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ABSTRACT

In standard models of the balance of payments, crises occur when investors begin to doubt the credibility of the government's commitment to its exchange rate policy. In this paper, we develop an alternative model in which balance of payments crises occur even if the credibility of government fiscal, monetary, and exchange rate policies is never in doubt. In this alternative model, international lending is constrained by the risk of repudiation. Balance of payments crises occur when the government and citizens of a country hit their international borrowing constraints. Our model is broadly consistent with events in Mexico from 1987-1995. More generally, our model suggests that countries which undertake sweeping macroeconomic and structural reforms should expect to face a balance of payments crisis when they exhaust their access to international capital inflows.

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1. Introduction

Over the course of the last ten months of 1994, the Banco de Mexico (the Mexican central bank), sold roughly $19 billion of its foreign exchange reserves.[1] By the end of the year, Mexico's financial difficulties took on the air of a crisis. In standard models of balance of payments crises, the central bank begins to lose reserves as it expands domestic credit to finance fiscal deficits. The loss of reserves culminates in a speculative attack in which investors trade their holdings of the local currency for the central bank's foreign exchange reserves as they become concerned about the credibility of the central bank's exchange rate policies.[2] This standard model has proved fruitful in understanding the dynamics of both inflation and the balance of payments in a great many applications.[3]

In terms of its implications for policy, the standard model of the balance of payments suggests that crises can be avoided if appropriate steps are taken to ensure the credibility of the central bank's commitment to its exchange rate targets. Sargent's (1986) analysis of the steps taken to end four hyperinflations is a classic statement of the importance of central bank credibility for ending inflation and the policy prescriptions derived from history for establishing that credibility.

[1]This amount is roughly 4-5% of Mexican GDP in 1994 at mid-1994 exchange rates.

[2]See Agénor and Flood (1994) for a survey of the literature on balance of payments crises and speculative attacks.

[3]Obstfeld and Rogoff (1995) and the IMF *International Capital Markets Report* (1995), Background Paper III study recent events in Mexico from this perspective. Calvo and Mendoza (1995) extend the standard model to argue that financial developments in 1993-1994 undermined the credibility of Mexico's exchange rate policy and lead to a speculative attack.

Over the last ten years or so, several governments in Latin America and elsewhere have undertaken fiscal, monetary, and exchange rate reforms designed in part to enhance the credibility of their new resolve to fight inflation. When interpreted in light of the standard model, the recent Mexican balance of payments crisis suggests that the impressive reforms implemented in Mexico since late 1987 were still not sufficient to convince international markets of the credibility of Mexico's commitment to monetary and fiscal restraint.

Our objective in this paper is to develop an alternative to the standard model of the balance of payments. This alternative model suggests a different interpretation of the recent Mexican crisis. In our alternative model, balance of payments crises occur even if the credibility of government fiscal, monetary, and exchange rate policies is never in doubt. In applying this alternative model to recent events in Mexico, we argue that uncertainty about the credibility of Mexican fiscal, monetary, or exchange rate policy may not have played the decisive role in generating this recent crisis.

Our model describes the balance of payments of a country whose government and citizens face limits on their international borrowing as a result of the risk of repudiation inherent in international capital markets. We follow the literature on international debt in assuming that this risk of repudiation arises from the lack of binding legal mechanisms for enforcing the repayment of international debts. In this model, when government implements macroeconomic or structural reforms which raise the wealth of the private sector, private expenditure increases and trade deficits result. If the reforms are sufficiently beneficial for the private sector, these trade deficits continue until both the private and public sectors hit their international borrowing constraints.

When these international borrowing constraints are reached, the flow of foreign capital into the country stops. At this point, the sale of the central bank's stock of foreign exchange reserves is the only means the country has left for financing continued trade deficits. In other words, in our model, when international borrowing constraints bind, domestic residents sell their holdings of their government's debt to the central bank for foreign exchange because they want to continue spending and have no other source of finance. These resident's desire to hold their government's debt falls whether or not they have doubts about the course of fiscal, monetary, and exchange rate policy.

The central bank of a country whose government and citizens have hit their international borrowing constraints does not enjoy a broad range of policy options. Essentially, the central bank will lose reserves as long as the country runs a trade deficit. For the trade deficit to stop, real interest rates must rise. Real interest rates rise when the central bank becomes unwilling or unable to use its stock of foreign exchange reserves to bridge the gap between the supply of public debt and residents' demand for that debt at world interest rates and the fixed exchange rate. At that point, the trade balance moves into surplus and the central bank stops losing reserves.

Our model is broadly consistent with developments in Mexico following the program of reforms initiated at the end of 1987. We focus on four developments in particular. First, Mexico experienced a substantial increase in private spending and trade deficits from 1988-1994. Second, the flow of portfolio investment into Mexico ended abruptly after the first quarter of 1994. Third, Mexico's trade deficit for the remainder of 1994 was financed largely by the sale of international reserves. And fourth, Mexico's trade balance

moved dramatically from deficit to surplus early on in 1995.

As reviewed in Rebelo and Végh (1995), Dornbusch and Werner (1994), and elsewhere, interpretation of the first fact, the boom in private spending and trade deficits in Mexico from 1988-1994, is a matter of considerable controversy. This controversy is heightened by the fact that this part of the Mexican experience is similar to the experience of a number of other countries that have undertaken exchange-rate based inflation stabilization programs. In this paper, for ease of exposition and to highlight the contrast between our model and the standard model, we offer only the simplest interpretation of how this spending boom might be linked to the reforms undertaken in Mexico. The nature of the links between reform and private spending clearly merit further research.

Again, unlike many other papers on Mexico, we do not emphasize the observation that the Banco de Mexico sterilized its loss of reserves during 1994 and then abandoned its targets for the nominal exchange rates in December of that year. While we could modify our model to accommodate monetary policy closer to the policy actually followed in Mexico, we choose not to modify our model in this way so as to underline our main point that the conduct of monetary and exchange rate policy need not play a role in generating a balance of payments crisis. Thus, in presenting our model, we assume that the government has a completely credible commitment to fixed nominal exchange rates. Of course, in our model, as in the standard literature on speculative attacks, the exact specification of the monetary and exchange rate policy followed by the central bank can affect the exact equilibrium path of private demand for public sector liabilities and thus the exact equilibrium path of foreign exchange reserves. However, the conclusion that, once the interna-

tional borrowing constraints are reached, a country's citizens will begin selling their holdings of their government's debt to their central bank for its foreign exchange reserves until real interest rates rise is not altered under alternative assumptions about the conduct of monetary and exchange rate policy.

The remainder of the paper is as follows. In sections 2 and 3, we present our model and characterize equilibria with fixed exchange rates in which the international borrowing constraints on the private and public sectors do not bind. In section 4, we show two examples of beneficial reforms that are not consistent in equilibrium with both fixed exchange rates and agents having unconstrained access to international borrowing. In section 5, we characterize a borrowing constrained equilibrium. In section 6, we present data from Mexico. In section 7, we interpret these data in light of our example economy from section 5 and discuss several other interpretations of the recent Mexican experience. Here, we focus in particular on relating our results to existing models of speculative attacks. In section 8, we conclude.

2. A Model

Ours is a discrete time small open economy model. We refer to the currency used in the rest of the world as the dollar. The price level in dollars is fixed and normalized to one. Let $q^*_{t+1} = \beta$ be the price paid in world capital markets in dollars at t for a one dollar zero coupon bond payable at $t+1$. Let $P^*_t = \prod_{s=0}^{t-1} q^*_s = \beta^t$ be the price in world capital markets at 0 for one dollar payable at $t \geq 1$. $P^*_0 = 1$. Agents and government in this small open economy take these prices as given. Government in this economy chooses sequences of expenditure g_t, tax rates, τ_t, bonds issued to do-

mestic citizens b_{t+1}, bonds issued to foreigners d_{t+1}, foreign exchange reserves f_{t+1}, and domestic money m_{t+1}. Initial stocks of government debt b_0, d_0, reserves f_0, and money m_0 are given. We assume that all government bonds are one period zero coupon bonds denominated in dollars. Let q_t be the price in dollars domestic citizens pay at t for a one dollar zero coupon bond issued by their government and payable at $t+1$. Let $P_t = \prod_{s=0}^{t-1} q_s$ be the domestic price (in dollars) at 0 for one dollar payable at $t \geq 1$. $P_0 = 1$. We refer to the domestic currency as the peso and let e_t be the nominal exchange rate. We assume purchasing power parity and normalize the real exchange rate to one so that the domestic price level is given by e_t^{-1}.

