

## **FISCAL STABILIZATION AND EXCHANGE RATE INSTABILITY**

### **A Theoretical Approach and Some Policy Conclusions Using Mexican Data**

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We construct a perfect foresight intertemporal general equilibrium model designed to analyze the impact of reductions in public spending. The model incorporates public infrastructure that enters private productions and a reserve-based government exchange rate policy. The model is estimated for Mexico and a three-year benchmark equilibrium is computed. Counterfactual simulations are carried out, with one of the conclusions being that a reduction in government spending can be inflationary. The results are sensitive to the elasticity of private output with respect to government infrastructure.

### **1. Introduction**

A striking feature in the recent economic performance of a number of countries, particularly in Latin America, has been the rapid rise in the size of the public sectors. In Mexico, perhaps the most striking example of such a phenomenon, total spending of the public sector, which represented only 25.6 percent of GDP in 1973, had risen to 46.5 percent of GDP by 1982. At the same time that this increase in the size of the government was taking place, there were also equally dramatic increases in inflation, the government budget deficit, and the external debt. A conclusion that has been drawn by planners in Mexico and elsewhere is that stabilization depends in some, perhaps vague, way on a successful reduction in this spending of the government.

A cursory examination of the composition of government spending in most of these countries reveals that the proportion of expenditures going to service debt, both domestic and foreign, has also risen dramatically. Accordingly,

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attempts to stabilize the government's fiscal situation have often focused upon reduction of the burden of interest obligations. It is, of course, rather difficult to do so with foreign currency denominated debt. It is also difficult to reduce the real value of domestic debt service by inflating the economy since most domestic public debt is short term and thus pays essentially inflation-indexed interest. Governments have thus attempted to carry out financial policies designed to lower nominal interest rates, while at the same time maintaining a fixed, or at least managed, exchange rate. Such policies have, however, often encountered serious problems. It appears that in many cases a high real interest rate is required to induce the public to hold domestic debt.<sup>1</sup> If a fall in the interest rate is observed, then there is an immediate flight of capital, causing the interest rate to rise once again. The fact that capital flows are highly sensitive to changes in interest and exchange rates thus greatly limits the scope of the government in carrying out stabilization measures via interest rate management.

Our aim in this paper will be to examine the implications for certain key macroeconomic variables, in particular the rate of inflation, the interest rate, and the rate of growth of real GDP, of reductions in public spending. The constraint on these reductions, and indeed often their intended target, is the level of foreign exchange reserves. To what extent is stabilization of these macro variables consistent with a sustainable foreign reserve position? We might consider both tax increases and expenditure reductions as stabilization measures. The experience of most developing countries has been, however, that it is quite difficult to raise real tax revenues.<sup>2</sup> We will therefore focus on reductions in government spending.

In order to give some sense of the magnitudes involved, table 1 gives Mexican data on real growth, inflation, the fiscal position of the government, and net foreign reserves for the period 1973–85. It is clear that expenditure, although at least theoretically controlled by the government, has grown dramatically.

Two general approaches have been used in examining government expenditures. The first of these is to consider the provision of public goods, and to derive conditions for their optimal production and allocation. The appeal of this approach is its theoretical consistency; however, it is very difficult to implement empirically. The second approach, which is frequently used in applied general equilibrium analysis, is to treat government output as useless, and to derive the cost of its production to the rest of the economy. If the

<sup>1</sup>More precisely, we mean that the interest rate deflated by the expected rate of devaluation of the domestic currency must be positive and large in order to induce people to hold domestic assets.

<sup>2</sup>In addition, methodologies for optimally increasing tax revenues have been discussed in detail elsewhere. See, for example, Stern (1984) for a useful survey, while Seade (1987) gives an example of current empirical work.

Table 1  
Mexico: Macro variables, 1973-85.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Real GDP <sup>a</sup>	8.4	6.1	5.5	4.3	3.4	8.2	9.2	8.3	7.9	-0.5	-5.3	3.7	2.7
Public sector revenues <sup>b</sup>	20.0	21.0	23.0	23.6	24.2	25.5	26.2	28.5	27.5	30.3	34.4	34.2	32.2
Public expenditure <sup>c</sup>	25.6	26.7	31.8	32.0	29.5	31.0	32.2	35.5	41.1	46.5	42.7	41.5	40.5
Budget balance <sup>d</sup>	-5.6	-5.7	-8.8	-8.4	-5.3	-5.5	-6.0	-7.0	-13.6	-16.2	-8.3	-7.3	-8.3
Trade balance <sup>d</sup>	-1.2	-3.4	-5.0	-3.0	0.1	-0.5	-1.2	-0.9	-1.7	6.2	10.0	7.5	4.9
Inflation <sup>e</sup>	16.0	22.4	10.4	22.4	41.2	15.8	18.3	24.5	25.5	57.5	99.3	63.6	55.2
Capital flight <sup>f</sup>	668	755	784	2,944	686	-66	231	-678	9,733	8,225	2,415	2,332	1,917

<sup>a</sup>Percentage change. Source: *Indicadores Economicos*.

<sup>b</sup>Total revenues of the public sector as a percent of GDP. Source: *Indicadores Economicos*.

<sup>c</sup>Total expenditures of the public sector as a percent of GDP. Source: *Indicadores Economicos*.

<sup>d</sup>As percent of GDP. Source: *Indicadores Economicos*.

<sup>e</sup>Percentage change in the annual average of the wholesale price index. Source: *Indicadores Economicos*.

<sup>f</sup>In millions of U.S. dollars. Source: Zedillo (1986).

output is to be worth producing, its benefits must outweigh its costs. This approach, while being relatively straightforward to apply, overlooks the fact that government production may have a direct positive impact on private production. Government infrastructure, for example, such as roads or education, may contribute to the efficiency of private output. An analysis that only looks at the crowding out effects of government spending ignores these benefits.

We will develop an intertemporal general equilibrium model that will be used to analyze reductions in government spending. We will develop our analysis in the context of an exchange rate regime that is typical of many developing countries: the rate is fixed, but if the foreign reserves of the central bank fall below some critical level, then the rate is devalued. The current and capital accounts are fully endogenous in our model, and the model simultaneously incorporates both public infrastructure as well as public crowding out of the private sector via the interest rate.

The next section will give a brief review of background literature as well as provide an intuitive explanation of our model. Section 3 will formally analyze the model, while section 4 will present policy simulations using Mexican data. Section 5 will be a conclusion.

## **2. Exchange rate determination and the reduction of government spending: Background and intuition**

The analysis of 'productive' government expenditure has a long history, dating to Samuelson (1954) and Musgrave (1959). For recent surveys of the literature see Brennan and Pincus (1983) and Johansson (1986). Our approach assumes that the government provides infrastructure that enhance private productivity. This approach has been developed in Grossman and Lucas (1974), Barro (1981, 1984), Barro and Grossman (1976), Johansson (1982), and Negishi (1979).<sup>3</sup> A problem with the analysis in most of these articles is that they assume there to be a one-to-one correspondence between government spending and the supply of public goods: in practice increases in government spending usually lead to rapidly decreasing marginal provision of public goods.

There have been several recent studies that construct intertemporal macroeconomic models designed to analyze fiscal reduction programs.<sup>4</sup> There are, however, virtually no such models that consider public investment, one of the major issues that we wish to examine. Accordingly they are unable

<sup>3</sup>One might also wish to include public goods in private consumption, an approach taken in Calvo (1979), Groenewold (1980, 1982, 1984), and Johansson (1982).

<sup>4</sup>Among these are Blanchard and Sachs (1982), Cuddington and Johansson (1986), Marchand, Mintz and Pestieau (1984, 1985), Moore and Neary (1984), and Neary and Stiglitz (1983).

to examine the trade-offs between private production and government spending that we wish to consider.

