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Exchange Rate-Based Stabilization with Endogenous Fiscal Response

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Abstract: In the context of a perfect foresight, intertemporal optimizing, cash-in-advance model, this paper studies the dynamics of an inconsistent exchange rate-based stabilization policy—a policy that fixes the exchange rate without an underlying fiscal adjustment to ensure that the exchange rate policy is sustainable in the long run. The perception that the exchange rate policy is temporary leads to an initial expansion in consumption, and since the model allows for distortionary taxes on consumption, to an endogenous increase in tax revenues large enough to eliminate the ex-ante fiscal deficit. Therefore an ex-ante inconsistent stabilization program displays, ex-post, all the features of a fiscally consistent one; i.e., a fixed exchange rate and no fiscal deficit. In contrast to the standard results, where the inconsistency between fiscal and exchange rate policy leads to a steady loss of international reserves and culminates in a "Krugman type" balance of payments crisis that forces the government to abandon the policy, this model predicts that along the path towards the "Krugman type" balance of payments crisis the economy displays no fiscal deficit and enjoys increasing international reserves.

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1. INTRODUCTION

The literature on balance of payments (b-o-p) crises, pioneered by Krugman (1979), studies the dynamics of inconsistent exchange rate-based (e-r-b) stabilization policy – a policy that fixes the exchange rate without an underlying fiscal adjustment to ensure that the exchange rate policy is sustainable in the long run. As a consequence of the inconsistency between fiscal and exchange rate policy, there is a steady loss of international reserves; and assuming that the central bank has a lower bound on its international reserve holdings, the exchange rate regime, i.e., the rate of devaluation, will have to be modified at some point in the future. The knowledge that a regime change will take place eventually tranforms, at a very precise point in time, a *balance of payments problem* – defined by Krugman (1979) as a situation in which a country is gradually losing reserves – into a *balance of payments crisis*, in which there is a sudden run against the domestic currency and a sudden fall of international reserves to a critical level. The sudden crisis is originated in the downward stock adjustment of the demand for money in anticipation of the regime change.

In Krugman's model, although the run against the domestic currency and the collapse of the exchange rate regime occur at a precise point in time, the inconsistency between exchange rate policy and fiscal policy, leading to the b-o-p crisis, is visible all along, since along the path to the crisis there is a fiscal deficit and a steady drainage of international reserves.

Calvo (1987) points out that the b-o-p literature has concentrated on the

b-o-p crisis itself, leaving aside equally important aspects of the dynamics of inconsistent stabilization policy, such as the consumption boom, the deterioration of the trade balance and current account, and the appreciation of the real exchange rate which generally characterizes the initial stages of e-r-b stabilization programs. It is only at the later stages that consumption contracts and the economy falls into recession (see Kiguel and Liviatan, 1992; Végh, 1992, and Calvo and Végh, 1994, Reinhart and Végh, 1995).

The simultaneous analysis of the two phenomena is pursued in Calvo (1987), which traces out the dynamics of inconsistent stabilization policy leading to a "Krugman type" b-o-p crisis, in the context of a perfect forseight, cash-in-advance economy. Calvo's model retains the predictions of the Krugman (1979) model; i.e., after the inconsistent policy is launched there is a steady loss of international reserves until a speculative attack against the domestic currency draws them sharply down to their critical level. At the same time the model accounts for the initial consumption boom and subsequent contraction that has generally been observed in e-r-b stabilization programs. The intuition behind the latter result is the following: a temporary reduction in the rate of devaluation reduces, also temporarily, the nominal interest rate. The reduction in the nominal interest rate reduces the current effective price of consumption vis à vis the future price and generates, via intertemporal substitution effects, an increase in current consumption. When the policy is abandoned - i.e. the rate of devaluation is increased - consumption falls below its pre-stabilization levels.[1]

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[1] For an analysis of the dynamics of inconsistent stabilization policy leading to a "Krugman type" b-o-p crisis in the context of a perfect forseight Sidrauski model, see Drazen and Helpman (1987).

In Calvo's model there is no link between the initial consumption boom and public sector finances. However, many of the tax systems in developing countries are based on spending taxes (such as the VAT, sales taxes or import tariffs), and the initial consumption boom should therefore endogenously increase tax revenues and improve the fiscal balance.[2] The endogenous improvement in the fiscal balance that may occur due to the forces unleashed in the initial stages of an e-r-b stabilization program turn it into an inappropiate measure of fiscal performance. In particular, the fiscal balance may be misleading as a basis for evaluating the sustainability (intertemporal consistency) of the stabilization program.[3]

This paper contributes to the understanding of the dynamics of temporary (inconsistent) stabilization programs leading to a "Krugman type" b-o-p crisis, by allowing for the presence of distortionary taxes on consumption in a Calvo (1987) cash-in-advance economy. Since temporary stabilizations in this context generate a boom in the level of consumption, tax revenues increase together with consumption and the fiscal deficit endogenously improves. The improvement may conceivably (for the appropriate values of the preference parameters) eliminate the fiscal deficit altogether. As a consequence, along the path to the b-o-p crisis the economy displays no fiscal deficit and no loss of international reserves.

A perfect foresight example is developed in which the announcement of an inconsistent stabilization program (in the sense that the program is

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[2] Moreover, since many countries that have carried out these programs were heavily indebted in foreign currency, the appreciation in the real exchange rate should generate an endogenous reduction in real interest payments.

[3] For empirical evidence on the links between the business cycle associated with e-r-b stabilizations and the behavior of government expenditures, tax revenues, and the fiscal deficit, based on Uruguay's stabilization experience, see Talvi (1995).

launched with an ex-ante incomplete fiscal adjustment) ends up ex-post displaying all the features of a fiscally consistent one: a program where the exchange rate is fixed, the fiscal deficit is eliminated, and international reserves increase up until the moment of the collapse of the program. It is in this type of context, where "what you see is not exactly what you get," that we believe we can understand why even apparently fiscally sound programs eventually collapsed.