There is an infinitely lived representative agent in this economy who is endowed with output $\{y_t\}_{t=0}^{\infty}$, initial stock of foreign assets a_0, the initial stock of bonds in the hands of citizens b_0, and the initial money stock m_0. This agent chooses a sequence of consumption c_t, foreign asset holdings a_{t+1}, domestic bond holdings b_{t+1}, and money holdings m_{t+1}. This agent has preferences over consumption given by $\sum_t \beta^t u(c_t)$ and faces cash-in-advance constraints

$$c_t \leq e_t m_t$$

and budget constraint

$$q_t^* a_{t+1} + q_t b_{t+1} + e_t m_{t+1} = y_t - \tau_t + a_t + b_t + e_t m_t - c_t$$

$$\lim_{t \to \infty} P_t^* a_{t+1} + P_t b_{t+1} = 0.$$

We also impose a tighter constraint on foreign borrowing by domestic citizens. We assume that foreign creditors can seize only a limited portion of the endowment of a citizen who does not pay his foreign debt and that the portion of the endowment that can be seized has value $\bar{a}$ to a foreign

creditor. Thus we impose the constraint that domestic citizen's holdings of foreign assets satisfy

$$a_{t+1} \geq -\bar{a}$$

for some $\bar{a} \geq 0$.

To facilitate discussion of our results, we use the following terminology to distinguish two components of government policy. Fiscal policy is the sequences of expenditure and tax rates $\{g_t, \tau_t\}_{t=0}^{\infty}$ chosen by the government of this small open economy. Monetary policy is the sequences of money, government bonds in the hands of domestic citizens, government bonds in the hands of foreigners, and foreign exchange reserves, $\{m_{t+1}, b_{t+1}, d_{t+1}, f_{t+1}\}$ chosen by the government of this economy. The government budget constraint is given by

$$q_t b_{t+1} + q_t^*(d_{t+1} - f_{t+1}) + e_t(m_{t+1} - m_t) = g_t - \tau_t + b_t + d_t - f_t$$

$$\lim_{t \to \infty} P_t b_{t+1} + P_t^*(d_{t+1} - f_{t+1}) = 0.$$

Since we distinguish government's gross international borrowing d_{t+1} and its gross international reserves f_{t+1}, we require both of these sequences to be positive.

We also impose a tighter constraint on government's international borrowing d_{t+1} than would be implied by the government budget constraint. We assume that foreign lenders have limited sanctions that they can impose upon this government if it were to default and that the transfers this government would be willing to make to avoid these sanctions have value $\bar{d}$ in world capital markets. We thus assume that foreign lenders to this government limit their lending so that

$$d_{t+1} \leq \bar{d}.$$

We have implicitly assumed here that foreign creditors cannot seize this government's foreign exchange reserves so that this limit on foreign borrowing is not affected by the government's stock of reserves.

Given initial conditions b_0, d_0, a_0, m_0, f_0 and output $\{y_t\}$, an *equilibrium* is a fiscal policy $\{g_t, \tau_t\}$, a monetary policy $\{m_{t+1}, b_{t+1}, d_{t+1}, f_{t+1}\}$, prices $\{q_t, q_t^*, e_t\}$ and an allocation for consumers $\{c_t, a_{t+1}\}$ that satisfy the government budget constraint and government foreign borrowing constraint and that maximize consumers' utility subject to their budget constraint, their foreign borrowing constraint, and their cash-in-advance constraint.

We distinguish two particular types of equilibria. An *equilibrium with fixed exchange rates* is an equilibrium in which $e_t = e$. An *equilibrium with fixed exchange rates and unconstrained access to international borrowing* is an equilibrium in which $e_t = e$, and $q_t = q_t^*$ for all t. In the first case, we allow $q_t < q_t^*$ for some dates t. This event can occur in equilibrium if international borrowing constraints are binding.

At this point, several remarks about our model are in order. In defining the consumer's budget constraint, we have allowed for the possibility that the consumer would hold negative quantities of the government bonds b_{t+1} and thus be indebted to his government. While it is true that many governments do engage in both direct lending programs and indirect lending through the banking system, we expect that domestic citizens would be net creditors to their government in most of the cases to which we would apply this model.

We have assumed that the government can issue two classes of bonds, one to citizens and one to foreigners. This distinction becomes important in the model if the constraint on international borrowing binds and bonds issued to do-

mestic residents pay a higher real interest rate than is available in world capital markets. During the 1970's and early 1980's, for most developing countries, the debt held by foreigners would typically have been loans from commercial banks in developed countries while government treasury securities would have been held domestically. In this case, classes of creditors to the government are easily distinguished. More recently, in Mexico's case, foreign residents purchased substantial quantities of Mexican treasury securities, making it more difficult to distinguish the nationality of its creditors.

In defining government policy, we assume that the domestic government issues its debt in dollars. Since we are investigating the constraints that fiscal and monetary policies must satisfy to be consistent with permanently fixed exchange rates, our results would not be affected if we changed the denomination of this debt. It is clear that if we were to model explicitly the government's incentives to devalue and/or default on its debt, we would need to consider the denomination of the government debt more carefully.

For simplicity, in our model, we have assumed that the constraint on government and consumer foreign borrowing does not depend on any actions that consumers or government might take. For consumers, this assumption follows from our assumption that this is a deterministic endowment economy. Since there are no assets that consumers might use as collateral, private creditors' only recourse in the case of a consumer's bankruptcy is to convince the domestic courts to garnish that consumer's endowment stream. We assume that the value (evaluated at the world interest rate) of the endowment that the domestic courts will garnish is constant and less than the value of the after-tax endowment stream itself. Thus private lending to the consumer is limited.

We have not explicitly modelled the government's motivation to repay its debts. The literature on sovereign lending has explored several answers to the question of why governments repay their international debt.[4] One answer offered is that governments repay their current debts to avoid being excluded from access to foreign borrowing in the future. Other answers focus on the range of direct sanctions that foreign creditors and their governments might use to induce a debtor government to repay its debts. These sanctions range from invasion to interference with trade, trade credit, and international transportation, to diplomatic pressure on a number of fronts. In both of these approaches in the literature, the maximum amount that foreign governments choose to repay is determined as the outcome of a bargain in which debtors and creditors agree on the transfers the debtor makes to preserve future access to credit or to avoid direct sanctions. Foreign borrowing is then limited not to exceed the maximum value of these transfers. In this paper, we abstract from consideration of the range of motivations that government officials might have to repay sovereign debts and of how those motivations might diverge from the motivations of the consumer to pay taxes to repay that debt. Instead, we simply assume that the maximum transfer that the government can be induced to make is constant and does not depend on the stock of foreign exchange reserves.

In defining separate foreign borrowing constraints for government and consumers, we depart from the convention used in most of the literature on international debt. In

[4]Eaton and Fernandez (1995) is a recent review of this literature. Kaletsky (1985) and Alexander (1987) review the range of sanctions international creditors have available for enforcing the repayment of international debts.

that literature, authors typically assume that the interests of government and consumers are identical and the decision whether or not to default is made collectively, so that foreign lenders constrain only their total lending to the country as a whole. Clearly, our assumption that the foreign borrowing of consumers and government is constrained separately implies that total lending to the country is constrained.

Finally, in this simple model, there is no explicit need for monetary authorities to maintain positive foreign exchange reserves to run a fixed exchange rate regime. Most of the literature on fixed exchange rates and balance of payments crises takes the assumption that foreign exchange reserves must remain positive for a fixed exchange rate to be viable as an axiom. We follow that literature in making the same assumption.

3. Characterizing Unconstrained Equilibria

In this section, we characterize the fiscal and monetary policies consistent with fixed exchange rate equilibria and equilibria with fixed exchange rates and unconstrained access to international borrowing. By way of review of existing results, in proposition 1, we characterize the constraints fiscal and monetary policy must satisfy to be consistent with a fixed exchange rate regime in an economy in which there are no constraints on the government's foreign borrowing. In a corollary, we characterize these constraints in an economy in which there is a constraint on the government's foreign borrowing but no constraint on the consumer's foreign borrowing. In proposition 2, we characterize the constraints fiscal and monetary policy must satisfy to be consistent with a fixed exchange rate and unconstrained access to foreign borrowing when constraints on foreign borrowing exist.