There is also a considerable literature on empirical evidence for the influence of government expenditures on real output. Most of the studies on developed countries, however, tend to neglect any direct influence of public spending on private investment or output, using instead a demand-driven approach. There have been, on the other hand, a number of papers that examine the relationship between government spending and private investment in developing countries.<sup>5</sup> The results of these studies are quite mixed, however, and, in addition, none of them is in the context of an intertemporal model of the type we wish to construct. Tun Wai and Wong (1982), for example, estimate partial equilibrium models for 11 developing countries, and conclude that in 10 of the 11 countries government spending has a positive impact on private investment. Blejer and Khan (1984), on the other hand, claim that the apparent lack of relationship that some authors report between public sector investment and private investment reflects the offsetting effects that different types of public investment have. Unlike the two previous studies, which use a partial equilibrium setting to analyze government spending, Sundarajan and Thakur (1980) carry out a study of India and Korea within a growth model framework. They conclude that the long-run multiplier effects of increased public investment in India are small, although in Korea they are quite large.

In conjunction with the examination of the interaction between government spending and private production, we also wish to consider the interaction between the balance of payments, fiscal deficits, and government exchange rate rules. There are a number of theoretical articles over the past few years that examine the impact of government policies on the exchange rate. Salant and Henderson (1978) discuss a rational speculative attack within the context of a gold market. Krugman (1979) presents a model in which consumers, who have perfect foresight, realize that the government can no longer defend the present fixed exchange rate, and create an attack upon the exchange rate. Attacks on the rate become, indeed, self-fulfilling. Similar conclusions are reached in Flood and Garber (1984) and Obstfeld (1984). In these papers, the attack upon the exchange rate comes from the inconsistency of internal macroeconomic policies with the exchange rate policy of the government. Obstfeld (1986) develops a model in which a balance of payments crisis may be entirely self-fulfilling, and not the result of any government macro policies. A recent paper that is perhaps closer to our direction of study in van Wijnbergen (1986), which specifically considers the

<sup>5</sup>See Blejer and Khan (1984), David and Scadding (1974), von Furstenberg and Malkiel (1977), Galbis (1979), Heller (1975), Sundarajan and Thakur (1980) and Tun Wai and Wong (1982).

interaction of the government budget deficit and attacks on the exchange rate.

There are, however, certain drawbacks to the approaches described above. On a theoretical level, they are all small country models with no non-traded goods; thus the only price determined in the model is the exchange rate.<sup>6</sup> Since we specifically wish to consider the impact of government purchases of capital and labor, used to produce infrastructure, on private output and investment, this is not a useful framework. Perhaps more important, with the exception of a paper by Blanco and Garber (1986), none of them is empirical.

Let us now turn to a description of our model.

### 3. The model

In this section we describe the formal structure of our model. It is fully intertemporal and has  $T$  discrete time periods, with an infinite time horizon future beyond period  $T$ . There is disaggregation in production, as well as heterogeneous consumers. We assume that the government intends for there to be a fixed exchange rate, but will allow the rate to vary depending upon its foreign reserve position.<sup>7</sup> We first describe the structure of production.

#### 3.1. Production

We assume that intermediate and final production in period  $i$  is given by an  $N \times N$  input-output matrix,  $A_i$ . Value added in the  $j$ th sector in time  $i$ ,  $va_{ji}$ , is given by a smooth production function that uses inputs of capital and labor from that period, as well as the existing stock of government infrastructure. Let  $y_{ki}^j$ ,  $y_{Li}^j$  be the inputs of capital and labor to the  $j$ th sector in period  $i$ . Let  $Y_{Gi}$  be the outstanding stock of government infrastructure in period  $i$ . The production of value added is then given by:

$$va_{ji} = va_{ji}(y_{ki}^j, y_{Li}^j, Y_{Gi}). \quad (3.1)$$

Here we are assuming that there is a single type of infrastructure, although extensions to sector-specific infrastructure would present no problem. Infrastructure may be thought of, for example, as roads, communications, education, and so forth, and enters private production as an increase in productivity. It is thus a public good in that its direct costs are zero, although its indirect costs may be very high. It is assumed that sector  $j$  cost-minimizes with respect to capital and labor. Each sector pays value added tax rates on inputs of capital and labor, given by  $t_{ki}^j$ ,  $t_{Li}^j$ , respectively, in

<sup>6</sup>An exception is Connolly and Taylor (1984), which does incorporate non-traded goods.

<sup>7</sup>Feltenstein (1986) constructs a similar model of the real sector in a two-period model, but assumes a fixed exchange rate, while Feltenstein, Lebow and Sibert (1988) use a pure float.

period  $i$ . Thus, if  $P_{K_i}$  and  $P_{L_i}$  are the prices of capital and labor in period  $i$ , then the prices charged by enterprises,  $P_i$ , are given by

$$\{P_i\} = va(P, Y_{Gi})(1+t)(I-A)^{-1}, \quad (3.2)$$

where  $va(P, Y_{Gi})$  is the vector of cost-minimizing nominal value added per unit of output, subject to  $P = \{P_{K_i}, P_{L_i}\}$  and  $Y_{Gi}$ , and  $t = \{t_{K_i}, t_{L_i}\}$ . Hence,  $va(P, Y_{Gi})(1+t)$  represents the vector of total cost of value added for each sector. It should be noted that eq. (3.2) requires constant returns to scale in production.

Private investment, on the other hand, is assumed to exhibit decreasing returns to scale. Investment responds to anticipated future returns on capital, as well as future interest rates. Suppose that  $H_i = H_i(y_{K_i}, y_{L_i})$  is a neoclassical production function that produces capital using inputs of capital and labor, and which exhibits decreasing returns to scale. Let  $C_{H_i}$  be the cost minimizing cost of producing the quantity  $H_i$  of capital. It is assumed that this capital does not begin to yield a return until the period after which it is produced. Accordingly, if  $P_{K_i}$  is the price of capital in period  $i$ ,  $r_i$  the nominal domestic interest rate, and  $\delta$  the rate of depreciation of capital, then we must have:

$$\begin{aligned} C_{H_i} = & \sum_{k=1}^{T-1} [(1-\delta)^{k-1} P_{K, i+k} H_i / \prod_{j=1}^k (1+r_j)] \\ & + \sum_{k=0}^{\infty} [(1-\delta)^{T+k-1} (1+\pi)^k H_i / \prod_{j=1}^{T+k} (1+r_j)]. \end{aligned} \quad (3.3)$$

Here the first term on the right-hand side represents the present discounted value of the income stream from the new investment over the  $T$  discrete time periods. The second term represents the present discounted value of the infinite time horizon after period  $T$ . Here we have assumed that the investor expects the nominal rental price of capital to increase by the rate of inflation,  $\pi$ , which is taken to be constant, in the future after period  $T$ . If we define  $r_i$ , the nominal interest rate as:

$$r_i = P_{M, i+1} / P_{B_i} - 1, \quad (3.4)$$

where  $P_{M_i}$  is the price of money at time  $i$  and  $p_{B_i}$  is the price of domestic bonds in period  $i$ , eq. (3.3) becomes:

$$\frac{P_{M2}C_1}{P_{B1}} = P_{K2}H_1 + \sum_{i=2}^T \frac{(1-\delta)^{i-1}P_{Bi}P_{K,i+1}}{P_{M,i+1}}. \quad (3.5)$$

Eq. (3.5) has two unknowns,  $y_{Ki}$  and  $y_{Li}$ . We may also assume that the investor chooses the ratio  $y_{Ki}/y_{Li}$  to minimize cost, thus giving a second equation in the same two unknowns. We may thus solve for capital and labor inputs to investment.<sup>8</sup> We will assume that debt is short term and must be rolled over at the end of each period. Accordingly, we will define the private issuance of bonds in period  $i$ , corresponding to period 1 investment,  $y_{BPi}^1$ , as:

$$y_{BPi}^1 = \frac{(1-\delta)^{i-1}P_{K,i+1}H_1}{P_{M,i+1}}, \quad i=1, \dots, T-1. \quad (3.6)$$

This definition of bond financing of private investment will permit Walras' law to hold in each period. Similarly, we may derive period 2 investment,  $H_2$ , as:

$$\frac{P_{M3}C_{H2}}{P_{B2}} = P_{K3}H_2 + \sum_{i=3}^T \frac{(1-\delta)^{i-2}P_{Bi}P_{K,i+1}H_2}{P_{M,i+1}}, \quad (3.7)$$

and the bond sales in period  $i$  to finance period 2 investment,  $y_{BPi}^2$ , are given by

$$y_{BPi}^2 = \frac{(1-\delta)^{i-2}P_{K,i+1}H_2}{P_{M,i+1}}, \quad i=2, \dots, T. \quad (3.8)$$

We may similarly calculate period  $j$  investment and bond sales in period  $i$ ,  $H_j$  and  $y_{BPi}^j$ , respectively.