The paper is organized as follows. **Section 2** introduces the model. **Section 3** obtains the steady state solution of the model with a constant and positive rate of inflation, which serves as benchmark for **Section 4,** where the dynamics of a temporary e-r-b stabilization with endogenous fiscal equilibrium is analyzed. **Section 5** performs some numerical simulations of the model. We calculate the required change in consumption necessary to eliminate the ex-ante fiscal deficit under alternative assumptions on the size of the pre-stabilization budget deficit. These values are then compared to actual increases in consumption observed in seven e-r-b stabilization programs. **Section 5** contains the policy implications of the model.

2. THE MODEL

2.1 The Consumer

Consider a small open economy with a representative consumer that derives utility from the consumption of a non-storable tradable good (which is assumed to have a constant price in terms of foreign currency). Lifetime utility is given by

$$\int_0^{\infty} U(c_t)\ \exp(-\beta t)\, dt \qquad (1)$$

where the instantaneous utility function, U(.) is assumed to be increasing, twice continuously differentiable, and strictly concave; c_t denotes consumption; and β is the subjective discount rate.

Consumers can hold two type of assets: domestic non-interest bearing money and an internationally traded bond which has a constant interest rate equal to r. Financial wealth of the representative consumer will be denoted by w and is given by:

$$w_t = b_t + m_t \qquad (2)$$

where m and b are real monetary balances and the stock of private bond holdings, respectively (debt is represented as negative bond holdings).

The consumer must use money to carry out his consumption purchases. Formally, he faces a liquidity-in-advance constraint

$$m_t \geq \alpha c_t \qquad \alpha > 0 \qquad (3)$$

which implies that real money balances are proportional to the value of consumption expenditures. Constraint (3) will hold with equality in equilibrium if the nominal interest rate is positive.[4]

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[4] The analysis in this paper deals only with situations in which the nominal interest rate is positive.

The evolution of the stock of private financial wealth is governed by the following differential equation:

$$\dot{w} = rw_t + y_t - (1 + \tau_t)c_t - i_t m_t \qquad (4)$$

where y denotes the endowment flow of the consumption good; τ is the consumption tax rate, and i denotes the instantaneous nominal interest rate in terms of domestic currency.

Using equations (3) and (4), and imposing the appropriate transversality conditions we can derive the intertemporal budget constraint of the representative consumer which is given by

$$w_0 + \int_o^\infty y_t \exp(-rt)\,dt = \int_o^\infty (1 + \tau_t + \alpha i_t)\ c_t \exp(-rt)\,dt. \qquad (5)$$

This equation says that the present value of consumption purchases cannot exceed the present value of the consumer's income stream and its initial level of wealth, w_o.

The consumer's optimization problem consists of choosing the path of c_t so as to maximize lifetime utility, equation (1), subject to the intertemporal budget constraint, equation (5). The first-order conditions for this optimization problem are:

$$U'(c_t) = \lambda(1 + \alpha i_t + \tau_t) \tag{6}$$

where λ is the (time invariant) Lagrange multiplier associated with the budget constraint (5).[5] Equation (6) indicates that at the optimum the marginal utility of consumption is proportional to the effective price of consumption, $1 + \alpha_t i_t + \tau_t$. The effective price of consumption includes the opportunity cost of holding the money that is needed to purchase goods as well as the consumption tax rate.

2.2 The Government

The government consists of a fiscal and a monetary authority which issues two types of debt: non-interest bearing debt (money) and an internationally traded bond which pays the world interest rate r (international reserves are represented by negative holdings of internationally traded bonds).

The evolution of the stock of government debt is governed by the following differential equation:

$$\dot{b}^g = rb_t^g + g_t - \tau_t c_t - (\dot{m} + \epsilon_t m_t) \tag{7}$$

where g are real government expenditures, and m + ϵm is the revenue collected by the government on account of the consumer's accumulation of real balances and the inflation tax. Since the only available way for the consumer to increase its holdings of money instantaneously is to sell

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[5] To eliminate inessential dynamics it has been assumed that the world real interest rate r equals the subjective discount rate β.

foreign bonds, at points where m takes a jump, we have

$$\Delta b^g = - \Delta m \ . \tag{8}$$

In line with the literature on balance of payments crises, we assume there is an upper bound on the ability of the government issue foreign bonds, which for the sake of concreteness, is assumed to be zero. Therefore,

$$b_t^g \leq 0 \qquad \textit{for all } t. \tag{9}$$

From equations (3) and (7) we can derive the intertemporal budget constraint of the government, which indicates that the present discounted value of government expenditures, plus the initial stock of debt ($b_o^g + m_o$) equals the present discounted value of the proceeds from consumption taxes and the inflation tax. Formally,

$$(b_o^g + m_o) + \int_o^\infty g_t \exp(-rt)\, dt = \int_o^\infty (\tau_t + \alpha i_t)\, c_t \exp(-rt)\, dt. \tag{10}$$

The combination of equations (5) and (10) yields the economy-wide intertemporal budget constraint

$$k_o + \int_o^\infty (y_t - c_t - g_t) \exp(-rt)\, dt = 0 \tag{11}$$

where $k_o = b_o - b_o^g$ is the value of the economy's initial bond holdings.

Equation (11) says that the present value of private and government consumption cannot exceed the present value of the endowment flow and the economy's initial claims against the rest of the world.