We begin with a lemma characterizing consumer behavior in a fixed exchange rate regime with unconstrained access to foreign borrowing.

Lemma 1: In any equilibrium with fixed exchange rates and unconstrained access to foreign borrowing, consumption $\{c_t\}_{t=1}^{\infty}$is constant for $t \geq 1$ at $\bar{c}$. Consumption at date 0, c_0 is given by $\min(\bar{c}, em_0)$. The constant $\bar{c}$ is the largest constant less than or equal to

$$(1-\beta)\left(\sum_t P_t^*(y_t - \tau_t) + a_0 + b_0 + em_0 - \min(\bar{c}, em_0)\right). \tag{3.1}$$

Seignorage for the domestic government is zero at all dates except date 0. At date 0, seignorage is given by $s_0 = \bar{c} - em_0$.

Proof: In this small open economy, under a fixed exchange rate, nominal interest rates are equal to world nominal interest rates. These interest rates are positive, so the consumer's cash in advance constraint is binding at all dates $t \geq 1$. Since these constraints are all binding, the consumer's budget constraint and first period cash-in-advance constraint simplify to

$$\sum_{t=0}^{\infty} P_t^* c_{t+1} = \sum_{t=0}^{\infty} P_t^*(y_t - \tau_t) + a_0 + b_0 + em_0 - c_0$$

$$c_0 \leq em_0.$$

¿From the first order conditions of the consumer's utility maximization problem, we get the result that $\{c_t\}_{t=0}^{\infty}$ is constant when exchange rates are fixed, $q_t = q^* = \beta$, and the date 0 cash-in-advance constraint is not binding. In the case in which the date zero cash in advance constraint would be violated if $c_0 = \bar{c}$, c_0 is set so that constraint binds. Seignorage at dates $t \geq 1$ is zero since consumption, the exchange rate, and money holdings are constant. Seignorage at date 0

is equal to the difference between consumer's initial endowment of money and the money stock they choose to hold when they are first offered that choice. ■

We now review the results characterizing the constraints that fiscal and monetary policy must satisfy to be consistent with fixed exchange rates when government does not face an international borrowing constraint.

Proposition 1: Assume that the there is no separate government foreign borrowing constraint other than the constraint that $\lim_{t\to\infty} P_t^*(b_{t+1} + d_{t+1} - f_{t+1}) = 0$. Given e, m_0, b_0, d_0, f_0, a_0, $\{y_t\}$ and fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$, define s_0 as in lemma 1. Then there exists an equilibrium with fixed exchange rates if fiscal and monetary policy satisfy a solvency constraint

$$\sum_t P_t^*(\tau_t - g_t) - (b_0 + d_0 - f_0) + s_0 = 0, \tag{3.2}$$

Moreover, if we assume that monetary authorities choose b_{t+1} and d_{t+1} to arbitrage away any difference between domestic and world interest rates, then, in any equilibrium with a policy of fixed exchange rates, the fiscal policy in that equilibrium satisfies the solvency constraint (3.2).

Proof: We begin with the latter hypothesis. Since consumers are constrained in their foreign borrowing, we cannot rule out the possibility that $q_t < q_t^* = \beta$ for some t without the assumption that the monetary authorities would arbitrage away the difference in bond prices. From lemma 1, in any equilibrium in which exchange rates are fixed and $q_t = q_t^* = \beta$ for all t, private consumption c_t is constant at $\bar{c}$ for all $t \geq 1$, and the cash-in-advance constraints are binding. Hence, the money supply is constant for $t \geq 1$, and seignorage is zero in all periods except date 0. Seignorage at date 0 is given by $s_0 = \bar{c} - em_0$. Thus (3.2) follows from the governments' budget constraint.

We now prove the first hypothesis. Consider $\{y_t\}$, initial conditions m_0, b_0, d_0, f_0, a_0, and fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$ that satisfies (3.2). We construct an equilibrium with fixed exchange rates as follows. Set $\{m_t\}_{t=1}^{\infty}$ constant at $\bar{c}/e$. Set $q_t = q_t^* = \beta$. Define $\{c_t\}$ as in lemma 1. Let $\{a_{t+1}\}$ be constant at zero. Let $\{f_{t+1}\}$ be any sequence that satisfies $\lim_{t\to\infty} P_t^* f_{t+1} = 0$. Use the consumer's budget constraint to define $\{b_{t+1}\}$. By construction $\lim_{t\to\infty} P_t(a_{t+1} + b_{t+1}) = 0$. Use the government budget constraint to define $\{d_{t+1}\}$. Since fiscal policy satisfies (3.2), $\lim_{t\to\infty} P_t(d_{t+1} + b_{t+1} - f_{t+1}) = 0$. ■

The proof of proposition 1 makes clear that if the government has no separate foreign borrowing constraint, it can maintain any bounded path for reserves that it likes as long as its fiscal policy satisfies (3.2). This result is presented in Obstfeld (1986) and elsewhere. The view that governments maintaining a fixed exchange rate need not be concerned with the trade balance as long as the fiscal budget is balanced has recently been espoused by Nigel Lawson and E. Walter Robichek. As is clear from this proposition, the timing of trade balances is irrelevant for the viability of fixed exchange rates in this economy. All that is required is that fiscal policy is set so that no ongoing seignorage is required to finance fiscal deficits.

Of course, the result that ongoing seignorage is zero in a fixed exchange rate regime is specific to this model. In general, the domestic government earns seignorage even in a fixed exchange rate regime. For instance, if we were to add growth in world output to this model and set world interest rates so that, unconstrained, domestic consumption grew at the growth rate of world output, then there would be growth in money demand and seignorage even in a fixed exchange rate regime. This seignorage would be equal to the growth

of domestic consumption. In this case, fiscal policy need only satisfy the constraint that taxes plus the seignorage obtained under a fixed exchange rate pay for government expenditure. This is the qualitative theoretical result that would generalize to other models. Given the difficulties estimating money demand in data even under a fixed exchange rate regime, it would be hard in applications to forecast the seignorage that would be obtained under a fixed exchange rate regime and thus the exact constraints on fiscal policy. It is clear, though, that monetary authorities cannot simultaneously pursue a fixed exchange rate policy and arbitrarily choose the level of seignorage they will generate.

In a corollary to proposition 1, we characterize the constraints fiscal and monetary policy must satisfy to be consistent with a fixed exchange rate equilibrium in an economy in which government is subject to an international borrowing constraint but consumers are not.

Corollary to Proposition 1: Assume that the there is no separate foreign borrowing constraint for consumers requiring $a_{t+1} \geq -\bar{a}$, but that there does exist a foreign borrowing constraint on the government requiring $d_{t+1} \leq \bar{d}$. Given $e, m_0, b_0, d_0, f_0, a_0$ $\{y_t\}$ and fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$, there exists an equilibrium with fixed exchange rates if and only if fiscal policy satisfies a solvency constraint (3.2).

Proof: We begin with the latter hypothesis. In any equilibrium, consumers, being unconstrained in their borrowing, arbitrage away any differences in domestic and world interest rates, so $q_t = q_t^* = \beta$ for all t, and private consumption c_t is constant for $t \geq 1$. If the exchange rate is fixed, interest rates are positive, so the cash-in-advance constraints are binding, the money supply is constant for $t \geq 1$, and seignorage is zero except at date 0. Thus (3.2) follows from the governments' budget constraint.

Now consider the first hypothesis. Given $\{y_t\}$ and initial conditions m_0, b_0, b_0^*, a_0, and fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$ that satisfies (3.2), we construct an equilibrium with fixed exchange rates. Let $\bar{c}$ be defined as in lemma 1. For $t \geq 1$, set $\{m_t\}$ constant at $\bar{c}/e$. Set $q_t = q_t^* = \beta$. Set $\{d_{t+1}\}$ constant at zero. Let $\{f_{t+1}\}$ be any sequence that satisfies $\lim_{t\to\infty} P_t^* f_{t+1} = 0$. Use the government budget constraint to define $\{b_{t+1}\}$. Since fiscal policy satisfies (3.2), $\lim_{t\to\infty} P_t(b_{t+1} + d_{t+1} - f_{t+1}) = 0$. Given $\{b_{t+1}\}$, use the consumer's budget constraint to define $\{a_{t+1}\}$. By construction $\lim_{t\to\infty} P_t(a_{t+1} + b_{t+1}) = 0$. ■

This corollary makes clear that international borrowing constraints are relevant for determining the feasibility of a fixed exchange rate policy only if both borrowing constraints exist. In sum, the lesson that has been drawn from proposition 1 is that a government which commits to sufficient fiscal and monetary discipline should be able to choose and costlessly defend any lower bound on reserves that it chooses.