The final productive agent in our model is the government. The government carries out current spending, which has no productive purpose. It also produces public infrastructure which enters private production as a productivity increase. This infrastructure is  $Y_{Gi}$ , given in the private sector value

<sup>8</sup>This solution requires decreasing returns to scale in production, since otherwise the two-equation system could be solved only for a unique price ratio.

added function in eq. (3.1). Infrastructure is produced via neoclassical production functions,  $g_i(y_{Ki}, y_{Li})$ , in period  $i$  which use inputs of capital and labor. The government thus competes directly with the private sector in the absorption of capital. In particular, it is not apparent whether the cost to the private sector of the government's absorption for infrastructure output will be outweighed by the productivity improvement generated by the infrastructure. Our simulations will show that this depends crucially upon the elasticity of private output with respect to the stock of public infrastructure. We will suppose that the government sets the real value of expenditure on infrastructure exogenously. Hence, no attempt is made to model optimizing behavior.

### 3.2. Consumption

We will assume that there is a single consumer in our model who has perfect foresight in all markets. He maximizes an intertemporal utility function subject to his expectation of future exchange rate changes, which are incorporated into his budget constraint.<sup>9</sup> Let  $x_i = (x_{1i}, \dots, x_{Ni})$  be the consumer's consumption vector in period  $i$  and let  $x_{Li}$  be his consumption of leisure. We will assume that the consumer receives utility only from the consumption of goods generated by the input-output matrix, and leisure. He is required to cover his expenditures from income in each period, and he pays ad valorem tax rates  $\{t\} = \{t_{1i}, \dots, t_{Ni}\}$  on the consumption of goods in period  $i$ . In order to derive a simple analytical expression we will also assume that he receives utility only from consumption in the first  $T$  time periods, although we will impose a savings rate in the final period. The consumer's utility function is of the form:

$$\prod_{i=1}^T x_{Li}^{\alpha_i} \left\{ \prod_{j=1}^n x_{ji}^{\alpha_{ji}} \right\}. \quad (3.10)$$

In practice we will assume that exponential discounting is used so that  $\alpha_{j(i+1)} = \alpha_{ji}/(1 + \sigma)$ , where  $\sigma \geq 0$  is the rate of time preference. Hence, eq. (3.10) may be written in log-linear form as:

$$\sum_{i=1}^T 1/(1 + \sigma)^{i-1} \left\{ \alpha_1 \log x_{Li} + \sum_{j=1}^N \alpha_{j1} \log x_{ji} \right\}. \quad (3.10a)$$

The consumer's problem is thus to maximize (3.10) subject to

<sup>9</sup>There is no problem in having multiple consumers. In our application to Mexico, however, we have a single consumer representing the domestic economy.

$$(1+t_j)P_jx_j + P_{L_j}x_{L_j} + P_{M_j}x_{M_j} + P_{B_j}x_{B_j} + e_jx_{BF_j} \leq \bar{Y}_j, \quad (3.11)$$

where

$$\bar{Y}_1 = P_{K_1}K_0 + P_{L_1}L_0 + P_{M_1}B_0 + e_1(1+r_{F1})B_{F0} + TR_1, \quad (3.11a)$$

$$\bar{Y}_j = (1-\sigma)^j P_{K_j}K_0 + P_{L_j}L_0 + TR_j, \quad (3.11b)$$

$$(1+t_j)P_jx_j + P_{L_j}x_{L_j} + P_{M_j}x_{M_j} + P_{B_j}x_{B_j} + e_jx_{BF_j} \\ \leq \bar{Y}_j + P_{M_j}x_{M,j-1} + P_{B_j}x_{B,j-1} + e_j(1+r_{Fj})x_{BF,j-1}, \quad j=2, \dots, T. \quad (3.11c)$$

We define  $x_{M_i}$ ,  $x_{B_i}$ , and  $x_{BF_i}$  as the consumer's demand for money, domestic, and foreign bonds, respectively, in period  $i$ , and  $e_i$  as the exchange rate in period  $i$ . Here  $e_i$  is defined as the domestic currency price of foreign assets. In addition,  $r_{F_i}$  is the exogenously given foreign interest rate. Finally,  $TR_i$  represents any transfer payments the consumer receives from the government, while  $K_0$ ,  $L_0$ ,  $M_0$ , and  $B_{F0}$  are his initial allocations of capital, labor, money, domestic, and foreign bonds.

The consumer is assumed to face two additional constraints. The first of these is a cash constraint that connects his holdings of money to his consumption and the interest rate. Accordingly, we set:

$$P_{M_j}x_{M_j}/[(1+t_j)P_jx_j] = ar_j^{-b} \equiv \beta_j, \quad j=1, \dots, T. \quad (3.12)$$

Hence, there is an obvious trade-off between current consumption and money holdings. Since money is carried over from period to period, as in eq. (3.11c), the utility implications of changes in the interest rate are not necessarily clear. We thus use a modified cash-in-advance formulation of money demand in which money demand depends not only upon the value of consumption but also upon the interest rate, reflecting opportunity cost. This is thus an imposed condition reflecting, we assume, institutional constraints rather than an outcome derived from optimizing behavior.

To be completely consistent with the structure of a perfect foresight general equilibrium model, consumers should choose between domestic and foreign assets on the basis of future returns; the consumer should only hold the asset with the higher total yield since there is no risk. We wish, however, to permit simultaneous holdings of both domestic and foreign assets. We therefore impose a constraint that has the same ad hoc characteristic as the constraint on money demand. The second additional constraint is that we assume that domestic and foreign bonds are not perfect substitutes and that the consumer chooses between them according to relative domestic and

foreign total bond yields, deflated by the anticipated exchange rate change. Accordingly we set:

$$\frac{P_{Bj}x_{BJ}}{e_jx_{BFj}} = c \left[ \frac{1+r_j}{(1+r_{Fj})e_{j+1}/e_j} \right]^d \equiv \tau, \quad j=1, \dots, T, \tag{3.13}$$

where  $c, d \geq 0$ . Thus, exchange rate changes along with relative domestic and foreign interest rates determine consumer savings and hence have direct welfare effects.

Finally, we close the consumer's problem by assuming that his savings rate in period  $T$  is given by an exogenous constant. The consumer does not receive utility from this savings. If savings are given by holdings of domestic plus foreign assets, then:<sup>10</sup>

$$P_{BT}x_{BT} + e_Tx_{BFT} = s(1+t_T)P_Tx_T. \tag{3.14}$$

Our use of money constraint, although apparently ad hoc, could be replaced by an equivalent formulation that incorporates money into the utility function. Our current formulation, however, permits direct estimation, which will be important later. We notice that since domestic bonds are short term,  $P_{M,i+1}x_{Bi}$  reflects both principal and interest in period  $i+1$  on a bond purchased in period  $i$ .