2.3 Equilibrium

The equilibrium current account path can be derived by combining the flow constraint of the consumer (4) and the flow constraint of the government (7) to obtain

$$\dot{k}_t = rk_t + y_t - (c_t + g_t). \tag{12}$$

Perfect capital mobility is assumed and it implies that:

$$i_t = r + \epsilon_t. \tag{13}$$

To obtain a closed-form solution for the equilibrium path of consumption, we assume the preferences are of the form

$$U(c_t) = \frac{c_t^{1-\frac{1}{\eta}} - 1}{1-\frac{1}{\eta}} \qquad \eta > 0 \tag{14}$$

where $\eta > 0$ is the intertemporal elasticity of substitution. Using equations (6) and (11), we obtain the following expression for the equilibrium value of the multiplier:

$$\lambda^{-\eta} = \frac{(b_o - b_o^g) + \int_o^\infty (y_t - g_t) \exp(-rt)\, dt}{\int_o^\infty (1 + \alpha i_t + \tau_t)^{-\eta} \exp(-rt)\, dt}. \qquad (15)$$

Substituting equation (14) into equation (6) yields the equilibrium consumption path

$$c_t = \frac{(1 + \alpha i_t + \tau_t)^{-\eta}}{\int_o^\infty (1+\alpha i_t+\tau_t)^{-\eta} \exp(-rt)\, dt} \left[(b_o - b_o^g) + \int_o^\infty (y_t - g_t) \exp(-rt)\, dt \right]. \qquad (16)$$

The ratio on the right hand side can be interpreted as the equilibrium marginal propensity to consume out of permanent income, which consists of a current effective price of consumption (the numerator) to an average effective price of consumption (the denominator).[6] If the current effective price of consumption $(1 + \alpha i + \tau)$ is expected to remain constant, the equilibrium marginal propensity to consume out of permanent income is equal to one. If the current effective price of consumption is expected to increase (decrease) at a future date and remain at that higher (lower) level thereafter, the current effective price will be lower (higher) than the average price, and therefore the equilibrium marginal propensity to consume out of permanent income will be higher (lower) than one.

These results are the same as those obtained by Calvo and Végh (1990). The

[6] This interpretation is due to Calvo and Vegh (1990).

key difference, however, is that ϵ is endogenous, and hence we need equation (10), the intertemporal budget constraint of the government, to close the model. An equilibrium is therefore defined as a path of nominal interest rates (devaluation rate), i_t, such that if it is expected to prevail, consumers will choose a path of consumption, c_t, which will generate tax revenues sufficient to finance the given stream of government expenditures, g_t, and the initial levels of government debt.

3. STEADY STATE EQUILIBRIUM WITH CONSTANT INFLATION.

To characterize the initial situation we assume, for simplicity, that y, g, τ and r are constant over time. Using equation (16) it is straightforward to show that the steady state equilibrium consumption is constant and equal to

$$\bar{c} = r(b_o - b_o^g) + (y - g). \tag{17}$$

Substituting equation (16) into (10), we obtain the steady state constant devaluation rate, which is given by

$$\bar{\epsilon} = \frac{g + rb_o^g}{\alpha \bar{c}} - \frac{\tau}{\alpha}. \tag{18}$$

In the discussion that follows, we assume the initial situation is characterized by a positive steady state rate of devaluation and inflation, which implies $g + rb^g > \tau\bar{c}$. Along that path, goverment debt, b^g, remains constant over time.

4. STABILIZATION WITH ENDOGENOUS FISCAL EQUILIBRIUM

We are now ready to examine the central experiment of the paper. Consider a situation where the government initiates a stabilization program and fixes the exchange rate (sets $\epsilon = 0$) without any underlying adjustment in the fiscal deficit; i.e., g and τ remain unchanged. This policy is infeasible in the long run, since it is inconsistent with the fiscal constraints. As a result, the government must revert to a consistent rate of devaluation at a finite point T, when the debt constraint is binding.

Formally, we assume

$$i_t = i^l = r \qquad 0 \leq t < T \tag{19}$$

$$i_t = i^h = \epsilon^h + r \qquad t \geq T \tag{20}$$

where $i^h > i^l$.

From the first order conditions of the consumer (6), or from equation (16), it is clear that consumption is constant in both periods, but higher during the interval [0,T), the transition period, than during the interval [t,∞], the post-stabilization period. Furthermore, consumption will be higher than the steady state level of consumption during the transition period, and lower during the post-stabilization period.

We consider a situation where, due to the existence of consumption taxes, the increase in current consumption (in response to a reduction in its intertemporal effective price) is just enough to generate an expansion in tax revenues, that eliminates the fiscal deficit altogether (as it will become clear below, this implies a restriction on the preference

parameters). Formally, the solution to our problem is given by the following system of equations:

$$\left(\frac{c^h}{c^l}\right)^{\frac{1}{\eta}} = \frac{1 + \tau + \alpha(r + \epsilon^h)}{1 + \tau + \alpha r} \tag{21}$$

$$c^h\,(\,1 - \exp(-rT)\,) + c^l\exp(-rT) = (y - g) + r(b_o - b_o^g) \tag{22}$$

$$\tau c^h(\,1 - \exp(-rT)\,) + (\tau + \alpha\epsilon^h)c^l\exp(-rT) = g + rb_o^g \tag{23}$$

$$\tau c^h = (\tau + \alpha\bar{\epsilon})\bar{c} = g + rb_o \tag{24}$$

where c^h and c^l represent consumption in the transition period and the post-stabilization period, respectively. Equation (24) implies that c^h must be such that fiscal balance is obtained.

Given equation (24) it must be the case, for the intertemporal budget constraint of the government to hold, that

$$(\,\tau + \alpha\epsilon^h)c^l = g + rb_o \tag{25}$$

which implies

$$\epsilon^h = \left(\frac{g + rb_o}{\tau c^l} - 1\right)\frac{\tau}{\alpha} = \left(\frac{c^h}{c^l} - 1\right)\frac{\tau}{\alpha}. \qquad (26)$$

Substituting equation (26) into equation (21) we obtain

$$x^{\frac{1}{\eta}} = 1 + \left(\frac{\tau}{1 + \tau + \alpha r}\right)(x - 1) \qquad (27)$$

where $x = c^h/c^l$. Using equations (27), (26) and (22) we solve for c^l, ϵ^h and T, repectively. Figure 1 graphically illustrates the solution the system.

