirely by two factors:

i. An exchange rate depreciation affects the size of any default and implies a utility cost associated with nonzero default. This factor induces the government to maintain an overvalued currency (note that this effect is not present if $a = 0$).

ii. In addition, however, the assumed marginal utility cost of exchange rate adjustments acts to prevent the government from making large exchange rate changes. If the currency is initially overvalued $(e^* > e_0)$, this reinforces the tendency to overvaluation, while if it is undervalued $(e^* < e_0)$, it acts to offset that tendency. Note that as $\psi \rightarrow \infty$, we have $e_1 = e_0$, which was the case analyzed in the previous section.

B. Perfect Foresight Equilibrium

To solve for the equilibrium in this case, we use equation (9) as before, together with the optimal exchange rate policy (13) and the arbitrage condition (1). From equation (9), we can derive the effects of exchange rate changes on the default ratio. Differentiating (9) with respect to e_1, this effect is given by:

$$d\theta/de_1 = (R_L\, d_L\, e_1^2)^{-1}\{ (t^* y_1 - g_1) - t^*\, \alpha(e^* - e_1)\} \tag{14}$$

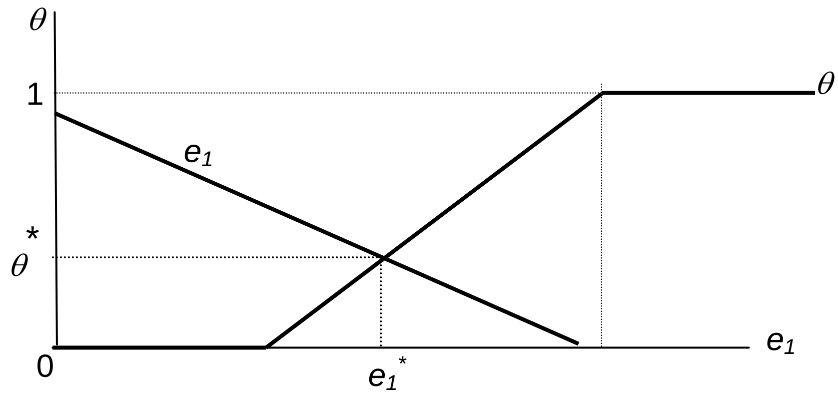
A depreciation of the exchange rate is likely to increase the default ratio (i.e., this effect is likely to be positive) the larger the initial primary surplus and the smaller the initial degree of real exchange rate overvaluation. Under these conditions, the loss in the foreign-currency value of the resources available to service debt will be large, while the revenue gains arising from the output effects of the depreciation will be small. However, if the initial value of the primary surplus is sufficiently small and the initial degree of real exchange rate overvaluation sufficiently large (thus making the output response to a change in the real exchange rate large as well), a depreciation yields sufficient revenue gains on balance to reduce the default ratio.

In the previous section, we argued in effect that $(t^*y_1 - g_1) - t^*\alpha(e^* - e_1) < 0$ was a reasonable assumption for Argentina on the eve of its debt crisis. The opposite may be true for Mexico. First, Mexico made a substantial fiscal adjustment in the late 1980s, and ran consistently large primary surpluses during the period leading up to its financial crisis at the end of 1994.[13] Second, while most observers concur that the Mexican peso was overvalued at the time of the crisis, estimates of pre-crisis overvaluation for Mexico have tended to be much smaller than for Argentina.[14] Thus, in the case of Mexico it is more likely $(t^*y_1 - g_1) - t^*\alpha(e^* - e_1) > 0$. Accordingly, on the assumption that $d\theta/de_1$ •0, equation (9) is depicted graphically in Figure 2 in the form of the curve labeled •.

[13] In contrast with Argentina's average primary surplus of 0.1 percent in the four years leading up to its crisis, Mexico's primary surplus averaged around 6 percent of GDP during 1991-94.

[14] Dornbusch and Werner (1994), for example, estimated the overvaluation of the Mexican peso on the eve of the crisis at around 20 percent.