We now consider the constraints that fiscal and monetary policy must satisfy to be consistent with fixed exchange rates and unconstrained access to international borrowing when both government and consumers are subject to international borrowing constraints. We begin with a lemma discussing the path of the trade balance in equilibrium with borrowing constraints.

Lemma 2: In any equilibrium,

$$\sum_{s=0}^{t} \frac{P_s^*}{P_t^*}(g_s + c_s - y_s) + \frac{1}{P_t^*}(d_0 - f_0 - a_0) \leq \bar{d} + \bar{a} \qquad (3.3)$$

for all t.

Proof: Subtracting the consumer's budget constraint from the government's budget constraint gives the familiar equation describing the evolution of the nation's net foreign

indebtedness

$$q_t^*(d_{t+1} - f_{t+1} - a_{t+1}) = g_t + c_t - y_t + d_t - f_t - a_t.$$

Iterating on this equation gives the equation

$$d_{t+1} - f_{t+1} - a_{t+1} = \sum_{s=0}^{t} \frac{P_s^*}{P_t^*}(g_s + c_s - y_s) + \frac{1}{P_t^*}(d_0 - f_0 - a_0).$$

The constraints that $d_{t+1} \leq \bar{d}$, $f_{t+1} \geq 0$, $a_{t+1} \geq -\bar{a}$ give the inequality (3.3). ■

Having characterized the path of the trade balance in equilibrium, in our next proposition, we demonstrate its importance for the feasibility of a fixed exchange rate regime with unconstrained access to foreign borrowing.

Proposition 2: Given fiscal policy $\{g_t, \tau_t\}$, income $\{y_t\}$, and initial conditions a_0, b_0, d_0, f_0, m_0, let $\bar{c}$ and c_0 be defined as in lemma 1. Then there exists an equilibrium with a monetary policy with fixed exchange rates and unconstrained access to international borrowing if and only if fiscal policy satisfies (3.2) and

$$\sum_{s=0}^{t} \frac{P_s^*}{P_t^*}(g_s + \bar{c} - y_s) + \frac{1}{P_t^*}(c_0 - \bar{c} + d_0 - f_0 - a_0) \leq \bar{d} + \bar{a} \quad (3.4)$$

for all t.

Proof: Begin with the latter hypothesis. As we saw in proposition 1, in an equilibrium with fixed exchange rates and unconstrained access to international borrowing, fiscal policy satisfies (3.2). The condition (3.4) follows from lemmas 1 and 2.

To prove the first hypothesis, consider $\{y_t\}$, initial conditions m_0, b_0, d_0, f_0, a_0, and fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$, and initial seignorage s_0 that satisfies (3.2). We construct an equilibrium with fixed exchange rates as follows. Set $\bar{c}$ and $\{c_t\}$ as

in lemma 1. Set $\{m_t\}_{t=1}^{\infty}$ constant at $\bar{c}/e$. Set $q_t = q_t^* = \beta$. Let $\{a_{t+1}\}$ be constant at $-\bar{a}$. Let $\{d_{t+1}\}$ be constant at $\bar{d}$. Use the consumer's budget constraint to define $\{b_{t+1}\}$. Use the government's budget constraint to construct $\{f_{t+1}\}$. Since (3.4) is satisfied, $f_{t+1} \geq 0$ for all t. By construction $\lim_{t\to\infty} P_t(a_{t+1} + b_{t+1}) = 0$. Since policy satisfies (3.2), $\lim_{t\to\infty} P_t(d_{t+1} + b_{t+1} - f_{t+1}) = 0$. ■

The early literature on speculative attacks and balance of payments crises, (see, for instance, Agénor and Flood (1994) for a survey), typically assumes that the proximate explanation for why monetary authorities lose reserves is that they purchase too much of their government's debt to finance a fiscal deficit. Obstfeld (1986) and others have shown that speculative attacks can occur if investors anticipate that the monetary authorities would begin to purchase their government's debt were an attack to occur. In light of the result summarized in proposition 1, the typical policy advice given to countries starting out with plans for a fixed exchange rate is to balance their fiscal budget and establish a central bank sufficiently independent that it can credibly commit not to monetize the government debt. Proposition 2 makes clear that fiscal and monetary discipline are not sufficient to ensure the viability of a fixed exchange rate together with unconstrained access to foreign borrowing. If trade deficits get too large, then international borrowing constraints will bind and monetary authorities will be forced to raise domestic real interest rates to defend their stock of international reserves even if fiscal, monetary, and the fixed exchange rate policies are both consistent with long term fiscal balance and perfectly credible.

4. Examples

Relatively recently, a number of countries have implemented fixed or managed exchange rate policies as part of programs to stabilize inflation, including Argentina (in 1991), Israel (in 1985), Mexico (in 1987), and Uruguay (in 1978). These countries also implemented significant fiscal adjustments, in part to enhance the credibility of the new exchange rate policy. As described in Rebelo and Végh (1995), one common element of these countries experiences is that they all experienced a sharp deterioration of their trade and current accounts following the implementation of the fixed exchange rate. While the underlying cause of these trade deficits is a matter of debate (Rebelo and Végh review several potential explanations), these deficits could lead to a balance of payments crisis even though the government's commitment to balance the fiscal budget was completely credible. We illustrate this point with two examples.

In the first example, we focus on the impact of a government reform that credibly lowers the growth of government spending below the growth of domestic output. In the second, we consider a reform that raises the growth of output above the growth of government expenditure. Both reforms lead to sustained trade deficits because they raise consumers' after tax wealth more than they raise current output less current government expenditure. As a result, these "positive" reforms may not be consistent with fixed exchange rates and unconstrained access to foreign borrowing.

Example 1: Consider a reform in which the domestic government credibly commits to reduce government expenditure (and thus the tax burden on the economy) at some future date T. Let $b_0 = d_0 = f_0 = a_0 = 0$. Assume $\{y_t\}$ is

constant at y. Consider a fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$ that satisfies (3.2) and has $g_t = g_0$ for $t = 0, 1, 2, \ldots, T-1$, and $g_t = g_T < g_0$ for $t = T, T+1, T+2, \ldots$. At international interest rates, the present value of government expenditure is given by

$$\sum_t P_t^* g_t = \frac{1-\beta^T}{1-\beta} g_0 + \frac{\beta^T}{1-\beta} g_T.$$

The value of government expenditure is equal to the value of taxes plus seignorage in period 0, so, in equilibrium with fixed exchange rates and unconstrained access to foreign borrowing, consumption is given by $c_t = \bar{c}$ for $t \geq 1$ with

$$\bar{c} = y - (1-\beta^T) g_0 - \beta^T g_T,$$

and the trade deficit in periods $t = 1, 2, 3, \ldots, T-1$ are given by $\beta^T(g_0 - g_T)$. The trade deficit at date zero is given by $\beta^T(g_0 - g_T) - (\bar{c} - c_0)$. The country's foreign debt $d_T - f_T - a_T$ is given by

$$d_T - f_T - a_T = \frac{1-\beta^T}{1-\beta}(g_0 - g_T) - \frac{1}{\beta^T}(\bar{c} - c_0).$$

If this debt exceeds $\bar{d} + \bar{a}$, then an equilibrium with fixed exchange rates and unconstrained access to foreign borrowing does not exist with this fiscal policy. Note that in this simple model, the timing of taxes and thus the timing of fiscal deficits does not affect equilibrium trade deficits.