We may solve the consumer's maximization problem in the following way. Because of the restriction of eq. (3.13) on the holdings of different assets, the ratio of the Lagrange multipliers of the  $j$ th to  $(j+1)$ th budget constraint is:

$$\mu_j = \frac{\tau_j P_{M,j+1}/P_{Bj} + (1+r_{Fj})e_{j+1}/e_j}{1 + \tau_j}. \tag{3.15}$$

Define  $N_j$  as the ratio of the Lagrange multiplier of the  $j$ th and  $T$ th constraint, i.e.

$$N_j = \sum_{j=1}^{T-1} \tau_j.$$

Now if

$$Y^* = \sum_{j=1}^T N_j Y_j \quad \text{and} \quad \tilde{\alpha} = \sum_{j=1}^T \alpha_{Lj} \sum_{i=1}^n \alpha_{ij},$$

then demand for leisure,  $x_{Lj}$ , is given by:

<sup>10</sup>This savings rate closure rule is equivalent to an exogenous bequest rule. An example of such a bequest rule is given in Fair (1984, ch. 3).

$$x_{Lj} = \alpha_{Lj} Y^* / (\bar{\alpha}_{Nj} - P_{Lj}), \quad j = 1, \dots, T. \quad (3.16)$$

Restriction (3.16) and the demand for money gives a total coefficient on spending in consumption,  $K_j$ , of

$$K_j = (1 - \beta_j) N_j - \beta_j N_{j+1} P_{M, j+1} / P_{Mj}.$$

Restriction (3.14) implies  $K_T = 1 + \beta_{j+s} + s$ . Now

$$x_{ij} = \alpha_{ij} Y^* / [\bar{\alpha} P_{ij} (1 + t_{ij}) K_j], \quad j = 1, \dots, n, \quad (3.17)$$

$$x_{Mj} = \beta_j Y^* \sum_{i=1}^n \alpha_{ij} / (\bar{\alpha} P_{Mj} K_j), \quad \text{for } i = 1, \dots, T. \quad (3.18)$$

Demand for bonds in each period is a residual, i.e. if

$$\begin{aligned} Y_1 &= \bar{Y}_1 - P_{L1} x_{L1} - (1 + t_1) P_1 x_1 - P_{M1} x_{M1}, \\ Y_j &= \bar{Y}_j + P_{Mj} (x_{M, j-1} + x_{B, j-1}) + (1 + r_{Fj}) e_j x_{BF, j-1} \\ &\quad - P_{Lj} x_{Lj} - (1 + t_j) P_j x_j - P_{Mj} x_{Mj}, \quad i = 2, \dots, T, \end{aligned}$$

Then

$$\begin{aligned} x_{Bj} &= \tau_j Y_j / [(1 + \tau_j) P_{Bj}], \\ x_{FBj} &= Y_j / [(1 + \tau_j) P_{Mj} e_j]. \end{aligned} \quad (3.19)$$

### 3.3. Budget deficits and the adjustment of the exchange rate

Let  $T_i$  be the total taxes collected by the government in period  $i$ , and let  $G_i$  be the value of its expenditures on goods and services in the period. If  $y_{BG(i-1)}$  is the government's issue of bonds in period  $i-1$ , then its budget deficit,  $D_i$ , in period  $i$  is

$$D_i = G_i + P_{Mi} y_{BG(i-1)} + e_i r_{Fi} \sum_{j=1}^{i-1} (D_{F0} + C_{Fj} - A_{Mj}) - T_i, \quad (3.20)$$

where  $C_{Fi}$  is the gross foreign borrowing of the government in period  $i$ ,  $A_{Mi}$  is its amortization of foreign debt, and  $D_{F0}$  is its initial foreign debt. Accordingly, the term in parentheses is the outstanding foreign debt of the government.

The government finances this deficit, if  $D_i$  is positive, from three sources. We will assume that the government's gross foreign borrowing in period  $i$ ,

$C_{Fi}$ , is exogenously determined.<sup>11</sup> Accordingly, the domestically financed portion of the budget deficit is given by  $D_i - C_{Fi}$ . Let  $s_{Bi}$  be that portion of the domestic financing requirements in period  $i$  that is covered by the sale of domestic bonds. Here  $s_{Bi}$  is any continuous function of  $P_{Bi}$ , the price of bonds. Thus, the government's issue of money and bonds in period  $i$ ,  $y_{Mi}$  and  $y_{Bi}$ , is given by:<sup>12</sup>

$$P_{Mi}y_{Mi} = (1 - s_{Bi})(D_i - C_{Fi}), \quad (3.21)$$

$$P_{Bi}y_{Bi} = s_{Bi}(D_i - C_{Fi}).$$

If, on the other hand,  $D_i$  is negative, i.e. a surplus, then  $D_i$  is paid out as transfer payments to the consumer,  $TR_i$  in eq. (3.11).

Apart from producing infrastructure, collecting taxes, and financing the budget deficit, the government also attempts to adjust the exchange rate. The supply of foreign reserves,  $Y_{FGi}$ , available to the government in period  $i$  is given by:

$$Y_{FGi} = Y_{FG,i-1} + X_i - M_i + x_{F,i-1} - x_{Fi} + C_{Fi}. \quad (3.22)$$

Here  $x_{Fi}$  represents the demand for foreign assets by citizens of the home country, so  $x_{F,i-1} - x_{Fi}$  represents private capital flows, while  $X_i$  and  $M_i$  are exports and imports, respectively. All terms on the right-hand side of eq. (3.22) are solved from the maximization problems of the domestic and foreign consumer. What is the demand of the government for foreign assets? Consider fig. 1, which represents the government's exchange rate policy in period  $i$ . The horizontal axis represents the market exchange rate in period  $i$ ,  $e_i$ , while the vertical axis represents the government's demand for foreign assets. In addition, let  $x_{Fi}$  represent the government's critical level of foreign reserves in period  $i$ . This critical level is determined exogenously, and in our simulations in section 4 it is arbitrarily taken to be equal to three months of imports.

Let us assume that a particular exchange rate in period  $i$ ,  $e_i$ , as shown in fig. 1, is depreciated from the previous period. Hence,  $e_i > e_{i-1}$ . In this case we can determine a well-defined government demand for reserves,  $x_{FGi}$ , in fig. 1 and given formally by:

<sup>11</sup>Clearly, it would be incorrect to claim that Mexico's current foreign debt has been forced upon it by foreign lenders. In section 4 we will use an empirical version of our model to attempt to replicate outcomes for 1983-85. We would claim that during this period, after the collapse of the Mexican external sector, that there was, indeed, a lender-imposed constraint on Mexican foreign borrowing. Thus, the assumed exogeneity of  $C_{Fi}$  seems reasonable after 1982, but would be implausible prior to that.

<sup>12</sup>We will later impose certain conditions on the form of  $s_{Bi}$ , as well as on the relationship between government spending and the rate of inflation.