Figure 2: Optimal Exchange Rate and Default Ratio



To determine how the optimal exchange rate policy is affected by the expected default ratio, substitute (1) into (13) and differentiate with respect to θ. This yields:

$$de_1/d\theta = - \frac{a(R + 1)d_S/\Delta}{(1 - \theta)^2} < 0, \qquad (15)$$

where $\Delta = \alpha[1 - t^* - z(t^*) + at^*] + \psi > 0$. An increase in the expected probability of default increases the contractual interest rate that short-term creditors demand, and the resulting increase in the government's debt-service obligations discourages it from devaluing the exchange rate, since doing so increases the size and thus the utility cost of a default. The curve depicting the optimal exchange rate policy as a function of the default rate is labeled e_1 in Figure 2, and is depicted with the negative slope implied by (15). The equilibrium values of the exchange rate and default rate are found at the intersection of the θ and e_1 curves, and are labeled θ^* and e_1^* in Figure 2.

Figure 2 illustrates a case in which the optimal default ratio is positive, but less than unity. Under this scenario, the government remains able to incur short-term debt, but only at punitive interest rates that factor in the expected default. It is easy to see, however, that this outcome is not necessary, and that there are alternative circumstances under which perfect foresight equilibria would entail full debt service or an anticipated default and a consequent inability by the government to incur new short-term debt.

To examine the effects of the exchange rate regime on such equilibria, consider the effects of changes in the penalty associated with altering the exchange rate, ψ. From equation (13), the effect of a change in ψ on the optimal exchange rate is given by:

$$de_1/d\psi = - \Delta^{-1} \left\{ (e^* - e_0) - \frac{aD}{\alpha(1 - t^* - z(t^*)) + at^*} \right\} \qquad (16)$$

This expression must be negative if the initial degree of overvaluation exceeds the optimal value corresponding to $\bullet = 0$ – i.e., if the government would have an incentive to depreciate the currency in the absence of the penalty attached to exchange rate changes. In that case, (16) implies that an increase in ψ would tend to discourage the government from depreciating the currency.

Now suppose that, starting from an initial position such as that in Figure 2 and from a sufficiently large initial overvaluation of the currency, the costs of making exchange rate adjustments were to *decrease* (say because a new political administration is not held to the exchange rate commitments made by a previous administration). For a given value of θ, if condition (16) holds, a reduction in ψ would be associated with a more depreciated value of e_1. That is, the e_1 locus in Figure 2 would shift vertically upward. Since the change in ψ has no effect on the θ locus, the increased “softness” of the peg would have the effect of increasing the default ratio, possibly to the point where the ratio equals unity. Anticipating a default under these circumstances, short-term creditors would refuse to extend new loans to the government.

B. Mexico

The application of such an exercise to the Mexican case is direct. In anticipating the effects of a devaluation of the Mexican peso, the key consideration for the government’s short-term creditors in deciding whether and on what terms to extend new short-term credits to the government would have been to determine by how much the devaluation would have increased real economic activity — and thus boosted tax revenues — in Mexico in the short run, given the fiscal effort that the Mexican authorities could have been expected to make (in the form of the optimal tax rate t^*). If the market determined that this effect was not likely to be very large (perhaps because the currency was not severely misaligned in the first place, or because misalignment had a relatively minor effect on real output), then the negative effect of the devaluation on the foreign exchange value of the government’s primary surplus would have worsened the government’s fiscal position in the short run. Under these circumstances, creditors would rationally have responded to the anticipated devaluation by renewing their loans at a higher premium in the expectation of a partial default or by refusing to roll over their loans at any interest rate, if their expectation was for a full default. However, the devaluation would nonetheless have been perceived as welfare-enhancing on the part of the government and thus would have been enacted despite its implications of default. From equation (16), the conditions that make such an outcome more likely, in addition to large initial overvaluation, are low perceived costs of default and large perceived benefits of eliminating misalignment.

V. MULTIPLE EQUILIBRIA

As argued in Section III, it is possible that for a highly overvalued exchange rate, the default rate is high or even unity. We saw from equation (14) that if the primary surplus is sufficiently small and the response of output to a depreciation sufficiently high, the default rate would tend to be decreasing with e_1. However, as can be readily verified from (14), $d^2\theta/de_1^2 > 0$. Thus, as the exchange rate depreciates and the degree of misalignment is reduced, it is possible that the effects of the exchange rate on the default rate would be reversed, resulting in a situation such as that analyzed in Section IV. If this is so, the situation we have analyzed may be characterized by multiple equilibria.