Example 2: Consider now a reform which leaves government expenditure constant but succeeds in increasing future output. Let $b_0 = d_0 = f_0 = a_0 = 0$. Consider a fiscal policy $\{g_t, \tau_t\}_{t=0}^{\infty}$ that satisfies (3.2), with $\{g_t\}$ constant at g, and $\{\tau_t\}$ set so that $\tau_t = g$ for all $t \geq 1$ and $\tau_0 = g - s_0$. Let $\{y_t\}$ be such that $y_t = y_0$, for $t = 0, 1, 2, \ldots, T-1$, and

$y_t = y_T > y_0$ for $t = T, T+1, T+2, \ldots$. At international interest rates, the present value of government expenditure is given by $g/(1-\beta)$. In equilibrium with fixed exchange rates and unconstrained access to foreign borrowing, consumption is given by $c_t = \bar{c}$ for $t \geq 1$ with

$$\bar{c} = (1 - \beta^T)y_0 + \beta^T y_T - g$$

and the trade deficit in periods $t = 1, 2, 3, \ldots, T-1$ is given by $\beta^T(y_T - y_0)$. The trade deficit at date zero is given by $\beta^T(y_T - y_0) - (\bar{c} - c_0)$. The country's foreign debt $d_T - f_T - a_T$ is given by

$$d_T - f_T - a_T = \frac{1-\beta^T}{1-\beta}(y_T - y_0) - \frac{1}{\beta^T}(\bar{c} - c_0).$$

If this debt exceeds $\bar{d} + \bar{a}$, then an equilibrium with fixed exchange rates and unconstrained access to foreign borrowing does not exist with this fiscal policy.

In sum, as proposition 2 and these examples make clear, the viability of a fixed exchange rate and unconstrained access to foreign borrowing in this model depends on the timing of trade deficits. Fiscal policy that leads to large and sustained trade deficits will not be consistent with fixed exchange rates and unconstrained access to foreign borrowing. Similarly, expectations that output will grow that also lead to sustained trade deficits will mean that even fiscal policy that satisfies period-by-period budget balance will not be consistent with fixed exchange rates and unconstrained access to foreign borrowing. If we expanded this model to include production and physical capital, it would be straightforward to construct additional examples in which reforms that reduced taxes on physical capital led to surges in consumption and investment spending and trade deficits that were inconsistent with fixed exchange rates and unconstrained access to foreign borrowing.

5. Borrowing Constrained Equilibria

In this section, we examine two example economies in which the international borrowing constraints bind. In these examples, condition (3.4) in Proposition 2 is violated. We first present an example that we label the Mexican model. In this example, the central bank maintains a fixed exchange rate and uses its stock of reserves to peg domestic interest rates equal to world interest rates until the stock of reserves is exhausted.[5] We refer to the second example as the Argentine model. In this example, the central bank maintains a fixed exchange rate and sets its stock of reserves equal to the domestic money supply at all dates.

Example 3: The Mexican Model

Consider a version of the economy in Example 2 with initial conditions b_0, d_0, f_0, a_0, and with $y_t = y_0$, for $t = 0, 1, 2, \cdots, T-1$ and $y_t = y_T$ for $t = T, T+1, T+2, \cdots$, where $y_T > y_0$. Let $b_0 = 0$, $d_0 = f_0 = \bar{d} > 0$, $a_0 > \bar{a}$, and $e_t = e$ for all t. Government spending is constant, $g_t = \bar{g}$ for all t, and the tax policy is set so that $\tau_t = g_t - s_t$ so the government budget balances period-by period. In this example we have imposed that the public sector cannot increase its foreign borrowing, although it still has room to decrease its reserves. The private sector can increased its indebtedness with the exterior.

We solve this example by guessing an equilibrium allo-

[5] Actually in a crucial meeting in December 1994 described by Pedro Aspe, former Secretario de Hacienda y Crédito Público in the Salinas government ("México en 1994: Las razones de la política cambiaria" copyrighted by *Información Selectiva, S.S.de C.V.*) Mexico's intention was to maintain reserves above 10 billion dollars. Our assumption in this example that the central bank allows reserves to drop to zero avoids notation without substantially changing the resulting equilibrium

cation. We construct the prices that support it, and paths for the fiscal and wealth variables that are consistent with it. We guess that the international borrowing constraints both bind in period $T-1$ and that from period T on, the households will choose a constant consumption, $c_t = \hat{c}_T$ for $t \geq T$, with

$$\hat{c}_T = (y_T - g) - (1-\beta)(\bar{d} + \bar{a}). \tag{5.1}$$

The last term in this expression is the interest on the foreign debt. We guess that first period consumption is $c_0 = \min(\hat{c}_1, em_0)$, and $c_t = \hat{c}_1$ for t between $t = 1$ and $t = T-1$, with

$$\begin{aligned} \hat{c}_1 &= (y_0 - g) + \frac{1-\beta}{1-\beta^T}(a_0 + em_0 - \hat{c}_0) \\ &\quad + \beta^T \frac{1-\beta}{1-\beta^T}(\bar{d} + \bar{a}). \end{aligned} \tag{5.2}$$

Next we guess that prices q_t are such that the household is induced to consume the indicated amounts. Since consumption is constant between periods 1 and $T-1$, and from period T on, the price $q_t = \beta$ at those dates. At period $T-1$, the first order conditions require $q_{T-1} = \frac{\beta u'(c_T)}{u'(c_{T-1})} = \frac{\beta u'(\hat{c}_T)}{u'(\hat{c}_1)}$. Since $\hat{c}_T > \hat{c}_1$, $q_T < \beta$, so the real interest rate rises above the world interest rate at date $T-1$ when the international borrowing constraint binds.

Given the fixed exchange rate policy, seignorage is zero at all dates except date 0 when $s_0 = \hat{c}_1 - \min(em_0, \hat{c}_1)$, and date $T-1$ when $s_{T-1} = \hat{c}_T - \hat{c}_1$.

To complete the description of equilibrium, we construct paths for the various assets, $b_{t+1}, a_{t+1}, d_{t+1}, f_{t+1}$. After period T, reserves and public and private foreign indebtedness are at their limit values: 0, $\bar{d}$, and $\bar{a}$. Before period T,

however the paths of these variables are not uniquely determined. Instead, the path of the country's total international indebtedness $(d_{t+1} - a_{t+1} - f_{t+1})$ is determined by the path of the trade balance, the path of consumers' asset holdings $(a_{t+1} + b_{t+1})$ is determined by their budget constraints, and the path of government debt $(d_{t+1} + b_{t+1} - f_{t+1})$ is given by the government budget constraint. Thus, there is a continuum of possible paths of foreign reserves, f_{t+1} that are consistent with equilibrium. These paths include one in which there is a temporary increase of foreign reserves financed on the government's part by issuing domestic government debt. Citizens increase their foreign indebtedness to finance their purchase of this extra domestic debt. For simplicity in constructing this example, we assume that the private sector first runs down its holdings of foreign assets until it reaches the limit $\bar{a}$, and then it begins to sell its holdings of its government debt b_{t+1}. The central bank uses its foreign exchange reserves to purchase this debt. Of course, in period $T - 1$, reserves are exhausted.

It is immediate to check that the constructed allocation and associated interest rates and paths for assets is an equilibrium: the allocation solves the maximization problem of the agent and satisfies the government's budget constraint.

We next turn to a second example which we refer to as the Argentinian model. This example is intended to capture the essential features of the monetary reforms enacted in Argentina in 1991.

Example 4: The Argentinian Model

In this example, we assume that the central bank sets reserves equal to the stock of money each period, so $f_{t+1} = m_{t+1}$. The initial conditions for this economy are exactly like for example 3, except that $f_0 = em_0$.

We proceed as before by guessing that the international

borrowing constraints are binding in period $T-1$. Under the specified monetary policy, the level of reserves is equal to the real value of money which in turn is equal to per period consumption: $c_t = em_t = f_t$ for $t = T, T+1, ...$ This yields:

$$\hat{\hat{c}}_T = \frac{1}{2-\beta}\left((y_T - g) - (1-\beta)\left(\bar{d} + \bar{a}\right)\right). \tag{5.3}$$

It is important to notice that $\hat{\hat{c}}_T > \hat{c}_T$, in other words, in this example final consumption is higher than in the Mexican case. This is a natural consequence of the fact that the policy of setting reserves equal to the value of the money supply tightens the international borrowing constraints. Thus, the country borrows less and pay less interest. As we will see, the actual utility achieved will be lower.