If the intertemporal elasticity of substitution, η, is restricted to be larger that one and smaller than $1 + \tau + \alpha r/\tau$, there is a feasible solution to the system where $c^h > \bar{c} > c^l$, i.e, $x > 1$. If η takes on any other value, the system of equations has no solution.[7] For the given value of $x > 1$, equation (26) solves for the value of inflation in the post-stabilization period. It is staightforward to see that the post-stabilization level of inflation will be higher than the pre-stabilization level.[8] Finally, the solution for $T > 0$ can be obtained by substituting the values of c^h and c^l into equation (22). The interpretation of these results will be discussed below.

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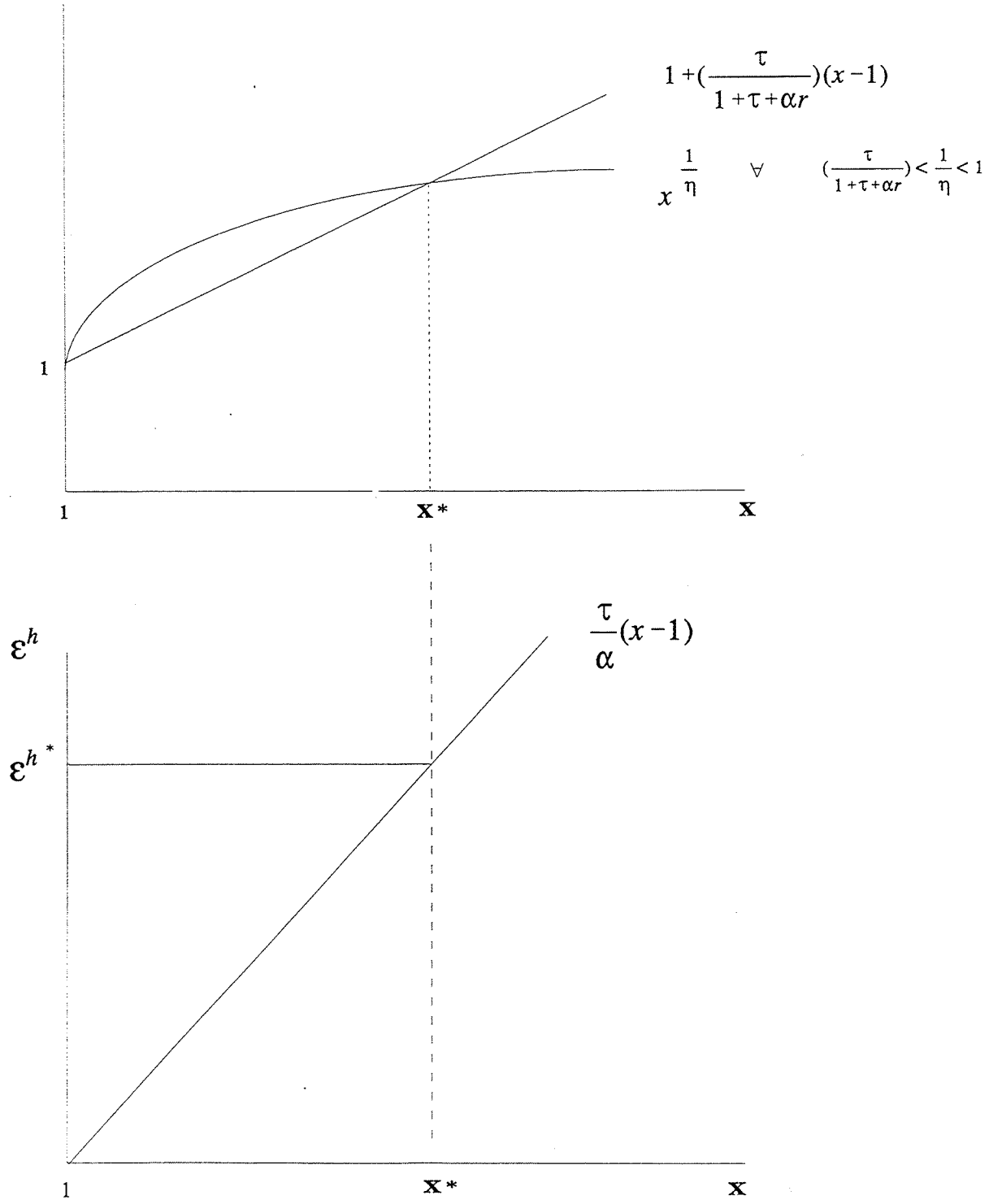
[7] The solution where $x = 1$ is not feasible. Equation (24) implies that $c^h > \bar{c}$; therefore, the solution where $x = 1$ violates the consumer's budget constraint (22).

[8] This is the result obtained by Sargent and Wallace (1981) in the case where the demand for money exhibits constant income velocity.

Figure 1: Graphical Solution of the Model



We now need to make sure that international reserves are fully depleted at time T without violating the non-positivity condition (9). It is sufficient to assume that initial government net debt (net of international reserves) is zero to ensure that international reserves will be fully depleted at T. To see this, consider the value of government net debt, just before the end of the stabilization program which is given by

$$\overline{b}_T^g = \Delta b_o^g \exp(rT) = -\Delta m_o \exp(rT) = -\alpha(c^h - \overline{c})\exp(rT). \tag{28}$$

On the other hand, the sudden change in the demand for money which occurs at t = T is given by

$$\Delta m_T = -\alpha(c^h - c^l). \tag{29}$$

In order to ensure full depletion of international reserves and to satisfy the non-positivity condition (9), it must be the case that at t = T

$$\overline{b}_T^g = -\alpha(c^h - \overline{c})\exp(rT) = -\alpha(c^h - c^l) = \Delta m_T. \tag{30}$$

Equation (22) can be rearranged to show that this condition will be satisfied, since

$$c^h - c^l = (c^h - \overline{c})\exp(rT). \tag{31}$$

Therefore, if government net debt is initially zero, the international reserves accumulated during the transition period will be fully depleted

at time T, when the stabilization program collapses.