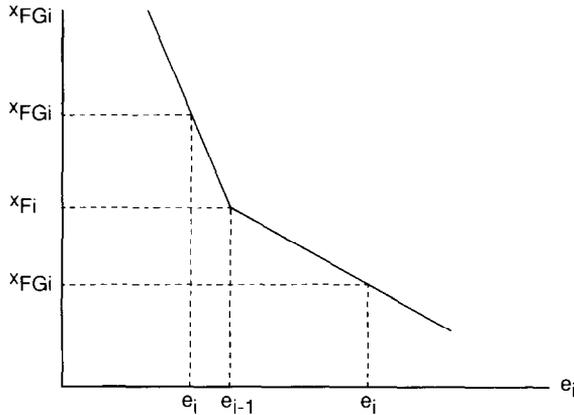


Fig. 1. Government demand for foreign reserves.  $x_{Fi}$  = target level of foreign reserves in period  $i$ ,  $x_{FGi}$  = actual demand for foreign reserves in period  $i$ ,  $e_i$  = exchange rate in period  $i$ .

$$x_{FGi} = f_i(e_i), \quad (3.23)$$

where  $f_i$  is any continuous, monotonically decreasing function. Equivalently, if there is a slight decrease in the equilibrium supply of, and hence demand for, foreign reserves by the government below its critical level, then there is a sharp depreciation in the exchange rate. We may then construct excess demand by the government for foreign reserves,  $D_i$ , as:

$$D_{Fi} = x_{FGi} - y_{FGi}. \quad (3.24)$$

In particular, we see that if  $e_i > e_{i-1}$ , then large increases in  $e_i$  cause only small decreases in  $x_{FGi}$ . If, in eq. (3.22), the current account improves more rapidly than the capital account deteriorates in response to the depreciation, then there will be a net decrease in  $D_{Fi}$  in eq. (3.24). Thus, in particular, increases in  $e_i$  above  $e_{i-1}$  tend to increase the supply of foreign assets for the government, thereby driving  $e_i$  down towards  $e_{i-1}$ . Suppose, on the other hand, that  $e_i < e_{i-1}$ . In this region small changes in  $e_i$  cause large shifts in  $x_{FGi}$ . Thus, in a particular situation, a decrease in  $e_i$ , i.e. an appreciation, will cause a sharp increase in  $x_{FGi}$ , leading to an increase in  $D_{Fi}$ . Hence, in terms of Mexico, the peso price of dollars increases and the exchange rate tends to move back toward  $e_{i-1}$ .

Thus, the government creates a correspondence between changes in the exchange rate and movements away from the critical level of reserves. If, as an extreme case, the graph in fig. 1 becomes horizontal at  $x_{Fi}$ , then this corresponds to a pure float when reserves fall to their critical level. This is

the scenario of much of the balance of payments crisis literature cited in section 2, which thus may be viewed as a special case of our model. A graph that is close to horizontal below  $x_{Fi}$  may be taken as representing the policy of a nervous government, while a graph that is closer to vertical reflects a relatively unconcerned policy.

The demonstration of an existence of equilibrium is straightforward. The only problem arises from the fact that the government's issuance of bonds or money in period  $i$ ,  $y_{BGi}$  and  $y_{Mi}$ , respectively, increases as the corresponding prices drop, thus leading to a downward-sloping supply curve. For example, as the price of domestic bonds,  $p_{Bi}$ , falls, the government must increase its bond sales in order to finance a particular budget deficit.<sup>13</sup> We will circumvent this problem in the following way. We will assume that the government has a fixed target,  $\tilde{y}_{BGi}$ , for the sales of bonds in each period. Let us define a price index,  $CPI_i$ , in period  $i$  as:

$$CPI_i = \sum_{j=1}^N \alpha_j P_{N(i-1)+j}, \tag{3.29}$$

where  $\alpha_j$  are a set of fixed consumption weights, and  $p_{N(i-1)+j}$  is the price of the  $j$ th good in period  $i$ . Let  $g'_i$  be the government's target output of real goods and services in period  $i$ . We will assume that the government sets a new target,  $g_i$ , that depends upon the price level as:

$$g_i = g'_i P_{Mi} / CPI_i.$$

Hence, as the money price level rises the government reduces real spending.

Let  $G'_i$  be the nominal cost of producing  $g'_i$ , and  $G_i$  the cost of producing  $g_i$ . Accordingly, the government's budget deficit in period  $i$ ,  $D_i$ , is given by:

$$D_i = \frac{G'_i P_{Mi}}{CPI_i} + P_{Mi} \tilde{y}_{BG, i-1} + e_i \left[ D_{F0} + \sum_{j=1}^{i-1} (C_{Fj} - A_{Mj}) \right] - T_i, \tag{3.30}$$

$$P_{Mi} y_{Mi} = \frac{G'_i P_{Mi}}{CPI_i} + P_{Mi} \tilde{y}_{BG, i-1} + e_i r_i \left[ D_0 + \sum_{j=1}^{i-1} (C_{Fi} A_{Mj}) \right]$$

<sup>13</sup>Strictly speaking, this does not necessarily create a problem in proving the existence of equilibrium. It does, however, create a problem in the computational methodology that we use in the next section since our algorithm does not always converge under these circumstances.

$$-T_i - P_{Bi}\bar{y}_{BGi} - e_i C_{Fi} \quad (3.31)$$

Hence,

$$y_{Mi} = G_i / CPI_i + \bar{y}_{BG, i-1} - \left\{ T_i + P_{MI}\bar{y}_{BGi} + e_i C_{Fi} - e_i r_i \left[ D_{F0} + \sum_{j=1}^{i-1} (C_{Fj} - AM_j) \right] \right\} / P_{Mi} \quad (3.32)$$

Thus, we have that  $y_{Mi}$ , the change in the money supply, is positively sloped with respect to  $P_{Mi}$ , the price of money, if

$$T_i + P_M \bar{y}_{BGi} + e_i C_{Fi} \geq e_i r_i \left[ D_{F0} + \sum_{j=1}^{i-1} (C_{Fj} - AM_j) \right].$$

This condition is equivalent to saying that the value of taxes plus domestic and foreign borrowing in period  $i$  must be greater than the government's foreign interest obligations. Although this would normally be the case, it would be quite possible to construct an example in which the converse was true.

#### 4. An application to Mexico

In this section we attempt to apply our model to the case of Mexico. We have estimated a number of the structural elements in the theoretical model using Mexican data, and then have simulated the model over a three-year period, representing 1983–85, in order to see whether it generates some approximation to Mexican reality. We then attempt to determine the implications of changes in certain government policies. Our data are as follows.

The Mexican input–output data are given by a  $72 \times 72$  matrix representing the year 1978.<sup>14</sup> Since our current aim is to explain certain macroeconomic phenomena, we have aggregated this intermediate and final production to give a  $7 \times 7$  matrix, the sectors of which are:

- (1) Agriculture
- (2) Manufacturing
- (3) Petroleum
- (4) Commerce

<sup>14</sup>See *Matriz de Insumo Producto 1978* (1983). We aggregated the matrix by simply adding corresponding rows and columns.

- (5) Transportation
- (6) Communications and services
- (7) Imports.

For each of these sectors we have estimated shares of capital and labor in Cobb–Douglas production functions. The shares are given in table A.1 in the appendix, and are assumed to remain constant over the three years of the model. We have also estimated shares of private capital and labor in government production, using the wage bill as the share of labor. These shares are taken to have their actual values for each of the years 1983–85 and are shown in table A.2 in the appendix.

Similarly, factor shares in investment were estimated as shares in the construction industry with the share of capital being 0.291 and the share of labor being 0.709.<sup>15</sup> We constructed initial allocations of factors and financial assets in the following way. We took the total returns to capital and labor in 1982 as representing their initial stocks. Thus, a unit of labor, for example, is that which earned one peso in 1982.<sup>16</sup> The initial stock of money is taken to be the end of 1982 stock of  $M_2$ .<sup>17</sup> The initial stocks of domestic bond holdings by private citizens was taken as total non-monetary savings held by the banking system (Pasivos no monetarios-instrumentos de ahorro).<sup>18</sup> Holdings of foreign assets by Mexical citizens were derived in the following way. Zedillo (1986) derives a series of annual capital flight figures from 1970 to 1984. We have added these flows from 1970 to 1982 to arrive at an end-of-1982 figure for holdings of foreign assets by Mexicans. The resulting allocations are shown in table A.3 in the appendix.