First period consumption is as before, $\hat{\hat{c}}_0 = \min(\hat{\hat{c}}_1, em_0)$, and between $t = 1$ and $t = T$, consumption is set to be constant at the level that makes the time $T-1$ borrowing constraint bind. We then have:

$$\begin{aligned} \hat{\hat{c}}_1 \;=\; & (y_0 - g) + \frac{1-\beta}{1-\beta^T}(a_0 + em_0 - \hat{c}_0) \\ & +(\bar{d} + \bar{a})\left(\beta^T \frac{1-\beta}{1-\beta^T} + \frac{1-\beta}{2-\beta}\right) \\ & -\beta^T \frac{1-\beta}{(1-\beta^T)(2-\beta)}(y_T - g) \end{aligned} \tag{5.4}$$

It is immediate to see that $\hat{\hat{c}}_1 < \hat{c}_1$.

Observe that in this equilibrium, when the international borrowing constraints bind, the central bank loses potential

revenue because it holds foreign exchange reserves that pay a lower interest rate than domestic government debt. This loss of potential revenue could be large if domestic real rates rise substantially when the international borrowing constraints bind. Consumers also pay a price for this monetary policy. In particular, in this Argentinian model, consumption is less smooth than it is in the Mexican model. Given the strict concavity of the utility function agents are "worse off" under the Argentinian model than under the Mexican model.

The examples of this section illustrate the point that the government does not have many good policy options for avoiding the sale of its foreign exchange reserves when international borrowing constraints begin to bind. In fact, these examples show that efforts to establish hard monetary discipline with a currency board (as in the Argentinian model) in order to avoid selling off the central bank's international reserves only tighten the international borrowing constraints and lower welfare.[6]

6. Data from Mexico

In this section we present some data on Mexico's saving, investment, trade balance, current account, capital account and balance of payments over the last 6-7 years. In table 1, we present data on Mexico's saving, investment, and current account since 1987. In 1987, Mexico's current account surplus was 2% of its GDP. By 1994, it had fallen into a deficit equal to 8% of GDP. Over the same time period, gross investment over GDP remained roughly constant at 20-22% and public saving varied in the neighborhood of 5-7% of

[6]It is clear that in these examples we do not consider the possible role a currency board might have in establishing the credibility of monetary and exchange rate policy.

GDP. Private saving, on the other hand, dropped from a peak in 1988 of 19% to a low of 9% of GDP in 1994. Thus, in purely accounting terms, the increase in the current account deficit is largely explained by the drop in private saving over the 1988-1994 time period.

Table 2 presents the current and capital accounts in dollar terms. Observe that net capital flows to the public sector are relatively small except in 1993. Net capital flows to the private sector, on the other hand, match or exceed the growing current account deficit from 1989 through 1993. By 1993, the majority of that net capital inflow to the private sector is portfolio rather than direct investment. Over the same time period, the central bank gradually acquires $20 billion in reserves. In 1994, the net capital flows to the private sector drop off dramatically. In particular, the net flow of portfolio investment recorded on this table drops from $18 billion in 1993 to $1.2 billion in 1994. In 1994, nearly two thirds of the current account deficit of $29-30 billion is financed by selling the central bank's foreign exchange reserves.

Table 3 presents Mexico's balance of payments for the year 1993 and quarterly for 1994Q1-1995Q1. This table differs from table 2 in part because it reveals more information about the gross flows of capital into Mexico. This table indicates that investment in the Mexican stock market and loans to commercial banks and the private sector in Mexico drop off dramatically in 1994Q2-1995Q1. This financing totalled roughly $30 billion in 1993 and 1994Q1 combined and only $1.3 billion over the next three quarters (1994Q2-1994Q4). We see the beginnings of the official bailout of Mexico in the $9.2 billion loan to the public sector in 1995Q1 (This loan was to the Banco de Mexico). We see that $4.7 billion flowed out of the money market in 1994Q4 and another $4.7

flowed out in 1995Q1. These data on the money market refer to the market for peso denominated Mexican treasury securities. Errors and omissions and gross sales of foreign assets are not unusually large of the course of 1994, so there does not seem to be evidence of unrecorded capital flight.

Figure 1 shows the monthly trade balance from 1985 through May of 1995. The outstanding observation here is the dramatic adjustment of the trade balance into surplus early in 1995. This adjustment appears to run counter to any trends exhibited earlier by the trade deficit. In table 3, we see that the current account had a similarly dramatic adjustment from deficit in 1993-1994 to near balance in the first quarter of 1995.

In applying our model to Mexico, it is important to note that the debt limits we assume apply to all forms of international capital flows and not simply to those strictly defined as international debt. Data on the stock of Mexico's foreign debt are reported in the World Bank's *World Debt Tables*. The *World Debt Tables* (1994) indicate that the ratio of Mexico's total external debt to its GNP measured in dollars at current exchange rates rose from 53% in 1982 to 83% in 1986 and then fell to 35% by 1993 while the ratio of Mexico's total external debt to its exports rose from 289% in 1982 to 356% in 1986 and then fell to 184% in 1993.[7] These data from the *World Debt Tables* do not cover some of the major sources of foreign investment into Mexico. In particular, the *World Debt Tables* covers neither foreigners' direct investments into Mexico, nor their investments in Mexico's

[7]Several authors, including Cline (1995) and Sachs, Tornell, and Velasco (1995), have used data on Mexico's foreign indebtedness from the World Bank's World Debt Tables to argue that Mexico's foreign indebtedness was fallling from 1986-1993 and thus it is not likely that Mexico had hit its international borrowing constraint in 1994.

stock market, nor their direct purchases of Mexican treasury securities.

Over the 1990-1993 time period, Mexico's balance of payments statistics indicate that a total of $91 billion in capital flowed into Mexico.[8] Of this flow, $33 billion is recorded in the World Debt Tables as the net flow on Mexico's total debt. Another $16.6 billion is direct investment and $22 billion is investment in the Mexican stock market. In addition, from reports that foreigners' holdings of Mexican treasury securities totalled $22 billion in December of 1994, we infer that something on the order of $20 billion in foreign investment went directly to purchase Mexican treasury securities over this time period. As noted in table 3, during the first quarter of 1994, Mexico received another $9 billion in inflows. If we add these cumulative flows to the $118 billion stock of external debt recorded in the World Debt Tables at the end of 1993, we get that the cumulated stock of foreign investment in Mexico at the end of 1994Q1 was on the order of $188 billion or nearly 60% higher than is recorded in the World Debt Tables. If Mexico had borrowed an additional $19 billion in 1994 to preserve its stock of foreign exchange reserves, the cumulated stock of portfolio investment alone in Mexico would have also been on the order of $190 billion. Comparing these figures to Mexico's exports of goods and services of roughly $61 billion in 1993 or $70 billion in 1994, we see that the ratio of the cumulated stock of foreign investments to exports in Mexico was roughly 270%-310% in early 1994, or roughly the same level it attained in 1982.

[8]The following data on capital flows into Mexico are taken from the IMF International Capital Markets Report (1995) p. 53, and from the World Bank's World Debt Tables 1994-1995. Data on foreigners' holdings of Mexican treasury securities is taken from the IMF International Capital Markets Report (1995) chart I.10 on page 62.

It is also important to note that comparisons of Mexico's indebtedness to its GDP measured at current exchange rates yield a highly volatile estimate of Mexico's debt to GDP ratio. According to the *World Debt Tables*, Mexico's GNP at current exchange rates fell from $161 billion in 1982 to $121 billion in 1986 and then rose to $332 billion in 1993. Evidently, the movement in the dollar value of Mexico's GNP can be quite dramatic. These movements in the dollar value of Mexico's GNP mirror the movements in Mexico's real exchange rate. Mexico's real exchange rate fell roughly 35% between 1982 and 1986 and then rose roughly 90% between 1986 and 1993.[9] The dollar value of Mexico's GNP will certainly be considerably lower in 1995 than in 1993 or 1994. Using a forecast[10] of $266 billion for the dollar value of Mexico's GDP in 1995, and the a preliminary figure of $132 billion for Mexico's total foreign debt[11] in 1994 gives a ratio of total debt to GDP of 50%, quite similar to the ratio for Mexico in 1982 even if we do not include other forms of portfolio investment in the debt figure. If we use the larger figure of $188 for the cumulated stock of foreign investment into Mexico, we get a debt ratio to GDP ratio of 71%, well in excess of the 1982 figure.

[9]Data on Mexico's real exchange rate are taken from IMF International Capital Markets Report (1995) page 74.

[10]This forecast is from the *Economist* July 15-21, 1995, page 90.