Finally, the path of government net debt and the primary fiscal deficit (which excludes interest payments) is described by the following equations:

$$\dot{b}^g = rb_o^g + g - \tau c^h = -r\Delta m_o \exp(rt) \qquad 0 \leq t < T \qquad (32)$$

$$\dot{b}^g = rb_T^g + g - (\tau + \alpha\delta\epsilon^h)c^1 = 0 \qquad t \geq T \qquad (33)$$

$$d_t = g - \tau c_t \qquad (34)$$

where d_t is the primary fiscal deficit.

We now proceed to the discussion of the main results of the paper, which are illustrated in Figures 2.1 and 2.2.

The consumption path follows from equations (24) and (27). When the rate of devaluation is reduced to zero at t=0, consumption rises above its steady state level and remains constant until t=T. At t=T consumption falls below its steady state level.

The path of government net debt, i.e., international reserves, is described by equations (32) and (33). At t=0, when consumption increases, the consumer exchanges money for bonds at the central bank to achieve the desired level of real money balances. This means that at t=0 there is an expansion in the supply of money matched with an identical gain of

Figure 2.1

Temporary Stabilization with Endogenous Fiscal Equilibrium

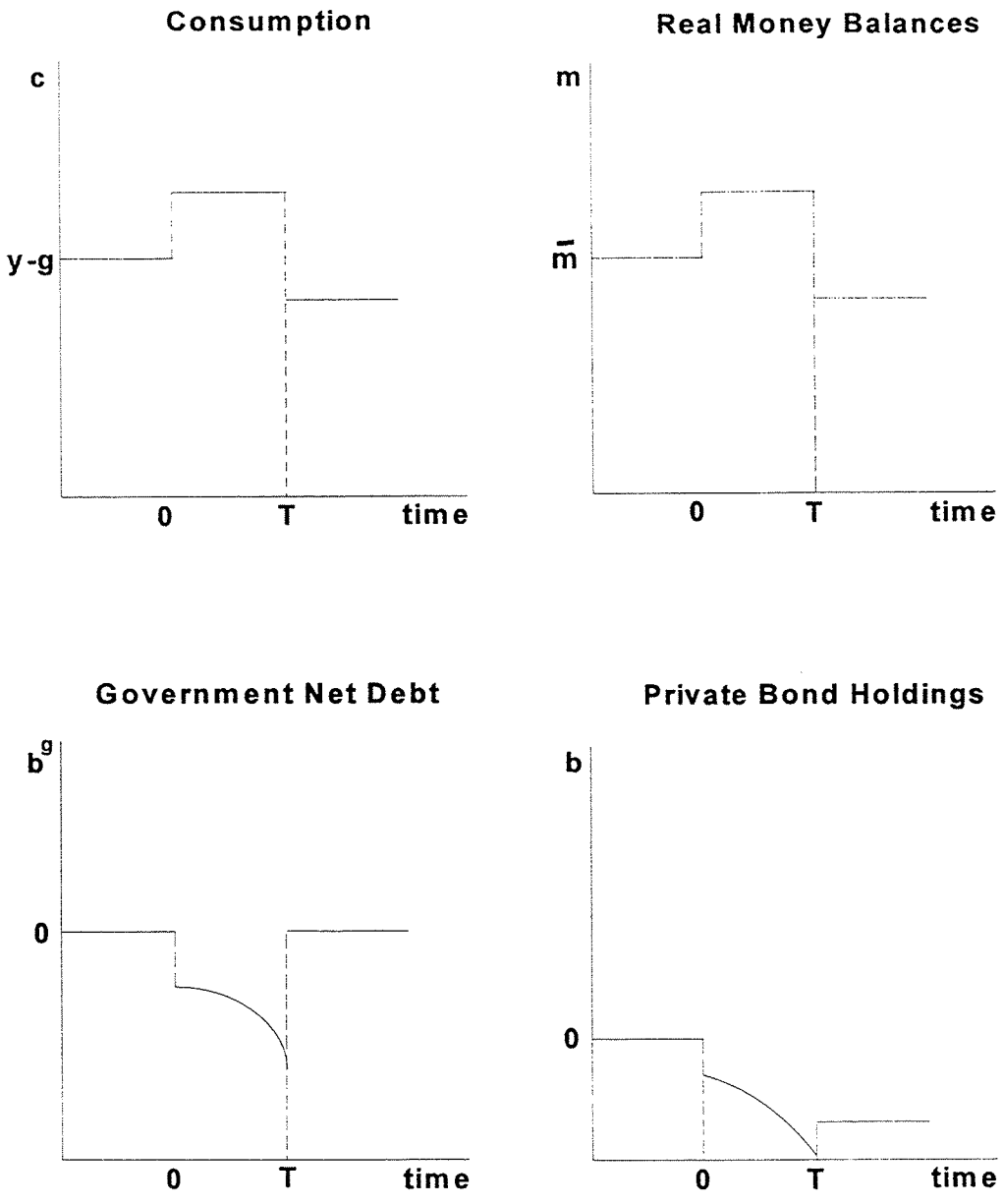
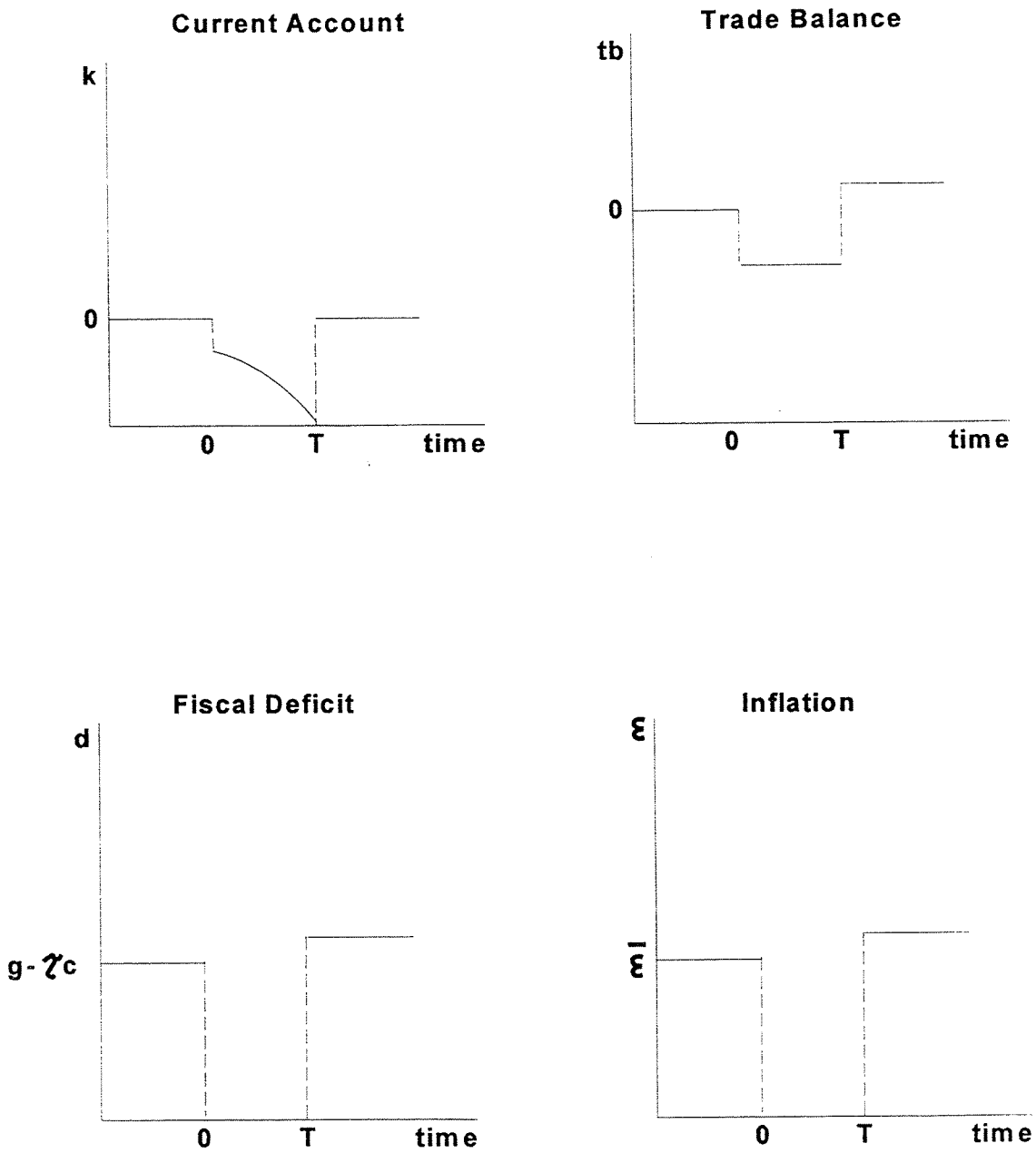