The critical value of e_0 at which the effects of the exchange rate on the default rate are reversed is found by setting (14) equal to zero and solving for e_0. We can then determine the values of the parameters for which multiplicity of equilibria can arise. The critical value, if it exists, is given by:

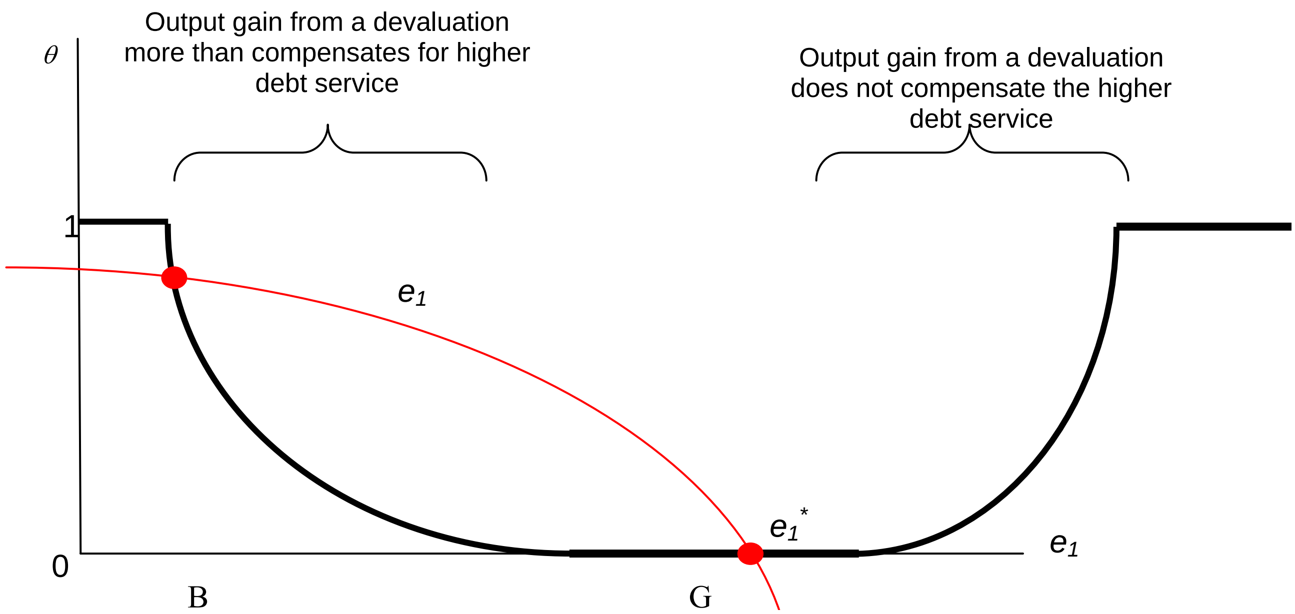
$$e^{CR} = e^{*} - (t^{*} y^{*} - g_1) / (\alpha t^{*} e^{*})$$

If this expression is negative, e^{CR} does not exist. We can see this as a condition on the parameter α. If $\alpha < (t^{*} y^{*} - g_1)/(t^{*} e^{*2})$, the economy's level of real output is not sufficiently responsive to real exchange rate misalignment to allow for the existence of multiple equilibria, and for such a country a devaluation implies a constant or higher default rate. This is the case presented in Figure 2.

However, if $\alpha \geq (t^{*} y^{*} - g_1)/(t^{*} e^{*2})$, then a positive value for e^{CR} exists. For any value of e_1 smaller than e^{CR}, exchange rate depreciation is associated with a constant or *decreasing* default rate. For any value of e_1 greater than e^{CR}, on the other hand, exchange rate depreciation is associated with a constant or *increasing* default rate. In that case, given the exchange rate policy response, two equilibria exist, as shown in Figure 3. In one equilibrium (labeled B in the figure below), the real exchange rate is heavily appreciated and the default rate is high because tax revenues are low. In the other (labeled G), the real exchange rate is relatively depreciated, tax revenues are high, and the default rate is low. It is straightforward to make a welfare comparison of these two equilibria (based on equation (2)). Welfare must be higher under the low-default equilibrium, because output is higher and the default rate is lower, permitting a higher level of private consumption.