[11]This figure for Mexico's total debt at the end of 1994 is from the Economist Intelligence Unit's *Country Report* for Mexico, 3rd quarter 1995, page 3. The figures in this report for total debt for years 1990-1993 are consistent with those in the World Debt Tables.

7. Interpretation of the Data

These data just presented are consistent in their broad outlines with the example of a borrowing constrained equilibrium presented in section 5. In our example, government reforms raise consumer wealth, increasing consumer spending. Increased consumer spending leads to trade deficits. Eventually, the private sector exhausts its ability to borrow[12] from abroad. In applying our model to Mexico, we suggest that this occurred early on in 1994. At this point, the government must choose either to raise real interest rates to move the trade balance into surplus and stem the loss of reserves or instead see domestic consumers sell their remaining holdings of domestic government bonds to the central bank to finance continued expenditure. We model Mexico as choosing the second option. Eventually, continued trade deficits exhaust the both the government's ability to borrow abroad and the central bank's stock of foreign exchange reserves. At this point, the country as a whole is borrowing constrained, real interest rates rise and the trade balance moves into surplus whether or not the government chooses to devalue the currency.

We have kept our model and examples simple so as to highlight our main ideas. As a result, we have glossed many important details of the recent Mexican experience. Several specific aspects of the recent Mexican experience are worth

[12]In the data in Table 2, we see that it was portfolio investment and not direct investment that stopped in 1994. The flow of foreign direct investment actually increased in Mexico in 1994. We follow the literature on international debt suggesting that the repudiation risk on direct investment may differ from that on portfolio investment. Mexico's balance of payments statistics indicate that the net flow of direct investment into Mexico also remained positive through the debt crisis of the 1980's.

discussing at greater length.

In our model, we have assumed that reforms cause the initial trade deficits because they raise future GDP less government expenditure more than they raise current GDP less government expenditure. Consumers spend because they feel wealthier and trade deficits are the result. We have chosen this explanation for its simplicity. In fact, the problem of explaining the boom in private expenditure and the appreciation of the real exchange rate in Mexico and in other countries undertaking exchange rate based stabilization programs is a matter of intense debate in the literature. Rebelo and Végh (1995) undertake an analytical survey of various explanations of these phenomena. In discussing Mexico, Dornbusch and Werner (1994) emphasize the theory that the increase in private expenditure observed in Mexico was caused by the appreciation of the real exchange rate that occurred over this period and that this appreciation of the real exchange rate was in turn caused by inflation inertia. Obstfeld and Rogoff (1995) observe that the behavior of Mexico's real exchange rate is qualitatively similar to that of Italy, Portugal, Spain, and Sweden prior to their failed attempts to remain in the EMS. Calvo and Mendoza (1995) contest the hypothesis that the boom in private spending and the widening of Mexico's current account deficits was caused principally by the impact of inflation inertia on Mexico's real exchange rate. They also suggest that the boom in private expenditure would not likely be curtailed by a moderate decline in the real exchange rate, observing that Mexico's real exchange rate did depreciate by 10% over 1994 even before Mexico devalued in late December. We refer the reader to these papers and the papers referenced therein for detailed discussion of various explanations of the boom in private expenditure in Mexico since 1987 and the similarities

between the Mexican experience and that of other countries. This is an area that clearly deserves further research.

It is worth emphasizing again that, in our model, a government need not abandon fixed exchange rates when international borrowing constraints bind. In particular, in our example in section 5, the government maintains a fixed exchange rate at all dates. In many respects, since early 1995, Argentina has experienced the same troubles attracting new inflows of foreign capital that Mexico has faced. Different from Mexico, Argentina has chosen to keep its currency board pegging the exchange rate of the peso to the dollar despite dramatic increases in domestic interest rates. In our model, the main benefit to a government in devaluing its exchange rate is that it raises some seignorage. The IMF International Capital Markets Report (1995) and Calvo and Mendoza (1995) offer a more subtle explanation examining how Mexico's decision to devalue may have been connected to developments in Mexico's banking sector.

In several respects, Mexico's experience at the end of 1994 and the beginning of 1995 are consistent with the predictions of speculative attack models of balance of payments crises. Calvo and Mendoza (1995) and background paper III in the IMF International Capital Markets Report (1995) in particular discuss Mexico's experience at the end of 1994 in the context of models of speculative attacks in some detail. Mexico lost roughly $10 billion in reserves in November and December of 1994, with more than $6 billion of the loss coming in December alone.

The view that Mexico suffered a speculative attack on its balance of payments at the end of 1994 is not inconsistent with our model. In standard models of speculative attacks, the dynamics of nominal interest rates, money demand, and the attack itself are all simultaneously determined in equilib-

rium. Our model is capable of generating similar dynamics of nominal interest rates and money demand, and thus is capable of generating a speculative attack. As illustrated in the examples in section 5, in our model, once a country has reached its international borrowing constraints, its real interest rate rises. Unless the monetary authorities deflate, the increase in the real interest rate leads to an increase in the nominal interest rate. Thus, the result that real money demand would drop suddenly when the reserve floor was reached and the international borrowing constraint began to bind would arise naturally in our model, even if the government's commitment to a fixed exchange rate was completely credible.[13]

We find recent data from Argentina interesting in this regard. Recall that Argentina has maintained a currency board throughout the current crisis. Despite this commitment to a fixed exchange rate, commercial bank deposits fell by 16% (more than $7.5 billion) from mid-December 1994 to the end of March 1995 and Argentina's foreign exchange reserves fell by almost $5 billion while prime interest rates rose by 33 percentage points to nearly 50% over the same time period.[14] At the same time, the trade balance in Argentina has moved from a deficit of $1-$2 billion per quarter in 1994 to a deficit of only $.7 billion in 1995Q1 and a surplus of $.3

[13]In the current presentation of our model, the consumption velocity of money is constant so real money demand rises when the international borrowing constraint begins to bind. To generate a speculative attack our model, one would have to modify the model to incorporate a sufficiently large interest elasticity of money demand to induce real money demand to fall when domestic interest rates rise as the international borrowing constraint begins to bind.

[14]These data are from the IMF International Capital Markets Report (1995) page 6.

billion in April of 1995.[15]

Figure 2 presents data on Mexico's monetary base and its components: international reserves and net domestic credit, from 1993 through mid-1995. The top line is reserves, the middle, the monetary base, and the lower line is net domestic credit. This figure clearly indicates that the Mexican central bank followed a policy of sterilizing the reserve loss over this time period, acquiring net domestic credit as it lost reserves to keep the monetary base stable. This monetary policy is typical of the pre-crisis policies assumed in the standard literature on speculative attacks. In the standard model, the expansion of domestic credit is assumed to be part of some expansionary fiscal or monetary policy that, in the long run, is inconsistent with the stated exchange rate policy. A speculative attack occurs when investors perceive that an attack would exhaust reserves leading to a change in the exchange rate policy.

The interpretation of the monetary policy pictured in figure 2 in the context of our model is slightly different. We assume that Mexico's private sector had hit its international borrowing constraint early on in 1994. From our model, it follows that, until real interest rates rose, Mexicans would then begin to sell their holdings of their government's debt to finance continued expenditure. The monetary policy pictured in figure 2 served to hold down real interest rates in Mexico despite this drop in domestic demand for Mexican government debt. Essentially, the Banco de Mexico accommodated the drop in domestic demand for Mexican government debt by purchasing a large part of the debt Mexicans were selling at something close to world interest rates.

Obstfeld and Rogoff (1995) espouse the view that un-

[15]The data on Argentina's trade balance is from the Economist Intelligence Unit's *Country Report* 2nd quarter 1995.

derlying cause of the events in Mexico in 1994 was that the Mexican government was "unable to convince investors and price setters of its long-term unconditional commitment to its exchange rate targets." They compare Mexico's balance of payments crisis to the speculative attacks that led to collapse of the European Monetary System in 1992-1993. They argue that had Mexico's commitment to its exchange rate targets been more credible, then the events that threw Mexico into crisis might never have happened. We suspect that this explanation is incomplete. In particular, this view does not offer an obvious explanation of the sudden movement of Mexico's trade balance from deficit into surplus shown in figure 1. We interpret the movement of Mexico's trade balance as evidence that Mexico as a whole lost access to further inflows of portfolio investment. It is worth noting that the various EMS countries that suffered speculative attacks in 1992-1993 and then devalued did not experience the dramatic trade balance adjustment experienced in Mexico. We suggest that the data on Mexico's trade balance is the central feature distinguishing the Mexican experience of 1994 from the experiences of the EMS countries in 1992-1993 and many other countries that have experienced speculative attacks on their balance of payments.