We need also to derive the initial stock of government infrastructure. Since there is no direct information on capital stocks, we have summed public fixed capital formation from 1970 to 1982, assuming a rate of depreciation of 5 percent, to arrive at a figure of 726.7 billion constant 1970 pesos.<sup>19</sup> Government current and capital expenditures for 1983–85 were taken to be their actual amounts.<sup>20</sup>

Foreign borrowing is given its actual values for 1983–85 for foreign borrowing by the banking system (Pasivos no monetarios con el sector

<sup>15</sup>See *Sistema de Cuentas Nacionales de Mexico* (1981), vol. I, table 16, p. 94. In reality, investment includes far more than just the construction industry. Because of the lack of better data we have chosen to take the shares of capital and labor in the construction sector as being representative of their overall shares in investment.

<sup>16</sup>The initial allocations of capital and labor are derived from *Sistema de Cuentas Nacionales de Mexico* (1985), table 1, p. 1, and table 20, p. 9.

<sup>17</sup>See *International Financial Statistics* (1985).

<sup>18</sup>See *Indicadores Economicos* (1986), table I-H-24.

<sup>19</sup>These are taken from *Sistema de Cuentas Nacionales de Mexico* (1979), table 137, p. 238; (1982), table 67, p. 104; (1985), table 65, p. 20.

<sup>20</sup>These are taken from *Sistema de Cuentas Consolidadas de la Nacion* (1985), table 65, p. 20; (1986), table 16, p.16.

externo),<sup>21</sup> while amortization is also given its actual values. Government tax rates on capital and labor are taken as the effective rate of revenue collection on the respective factors in each year, 1983–85.<sup>22</sup> Similarly, effective rates are determined for PEMEX,<sup>23</sup> for the agricultural sector,<sup>24</sup> and for the remaining four sectors in the economy.<sup>25</sup> The resulting tax rates were 4 percent on capital and 7 percent on labor in 1983–84, and 4 percent on capital and 6.9 percent on labor in 1985. The sectoral indirect tax rates are given in table A.4 in the appendix.

In order to generate the necessary parameters in the Mexican consumer's maximization problem, we have derived consumption weights from the aggregation of the original input–output matrix.<sup>26</sup> The foreign consumer is represented by an export equation that determines the total U.S. dollar amount that he will spend on Mexican exports. This total is then divided into consumption on Mexican output of agriculture, manufacturing and petroleum with shares of 0.075, 0.531, and 0.394, respectively.<sup>27</sup> The aggregate export equation was estimated by OLS using annual data for non-oil exports over the period 1950–85 with the following results:

$$\log E = -0.88 - 0.12 \log RP + 0.12 \log RP_{-1} - 0.22 \log RP_{-2}$$

(0.69) (-0.04) (0.31) (-0.64)

$$+ 1.75 \log U - 0.77 \log U_{-1} - 0.88 \log U_{-2}$$

(2.13) (-0.65) (-1.18)

$$+ 0.95 \log E_{-1},$$

(14.05)

$$R^2 = 0.99, \quad H\text{-statistic} = 1.48.$$

Here we make the following definitions:

(a)  $E$  = Mexican non-oil exports in U.S. \$s.

<sup>21</sup>See *Indicadores Economicos* (1986), tables I-4, 6, 8 and I-H-24.

<sup>22</sup>See *CIEMEX-WHARTON* (1986), tables 4, 15 and *Sistema de Cuentas Consolidadas de la Nacion* (1985), table 3.

<sup>23</sup>See *CIEMEX-WHARTON* (1986), table 15; *Sistema de Cuentas Consolidadas de la Nacion* (1985), table 26; (1986), table 41.

<sup>24</sup>See *Sistema de Cuentas Consolidadas de la Nacion* (1985), table 5.

<sup>25</sup>See *Sistema de Cuentas Consolidadas de la Nacion* (1985), tables 3, 5–9; (1986), table 21.

<sup>26</sup>Consumption weights for domestic goods are derived from *Matriz de Insumo-Producto* (1978, 1983), table 1, while the weights for imports came from the same source, table 5.

<sup>27</sup>These shares are derived from *Sistema de Cuentas Consolidadas de la Nacion* (1985), table 69, where we have used 1982 shares in exports.

(b)  $RP$  = Relative U.S. \$ price index of Mexican exports to the U.S. price index.

(c)  $U$  = U.S. nominal GDP.

The figures in parentheses in eq. (4.1) are  $t$ -statistics. We notice that U.S. GDP and the lagged dependent variable are significant, and that the long-run elasticities all have the correct signs. The long-run relative price elasticity is 4.4, while that of U.S. GDP is 2.0. Finally, we did not attempt to estimate an oil export equation, and oil exports were taken to be exogenous.

To other equation estimations are needed to close the determination of consumption. A money demand equation was estimated using annual data for the period 1950–85. We wish to estimate an equation of the form:

$$\log M^d = a_0 + a_1 \log C + a_2 r,$$

where

$$\log M - \log M_{-1} = \beta (\log M^d - \log M). \quad (4.2)$$

Here we define:

(a)  $M^d$  = desired stock of money,

(b)  $M$  = money supply,

(c)  $C$  = nominal consumption,

(d)  $r$  = domestic interest rate,

(e)  $\beta$  = an adjustment parameter representing the speed of adjustment of actual to desired money stocks.

In order to maintain homogeneity in consumption, as required in the general equilibrium model,<sup>28</sup> we set  $a_1 = 1$  and obtain:

$$\log M/C = \beta a_0 + \beta a_2 r + (1 - \beta) \log M_{-1}/C. \quad (4.3)$$

Eq. (4.3) was estimated over the period 1950–85 using  $M_1$  for money and replacing  $r$  by  $\pi$ , the inflation rate in the wholesale price index.<sup>29</sup> The results are:

$$\log M/C = -0.37 - 0.23r + 0.83 \log M_{-1}/C. \quad (4.4)$$

(-0.41) (-3.71) (7.21)

$$R^2 = 0.65, \quad D.W. = 1.88.$$

We may then identify the underlying parameters as:

<sup>28</sup>A uniform increase in the price level cannot have an effect on excess demand, as would be the case if  $a_1 \neq 1$ , if we are to demonstrate the existence of an equilibrium.

<sup>29</sup>This was done because interest rates were controlled for much of our sample period and hence do not reflect true opportunity costs. Our general equilibrium model, however, uses  $r$ .

$$a_0 = -2.18, \quad a_1 = 1, \quad a_2 = -1.35, \quad \beta = 0.17, \quad (4.5)$$

so that the demand for money function given in eq. (3.12) is:

$$M = 0.113r^{-1.35}C. \quad (4.6)$$

We must also estimate the portfolio balance equation given in eq. (3.13). We used an equation of the form:

$$\log(x_d/x_f) = b_0 + b_1(e - e_{-1}) + b_2 \log(x_d/x_{f-1}), \quad (4.7)$$

where  $x_d$  and  $x_f$  represent the peso value of domestic and foreign asset holdings by Mexican consumers, respectively, and  $e$  is the peso/U.S. exchange rate. This was estimated over the period 1970–85 with annual data, since there is no information on capital flight prior to 1970, with the results:

$$\log(x_d/x_f) = 0.28 - 0.72(e - e_{-1}) + 0.45 \log(x_d/x_{f-1}). \quad (4.8)$$

(2.79) (-3.00) (2.79)

$$R^2 = 0.74, \quad D.W. = 2.48.$$

We thus note that all parameters are significant and have the correct sign. We tried a number of different specifications of the portfolio balance equation, attempting to determine an impact of relative interest rates. In none of the tests did we find interest rates to be significant, however, probably reflecting the controls that were in place on Mexican interest rates for much of the sample period.

Our next task is to stimulate the model, based on 1982 initial allocations, to see if it has some resemblance to the actual outcomes for 1983–85. Accordingly, we allow government current and capital expenditure to take their actual values for 1983–85. We also assume that the Central Bank maintains a level of reserves equal to three months of the level of imports in 1982. Clearly, this is an arbitrary rule, but it corresponds to a standard policy prescription. Thus, the government's exchange rule, given in fig. 1, would be a horizontal line, i.e. a float. Clearly this is contrary to actual policy, when the government was actively intervening both in foreign exchange markets and the domestic money markets. Thus, it should not be expected that our simulations precisely replicate Mexican outcomes.