It is worth making several observations about this possible multiple-equilibrium outcome. First, multiple equilibria can arise only in countries with a relatively high

Figure 3: Multiple Equilibria



output response to real exchange rate misalignment. Countries whose exports are based on a small set of primary commodities probably do not fit that pattern. However, middle-income emerging economies that have oriented their development towards the export market, such as Mexico and Argentina, may well do so. Second, under a soft peg, the government has no means of selecting between these outcomes. However, it may be able to avoid the bad equilibrium through its choice of exchange rate regime. Specifically, if the country adopts a hard peg, the exchange rate response curve becomes vertical and there is only one equilibrium. If the value of the exchange rate is chosen appropriately under a hard peg, for example, the good equilibrium G would be unique.

Thus, the existence of multiple equilibria highlights the risks and dilemmas faced by emerging market economies. On the one hand, an open economy characterized by a high elasticity of output to the real exchange rate can effectively use the exchange rate as an instrument to promote export-oriented growth. On the other hand, exchange rate flexibility makes the economy more dependent on investors' expectations. In this case, it is possible to end up in a bad equilibrium characterized by a debt crisis, a real exchange appreciation, and a recession. That outcome can be avoided by the choice of a hard peg (currency board or monetary union), in which case only one equilibrium exists and is fully determined by the choice of the parity, which can potentially anchor investors' expectations to the good equilibrium. However, for this felicitous outcome to emerge, the parity must be *right* -- that is, in the no-default zone of Figure 3. If the peg is set at an overvalued or undervalued level, default can readily occur. Moreover, as we have seen, the position of the θ curve depends on the economy's equilibrium real exchange rate. Because of the rigidity of the hard peg, external shocks can move the country from a no-default zone to a default zone. In this case, the inability to make exchange rate adjustments when they are required increases the likelihood of a debt crisis.

VI. SUMMARY AND CONCLUSIONS

We have developed a model that is able to capture the links between exchange rate policy and debt default. Existing empirical work acknowledges that this link is strong. However, the interactions between exchange rate policy and debt repayment have not been investigated analytically. Our model allows us to determine what types of equilibria can be expected and why. We find that the exchange rate that creditors expect to prevail in the future will in general affect the supply of credit to the government, but the direction of this effect depends on the economy's circumstances.

For instance, when the government's primary surplus is small and exchange rate misalignment is very costly in terms of foregone government revenues, the absence of the option to alter the exchange rate, as under a hard peg, can put the government in a no-devaluation and default equilibrium. On the other hand, when the government is running a relatively large primary surplus, and when devaluation is not likely to have very large positive effects on government revenues (either because the exchange rate is not far from equilibrium or because the economy's real output is not greatly affected by exchange rate misalignment), it can be optimal for a government managing a soft peg to implement an exchange rate change that results in a debt crisis.

Our model is thus able to reconcile the seemingly contradictory experiences of Mexico and Argentina. By 2002, the severe overvaluation of its currency placed Argentina at the extreme left-hand side of the θ curve in Figure 3, where $\theta = 1$. The hard peg embodied in its currency board prevented it from escaping this region by depreciating its currency. By contrast, with its currency experiencing much milder overvaluation, Mexico was on the upward-sloping portion of the θ curve in 1994. However, the increased "softening" of its exchange rate regime during the course of the year caused it to implement a devaluation that shifted it to the extreme right-hand side of the curve, where $\theta = 1$.

Put simply, the debt crisis in Argentina was brought on by the government's inability to depreciate the exchange rate, in a context in which doing so would have made the government a *more* attractive borrower, while the debt crisis in Mexico was brought on by an increased incentive for the government to depreciate the exchange rate, in a context in which doing so made the government a *less* attractive borrower.

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