Figure 2.2

Temporary Stabilization with Endogenous Fiscal Equilibrium



international reserves. During the transition period, international reserves continue to accumulate (government net debt decreases) due to the interest earned on the initial gain and the fact that the primary fiscal deficit is balanced. At t=T, when consumption falls, the consumer exchanges bonds for money at the central bank to reduce the level of real balances. This means that at t=T there is a contraction in the supply of money matched with a loss of international reserves until reserves hit their critical level. Therefore, the model predicts that the stabilization program will end with a run on central bank reserves.

The trade balance, $tb_t = y - g - c_t$, jumps into deficit at t=0 due to the jump in consumption, and so does the current account (see equation 12). The trade balance deficit remains constant throughout the stabilization program, but the current account deficit deteriorates over time due to the increase in interest payments on private foreign debt. At t=T the current account jumps back into balance. Since at t=T foreign debt ceases to grow but does not decline, the trade balance must jump into surplus.

The primary fiscal deficit, as measured by equation (34), improves at t=0 when the stabilization program is launched. However, it is important to stress the endogenous nature of the improvement. The government initiates a program without any underlying fiscal adjustment; i.e., there is no change in either g or τ. The public's perception that the program is only temporary (inconsistent) reduces the effective relative price of current consumption, thereby generating a consumption boom. The consumption boom increases consumption tax revenues, and we have assumed that the increase is large enough to eliminate the budget deficit. Hence a stabilization program that is initiated with an ex-ante incomplete fiscal adjustment; i.e, the exchange rate policy is unsustainable in the long run, and by its very nature creates the perception of temporariness, unleashes a

consumption boom that contributes to eliminate the fiscal deficit and to generate the ex-post appearance of a full blown stabilization program in which the exchange rate is fixed and the fiscal deficit eliminated.

When the program collapses at t=T, consumption falls below its steady state level thereby reducing consumption tax revenues below pre-stabilization levels. Since g and τ remain unchanged, the fiscal deficit widens relative to pre-stabilization levels. The widening of the fiscal deficit after t=T is due to the reduction in tax revenues originated in a permanent fall of consumption, i.e., the tax base, below its steady state level.