8. Conclusion

Standard models of the balance of payments assume that central banks become vulnerable to speculative attacks when investors question the credibility of their commitment to their stated exchange rate targets. In the simplest of these models, the loss of foreign exchange reserves usually begins when the central bank expands domestic credit to finance fiscal deficits. This balance of payments deficit be-

comes a crisis when investors attack the central bank's remaining reserves speculating that exchange rates will soon change. There certainly was a combination of events in Mexico in 1994, including assassination, civil strife, and increasing weakness in the banking sector, that may have combined to cast doubt on the credibility of Mexico's commitment to its targets for its exchange rate. We suggest that these events may not have played the central role ascribed to them in standard analyses.

To buttress that suggestion, we have developed an alternative model of the balance of payments in which crises can occur even if fiscal, monetary, and exchange rate policies are completely credible. Our model suggests that if Mexico had hit its international borrowing limits early on in 1994, pressure on the Banco de Mexico to sell its stock of reserves was inevitable since these reserves would then have been the last source Mexico had for funding for further trade deficits. Thus, our model suggests that the Banco de Mexico had no alternative but to sell its foreign exchange or see real interest rates rise sufficiently to move Mexico's trade balance into surplus immediately after the flow of private portfolio investment came to an end early in 1994. Our results suggest that efforts to enhance the credibility of the Banco de Mexico's exchange rate policy may not have helped to remove it from the horns of this dilemma for long.

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Table 1.

Saving, Investment, and the Current Account in percentages of GDP

	1987	1988	1989	1990	1991	1992	1993	1994
National Saving	21.6	18.2	18.5	18.7	17.6	16.0	14.1	13.7
Private Saving	14.3	18.8	16.1	12.1	10.0	8.7	8.9	9.1
Public Saving	7.3	-0.7	2.4	6.6	7.6	7.3	5.2	4.6
Gross Dom. Invest.	19.3	20.4	21.4	21.9	22.4	22.8	20.6	21.6
Current Account	2.2	-2.3	-2.9	-3.2	-4.8	-6.8	-6.4	-8.0

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Table 2.
Financing of the Current Account in US$ billions

	1987	1988	1989	1990	1991	1992	1993	1994
Current Account	2.9	-3.8	-6.1	-7.5	-14.9	-24.8	-23.4	-29.5
Capital Account	3.8	-2.9	5.1	10.9	22.5	26.7	30.5	11.6
of which								
Public sector net	3.6	1.2	-0.7	-0.2	3.0	1.5	7.5	2.5
Private sector net	0.2	-4.1	5.8	11.1	19.5	25.2	23.0	9.1
of which								
Direct Investment	1.8	1.7	2.7	2.6	4.8	4.4	4.9	7.9
level end-yr gross								
For. Ex. Reserves	8.0	6.0	6.5	10.1	17.9	19.4	25.4	6.3

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Table 3

Mexico's Balance of Payments 1993-1995Q1 in US $ billions

	1993	94Q1	94Q2	94Q3	94Q4	95Q1
Current Account	-23.4	-6.7	-7.1	-7.7	-7.3	-1.2
Capital Account	32.5	9.1	0.9	5.2	-3.1	2.5
of which						
loans to Comm. Banks						
and private sector	12.5	4.1	0.5	-0.5	0.8	-2.4
loans to public sector	1.5	1.3	0.6	0.5	0.3	9.2
Direct Investment	4.4	1.8	1.6	2.3	2.2	0.6
Stock Market	10.7	3.5	0.2	0.7	-0.4	0.1
Money Market*	7.0	1.5	0.0	1.2	-4.7	-4.7
Sales of frgn assets**	-3.6	-3.1	-1.8	0.9	-1.5	-0.4
Errors and Ommisions	-3.1	-2.3	-2.4	2.6	0.5	-0.6
Change in net intl. rsrvs	6.0	0.1	-8.7	-0.1	-10.0	0.7

*money market is for peso denominated treasury securities

**negative signs here indicate Mexican accumulation of foreign assets

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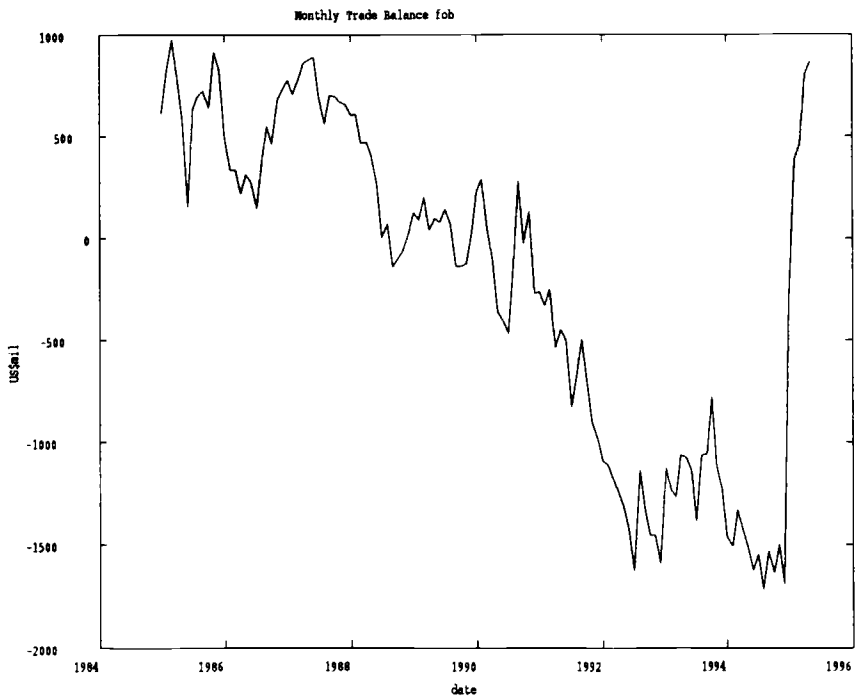

Figure 1: Monthly Trade Balance fob US$mil

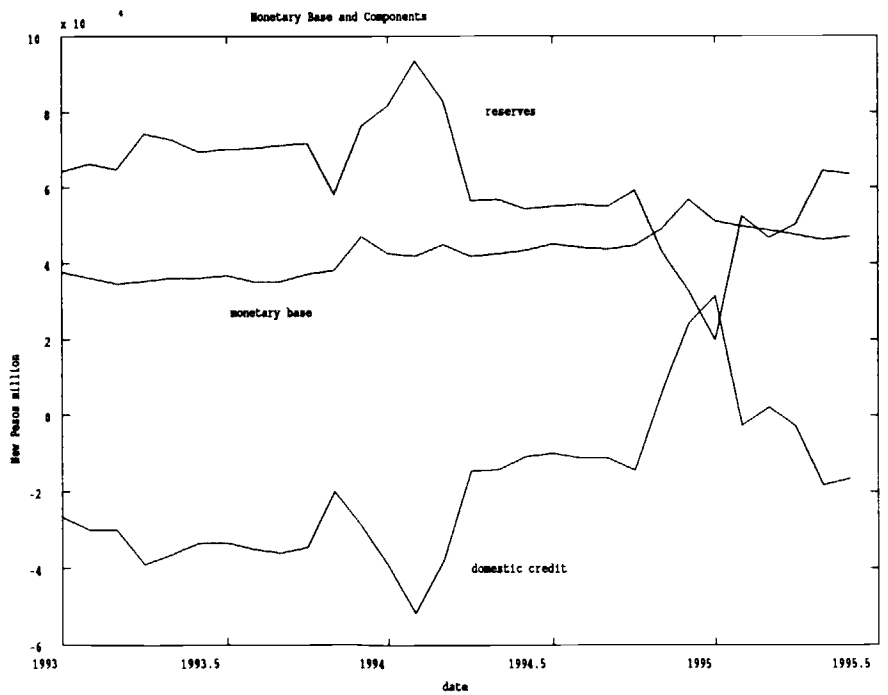

Figure 2: Mexico's Monetary Base and Components
1993-1995