Finally, we assume that the elasticity of private value added with respect to the stock of government infrastructure, as in eq. (3.1), is 0.05, a figure deliberately taken to be quite low. It is by no means necessary for government capital to be productive. Indeed, in the final simulation reported in this section we have taken the elasticity of private production with respect

Table 2

Base simulation with fixed central bank reserves and historical government spending.

	1983	1984	1985
Change in real GDP <sup>a</sup>	-5.3 (-5.3)	1.9 (3.7)	1.0 (2.7)
Government spending <sup>b,c</sup>	16.6 (18.9)	15.5 (16.3)	17.9 (18.7)
Tax revenues <sup>b,c</sup>	9.7 (12.9)	10.1 (11.9)	9.3 (11.9)
Government budget deficit <sup>b</sup>	-6.9 (-6.0)	-5.4 (-4.4)	-8.6 (-6.8)
Private investment <sup>b</sup>	8.4 (9.7)	7.9 (9.2)	12.7 (10.1)
Exports <sup>b</sup>	14.6 (15.4)	11.9 (14.2)	15.3 (12.5)
Imports <sup>b</sup>	10.0 (5.4)	10.4 (6.7)	9.9 (7.6)
Trade balance <sup>b</sup>	4.6 (10.0)	1.5 (7.5)	5.4 (4.9)
Inflation rate <sup>a</sup>	107.6 (107.6)	71.0 (70.4)	37.9 (53.6)
Interest rate <sup>a</sup>	59.2 (59.2)	55.4 (49.5)	43.6 (63.4)
Change in exchange rate <sup>a</sup>	112.9 (112.9)	42.7 (39.2)	35.4 (52.3)
Reserves of Central Bank	3.4	3.4	3.4
Change in real exchange rate	-2.5 (-2.5)	19.8 (17.5)	1.8 (1.9)

<sup>a</sup>In percent.<sup>b</sup>In percent of GDP.<sup>c</sup>We have re-calculated the actual values of *G* and *T* so that their components correspond to those included in our model.<sup>d</sup>In billions of U.S. dollars. This simulation assumes a fixed stock of reserves, so there is no point in making comparisons with actual reserves.<sup>e</sup>The change in the real exchange rate is calculated as the change in the U.S. dollar price of Mexican goods, hence as (*P/e*).

to government infrastructure to be 0.0. Finally, we have taken the government's domestic debt issuance to be equal to its historical values for 1983-85.

Table 2 reports the simulation outcomes of macroeconomic variables, with historical values in parentheses.<sup>30</sup> We notice that, in most cases, the direction of change of the macroeconomic variables has been correctly determined. Indeed, only about 4 out of 24 directions of change in 1984-85 are incorrect, these being tax revenues in 1984, along with 1985 imports and exports, as well as the interest rate. We see that simulated budget deficits track the actual deficits fairly closely. The simulation tends to overestimate imports, possibly because the Mexican government was using restrictions during this time period that are not reflected in our parameter estimates. Finally, the change in the real exchange rate approximates reality, as does the real interest rate. One would not expect a precise duplication of nominal rates, since the simulation imposes a floating exchange rate, while in reality there was considerable government intervention during this time period.

Suppose we now turn to a somewhat interesting example that reflects our initial concern with ways of reducing the size of the public sector. Accordingly, we carry out a simulation that fixes the government's demand for

<sup>30</sup>The model was solved using a variant of Merrill's shrinking grid fixed-point algorithm. A copy of the computer program developed by the authors is available upon request.

Table 3  
Simulation with fixed central bank reserves and reduced government spending.<sup>a</sup>

	1983	1984	1985
Change in real GDP	-5.3	1.7	0.9
Government spending	16.9	16.2	18.3
Tax revenues	9.7	10.1	9.3
Government budget deficit	-7.2	-6.1	-9.0
Private investment	8.2	7.9	12.7
Exports	14.8	11.9	15.3
Imports	10.4	10.5	9.9
Trade balance	4.4	1.4	5.4
Inflation	54.7	76.4	38.9
Interest rate	56.4	50.2	41.7
Change in exchange rate	58.9	45.9	35.8
Reserves of Central Bank	3.4	3.4	3.4
Change in real exchange rate	-2.6	20.9	2.2

<sup>a</sup>All footnotes to table 2 apply here.

reserves, as in the example reported in table 2, but reduces real government spending on goods and services, both current and capital, by 25 percent in each period. Presumably this should reduce the rate of growth of infrastructure, but should also have anti-inflationary effects. The results, however, are rather different (table 3).

We thus notice that there has been a decline in the aggregate growth of real GDP over 1983-85 by about 0.3 percent. This decline might be expected, given the decrease in government spending on infrastructure. At the same time, however, the rate of inflation has increased in both 1984 and 1985, after having fallen in 1983. The initial decline in the inflation rate is expected, since the implications of the reduction in spending on infrastructure are not felt until the period after the reduction takes place. The increases in inflation thereafter are the result of the reduced productivity of private capital, as well as increases in the size of the government budget deficits as percentages of GDP. Nominal GDP falls, given the sharply decreased inflation rate in 1983, and there is thus a large increase in real interest obligations of the government in that year, reflecting the increase in the real interest rate. Since this debt carries over from year to year, there are corresponding increases in real expenditure of the government, and hence its budget deficit, in 1983-85. There is also a slight appreciation in the real exchange rate as the decline in domestic interest rates brings about an increase in real money holdings. The trade balance therefore also shows a small deterioration. Accordingly, the effects of the reduction in public spending are not as favorable as might be anticipated.

Suppose now that the government, alarmed by the effects of the expenditure reduction, decides to allow reserves to act as a partial buffer to foreign

Table 4  
Simulation with active government exchange rate policy and reduced spending.<sup>a</sup>

	1983	1984	1985
Change in real GDP	-4.6	1.4	0.9
Government spending	17.3	16.4	18.5
Tax revenues	9.6	10.1	9.3
Government budget deficit	-7.7	-6.3	-9.2
Private investment	8.1	7.9	12.7
Exports	14.2	11.6	15.0
Imports	10.2	10.5	9.9
Trade balance	4.0	1.1	5.1
Inflation	49.9	78.5	39.5
Interest rate	64.6	57.0	43.1
Change in exchange rate	50.8	48.3	37.3
Reserves of Central Bank	0.6	-0.8	-1.5
Change in real exchange rate	-0.6	20.4	1.6

<sup>a</sup>All footnotes to table 2 apply here.

exchange market pressures.<sup>31</sup> The government, instead of floating the exchange rate, decides to carry out an exchange rate policy of 'leaning against the wind'. We will assume that, in fig. 1, the slope of the line above  $x_{Fi}$  is  $-12$ , while to the right of  $x_{Fi}$  it is  $-6$ . These numbers are, of course, arbitrary but they indicate that the government devalues rapidly when reserves fall below their critical levels and revalues slowly when they rise above them. All other policy parameters remain as in the simulation of table 3. When we re-simulate the model the results are as shown in table 4.

Thus, real GDP grows by almost 0.5 percentage points more in this case than it does under the floating regime. There have been significant increases in the real interest rates in all years, leading to corresponding increases in budget deficits, as compared with the previous case. The real exchange rate is higher in all years than before, due to its initial appreciation, so that there is a decline in the trade balance. The real exchange rate appreciation has reduced the cost of consumption, while the increase in real interest rates has caused the domestic consumer to realize a positive wealth effect. Both effects bring about an increase in consumption and hence GDP. There is a clear cost to this increase, namely the loss in foreign reserves of the government. Indeed, the net reserves of the government are now \$ $-1.5$  billion in 1985, representing a decline of \$4.9 billion from their level of the previous example. Hence, this policy would not be sustainable for any length of time.