The path of inflation is described by equation (26). Inflation drops to zero when the exchange rate is fixed and remains low until the program collapses. At t=T inflation rises to a new steady state level that is higher than the pre-stabilization level.[9]

Finally, it is interesting to highlight the predicted co-movement of the inflation rate and the fiscal deficit. During the transition period, inflation declines together with the (endogenous) decline in the fiscal deficit, and in the post-stabilization period inflation rises as the fiscal deficit widens. This co-movement creates the appearance that the reduction in the fiscal deficit is responsible for the reduction in the inflation rate, and the ensuing deterioration of the fiscal deficit responsible for its resumption, when in fact, it is exactly the opposite: the temporary reduction in the rate of inflation generates a consumption and tax revenue boom which improves the fiscal position.

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[9] When $\bar{c} = c^1$ it follows from equation (18) and (26) that $\bar{\epsilon} = \epsilon^h$. When $\bar{c} > c^1$, this implies that $\epsilon^h > \bar{\epsilon}$.

6. NUMERICAL EXAMPLES

This section uses equation (24) and the first order conditions of the consumer to perform the following calculations:

i) the change in consumption necessary to eliminate the fiscal deficit under alternative assumptions about the size of government expenditures, g; tax rates τ; and the size of the fiscal deficit when the stabilization program is launched;

ii) the size of the intertemporal elasticity of substitution (η) necessary to generate the change in consumption calculated in (a).

In order to calculate the size of η, we use the first order conditions of the consumer's maximization problem to obtain:

$$\eta = - \frac{ln\ (c^h/c^l)}{ln\ (p^l/p^h)} \tag{35}$$

where $p^l = 1 + \tau$ and $p^h = 1 + \tau + \alpha i^h$.

For the purpose of the numerical examples we must distinguish the relevant monetary aggregate that consumers hold for transaction purposes, m, from the aggregate over which the government collects inflation tax revenues. The latter monetary aggregate is defined as:

$$h_t = \delta m_t \tag{36}$$

where h is the real stock of high-powered money and δ is the inverse of the money multiplier.

Table 1, column (6), reports the required changes in consumption to eliminate the fiscal deficit, as a function of the pre-stabilization fiscal deficit ($\bar{\epsilon}\delta\bar{m}$), of government expenditures, g, and of consumption tax rates, τ. In all cases the rate of devaluation (and inflation) is assumed to be reduced from its initial steady state level, ($\bar{\epsilon}$), down to zero, (ϵ^1). The following observations emerge from Table 1: [10]

i) For given values of government expenditures, the increase in consumption necessary to eliminate the budget deficit rises with the pre-stabilization level of the fiscal deficit. Consider, for instance, $g + \tau = 0.30$; the required increase in consumption varies from 3.4 percent when the fiscal deficit is 1 percent of GDP, to 15.3 percent when the fiscal deficit is 4 percent of GDP.

ii) For given values of government expenditures, the value of η increases with the pre-stabilization level of the budget deficit. Consider, for instance, $g + \tau = 0.$; the values of η necessary to generate a

[10] The following parameter values were used to perform the calculations: $\alpha = 0.15$, $\delta = 0.34$, $\bar{c}/y = 0.70$ and T = 4 years. The value of the parameter α however, is consistent with the value used by Calvo, Reinhart and Vegh (1994).

TABLE 1

CHANGE IN CONSUMPTION NECESSARY TO ELIMINATE THE BUDGET DEFICIT (*)

(in percent per year)

$\overline{\epsilon}\delta\overline{m}$	$\overline{\epsilon}$	g	τ	ϵ^1	ΔC	η
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0.01	28.6%	0.25	34.3%	0	4.1%	1.29
		0.30	41.4%		3.4%	1.13
		0.35	48.6%		2.9%	1.02
0.02	57.1%	0.25	32.9%	0	8.7%	1.33
		0.30	40.0%		7.1%	1.16
		0.35	47.1%		6.0%	1.04
0.025	71.4%	0.25	32.1%	0	11.1%	1.34
		0.30	39.3%		9.1%	1.17
		0.35	46.4%		7.7%	1.05
0.03	85.7%	0.25	31.4%	0	13.6%	1.36
		0.30	38.6%		11.1%	1.18
		0.35	45.7%		9.3%	1.06
0.04	114.3%	0.25	30.0%	0	19.0%	1.40
		0.30	37.1%		15.3%	1.21
		0.35	44.3%		12.9%	1.08

(*) The value of output (y) has been normalizad to one. Therefore consumption, government expenditures, and inflation tax revenues are expressed in terms of output.

Notes:

Column (4) calculates the consumption tax rate that insures a zero fiscal deficit after inflation tax revenues.

Column (6) measures the change in consumption necessary to eliminate the budget deficit under alternative scenarios about the size of government expenditures and inflation tax revenues.

Column (7) calculates the size of the intertemporalelasticity of substitution to generate the necessary change in consumption.

required increase in consumption of 3.4 percent and 15.3 percent are 1.13 and 1.21, respectively.[11]

iii) For given values of government expenditures, all the calculations of Table 1 remain unchanged if the steady state devaluation ($\bar{\epsilon}$) is higher, as long as δm is reduced correspondingly, such that $\bar{\epsilon}\delta\bar{m}$ remains unchanged (this implies that steady state inflation tax revenues and the pre-stabilization fiscal deficit also remain unchanged). In other words, the numerical calculations of Table 2.1 also apply to countries with substantially higher rates of inflation and lower levels real money balances.

How likely is it that actual increases in consumption in the initial stages of e-r-b stabilizations are of the magnitude of those required in Table 1? Consider, for instance, the case where $g + \tau = 0.30$. According to our simulation, consumption must increase 15.3 percent to eliminate a pre-stabilization fiscal deficit of 4 percent of GDP.

Reinhart and Vegh (1994) report that the actual increase in consumption (comparing the peak level to the initial level) observed in seven e-r-b stabilizations of the late 1970s and 1980s. It averaged 18.8 precent, ranging from a low of 11 percent in the Cruzado Plan to a high of 33 percent in the Chilean Tablita.

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[11] Reinhart and Vegh (1994) report estimates of the intertemporal elasticity of substitution (η) for seven countries that have undertaken e-r-b stabilization programs. The estimates range from 0.19 for Chile to 0.53 for Uruguay. Therefore, the required size of η appears to be large relative to the estimates. We conjecture that the inclusion of durable goods in the model will increase the size of the consumption response to a temporary decline in nominal interest rates for any given value of η. However, it is important to stress that for the purpose of the message this paper is trying to convey, the mechanism that produces the initial consumption boom and the subsequent decline is less important than the fact that the boom-bust cycle in consumption actually occurs.

These figures suggest that as long as tax systems are based on spending taxes, the possibility of a significant endogenous improvement in the fiscal deficit in the initial stages of an e-r-b stabilizations may not be a rare occurrence.

7. MAIN CONCLUSIONS AND POLICY IMPLICATIONS

In a model in which events are fully anticipated, the response of consumption and tax revenues to the announcement of an inconsistent exchange rate-based stabilization program generates the following pre-collapse dynamics: the rate of inflation falls dramatically, the balance of payments strengthens (the central bank accumulates reserves), the economy booms (consumption rises), and as a consequence, the fiscal deficit improves and may eventually disappear altogether. In other words, the program will display all of the ingredients of a success story.

Furthermore, along the path towards the collapse of the stabilization program, the economy displays none of the usual early warning signals that it is headed toward a balance of payments crisis, since there is no fiscal deficit and international reserves are increasing. In contrast to the previous literature about inconsistent stabilization policy leading to a "Krugman type" balance of payments crisis, where the symptoms of an imminent crisis are visible all along, in this model the collapse of the program comes as a "surprise."

Two important policy implications emerge from the analysis.

i) The sustainability of a stabilization program is generally assessed by the strength of the fiscal position as measured by the current fiscal deficit. Under this test, the program will appear sustainable. However,

the response of tax revenues to the initial consumption boom may turn the fiscal deficit into a completely inappropriate measure to assess the sustainability of a stabilization program. In the example presented, the budget is balanced but the stabilization program is still inconsistent and heading toward a balance of payments crisis. Some measure of a "cyclically adjusted budget deficit" may be necessary to capture the nature of the inconsistency.

ii) According to the Robicheck-Lawson tradition, large current account deficits should not matter as long as they originate in the private sector and are not driven by a fiscal deficit. Under this test, the program will also display the characteristics of a sustainable one. However, to the extent that the private sector consumption responds endogenously to inconsistent policies and tax revenues respond endogenously to consumption, dismissing large current account deficits as mainly a private sector phenomenon (which in a national income accounting sense is true in this example, since the budget is balanced) may turn out to be a mistake. In fact, the continuous deterioration of the current account deficit is, in this example, the only visible sign that the economy is on an unsustainable path and the stabilization program is headed for a collapse.

The policy relevance of the results of the model is highlighted by the numerical examples presented in the paper. They suggest that for tax systems based on spending taxes, the possibility of a significant improvement in the fiscal deficit due to the consumption boom that has been generally observed in the initial stages of exchange rate-based stabilizations, may be the rule rather than the exception.

REFERENCES

Calvo, Guillermo A., "Temporary Stabilization: Predetermined Exchange Rates," Journal of Political Economy, Vol. 94, 1986, 1319-29.

———, "Balance of Payments Crises in a Cash-in-Advance Economy," Journal of Money, Credit, and Banking, Vol 19, 1987, 19-32.

———, Carmen M. Reinhart, and Carlos A. Vegh, "Targeting the Real Exchange Rate: Theory and Evidence," IMF Working Paper, Forthcoming in Journal of Development Economics.

———, and Carlos A. Vegh, "Interest Rate Policy in a Small Open Economy," IMF Staff Papers, Vol 37, 1990, 753-776.

———, and Carlos A. Vegh, "Exchange Rate-Based Stabilization under Imperfect Credibility," in Andreas Worgotter and Helmut Frisch, eds., Open Economy Macroeconomics, MacMillan Press, London, 1993, 3-28.

———, and Carlos A. Vegh, "Inflation Stabilization and Nominal Anchors," Contemporary Economic Policy, Vol XII, 1994, 35-45.

Drazen Allan, and Elhanan Helpman, "Stabilization with Exchange Rate Management," The Quarterly Journal of Economics, November 1987, 836-855.

Kiguel Miguel, and Nissan Liviatan, "The Business Cycle Associated with Exchange Rate Based Stabilization," The World Bank Economic Review, Vol 6, 1992, 279-305.

Krugman, Paul R., "A Model of Balance of Payments Crises," Journal of Money, Credit and Banking, Vol XI, 1979, 311-25.

Reinhart, Carmen M., and Carlos A. Vegh, "Nominal Interest Rates, Consumption Booms, and Lack of Credibility: A Quantitative Examination," mimeo, IMF, 1992, forthcoming in Journal of Development Economics.

——— , "Inflation Stabilization in Chronic Inflation Countries: the Empirical Evidence," mimeo, IMF, 1994.

Sargent, T. J. and N. Wallace, "Some Unpleasant Monetarist Arithmetic," Quarterly Review of the Federal Reserve Bank of Minneapolis, Fall 1981, 1-17.

Talvi, Ernesto, "Fiscal Policy and the Public Sector in Exchange Rate Based Stabilizations: Evidence From Uruguay's 1978 and 1991 Programs," Working Paper 313, Office of the Chief Economist, Inter-American Development Bank, 1995.

Vegh, Carlos, "Stopping High Inflation: An Analytical Overview," IMF Staff Papers, September 1992, 626-695.