Suppose now, as a final experiment, we consider the elasticity of private

<sup>31</sup>Recall that in the previous two simulations reserves were held fixed so that the exchange rate was pure float.

Table 5

Expenditure reduction under differing assumptions concerning the productivity of public infrastructure.<sup>a</sup>

	1983	1984	1985
Real GDP	100.0 (100.0)	104.0 (101.7)	104.2 (102.6)
Price level	100.0 (100.0)	172.1 (176.4)	237.3 (245.0)

<sup>a</sup>The numbers in parentheses are index numbers representing the outcomes of table 3. The other numbers represent the outcomes obtained with a 0.0 infrastructure elasticity.

output with respect to the stock of public infrastructure. This has been taken to be 0.05 in all previous simulations. Since this parameter has not been estimated, one might wonder what the effect of assuming an elasticity of 0.0 would be in carrying out the expenditure reduction experiment. It is difficult to make direct comparisons between models represented by different structural parameters, since doing so would require recalibrating the models to produce the same benchmark outcomes. We can nonetheless make certain qualitative judgments concerning simulated outcomes assuming the two different output elasticities. Accordingly, we have re-simulated the structural model represented in table 3. with the infrastructure elasticity changed from 0.05 to 0.0. All other policy and structural parameters remain the same. The resulting key outcomes are given in table 5.

As might be expected, the rate of growth of real GDP under expenditure reduction is greater if the assumed infrastructure elasticity 0.0 than if it is 0.05, although real GDP levels, which are not shown here, are lower in the former than in the latter case. We do not attempt to compare levels since the two versions of the model do not produce the same benchmark results. The rate of inflation is also lower when public infrastructure is non-productive than when the relevant elasticity is positive, since the expenditure reduction has less impact in reducing the productivity of private capital.

## 5. Conclusion

We have constructed a  $T$ -period, perfect foresight, intertemporal general equilibrium model that is designed to analyze the impact on the economy of reductions in public spending. The model incorporates certain features that are important in analyzing public policy in Mexico, the country to which the model is applied. Among these features are public infrastructure that enters private production and a reserve-based government exchange rate policy. The parameters of the model are estimated using Mexican data and a three-year benchmark equilibrium is computed for 1983–85. Counterfactual simulations are then carried out, with one of the conclusions being that,

depending upon the elasticity of private output with respect to government infrastructure, it is possible for a reduction in public spending to be inflationary.

Our conclusions are highly sensitive to the elasticity of private output to public infrastructure. Since we have not estimated these elasticities, our results must be viewed as being subject to considerable doubt. It is quite striking, however, that even with the low assumed elasticity of private output with respect to public infrastructure of 0.05, it is possible to construct examples where reducing government spending can become inflationary after initially inducing a decline in the price level. In addition, an exchange rate policy that uses reserves to act as a buffer to expenditure reduction can bring some short-term relief. Our simulations indicate, however, that this relief may not be sustainable in the long run, due to the resulting loss in reserves. Accordingly, we should be cautious about dogmatically suggesting reductions in public spending, and should carefully consider the coordination of the spending cuts with appropriate monetary and exchange rate policies.

## Appendix

Table A.1  
Factor shares in private production.<sup>a</sup>

Sector	Share of capital	Share of labor
1	0.762	0.238
2	0.552	0.448
3	0.659	0.341
4	0.757	0.243
5	0.636	0.364
6	0.495	0.505

<sup>a</sup>See *Matriz de Insumo-Producto Ano 1978* (1983). Sector 7, imports, does not use inputs of capital and labor.

Table A.2  
Factor shares in government production.<sup>a</sup>

	Share of capital	Share of labor
1983	0.463	0.537
1984	0.461	0.539
1985	0.447	0.553

<sup>a</sup>See *Informe Annual 1985* (1986), p. 163.

Table A.3  
Initial allocations.

Capital <sup>a</sup>	Labor <sup>a</sup>	Money <sup>a</sup>	Domestic bonds <sup>a</sup>	Foreign bonds <sup>b</sup>
5.202	3.828	3.311	2.328	2.189

<sup>a</sup>In 1,000 × billion pesos.

<sup>b</sup>In 10 × billion U.S. \$.

Source: *International Financial Statistics*, various issues.

Table A.4  
Indirect tax rates.

	1	2	3	4	5	6	7 <sup>a</sup>
1983	0	0.053	0.286	0.053	0.053	0.053	0.0798
1984	0	0.051	0.277	0.051	0.051	0.051	0.0710
1985	0	0.051	0.256	0.051	0.051	0.051	0.0798

<sup>a</sup>The tariff rate for sector 7, imports, is derived from *CIEMEX-WHARTON* (1986), tables 8, 9, 15.

## References

- Barro, R.J., 1981, Output effects of government purchases, *Journal of Political Economy* 82, 1095–1117.
- Barro, R.J., 1984, *Macroeconomics* (John Wiley & Sons, New York).
- Barro, R.J. and H.I. Grossman, 1976, *Money, employment and inflation* (Cambridge University Press, Cambridge, England).
- Blanchard, O.J. and J. Sachs, 1982, Anticipations, recessions and policy: An intertemporal disequilibrium analysis, Working paper 971 (NBER, Cambridge, MA).
- Blanco, H. and P. Garber, 1986, Recurrent devaluation and speculative attacks on the Mexico Peso, *Journal of Political Economy* 94, 148–166.
- Blejer, M.I. and M.S. Khan, 1984, Government policy and private investment in developing countries, *International Monetary Fund Staff Papers* 31, 379–403.
- Brennan, G. and J.J. Pincus, 1983, Government expenditure growth and resource allocation: The nebulous connection, *Oxford Economic Paper* 35, 351–365.
- Calvo, G.A., 1979, Fiscal policy, welfare, and employment with perfect foresight, *Journal of Macroeconomics* 1, 149–66.
- Ciemex-Wharton: Mexican outlook, 1986 (Wharton Econometric Forecasting Associates, Inc., Philadelphia).
- Connolly, M.B. and D. Taylor, 1984, The exact timing of the collapse of an exchange rate regime and its impact on the relative price of traded goods, *Journal of Money, Credit, and Banking* 16, 194–207.
- Cuddington, J.T. and P.O. Johansson, 1986, The macroeconomic effects of public investment expenditures in the short and long runs, World Bank, unpublished Mimeo.
- Cuentas Consolidadas de la Nacion, 1985, Banco de Mexico.
- David, P.A. and J.L. Scadding, 1974, Private savings: Ultra-rationality, aggregation and Denison's Law, *Journal of Political Economy* 82, 225–249.
- Fair, R.C., 1984, Specification, estimation, and analysis of macroeconomic models (Harvard University, Cambridge, Massachusetts).
- Feltenstein, A., D. Lebow and A. Sibert, 1988, An analysis of the welfare implications of alternative exchange rate regimes: An intertemporal model with an application, *Journal of Policy Modeling* 10, no. 4, 611–629.

- Feltenstein, A., 1986, An intertemporal general equilibrium analysis of financial crowding out, *Journal of Public Economics* 31, 79–104.
- Feltenstein, A., 1984, Money and bonds in a disaggregated open economy, in: H. Scarf and J.B. Shoven, eds., *Applied general equilibrium analysis* (Cambridge University Press, Cambridge) 209–242.
- Flood, R. and P.M. Garber, 1984, Collapsing exchange rate regimes: Some linear examples, *Journal of International Economics*.
- Galbis, V., 1979, Money, investment, and growth in Latin America 1961–1973, *Economic Development and Cultural Change* 27, 423–443.
- Groenewold, N., 1980, Fiscal policy with direct effects, *Economics Letters* 5, 219–224.
- Groenewold, N., 1982, Fiscal policy in a perfect foresight model with 'useful' government expenditure, *Australian Economic Papers* 21, 47–60.
- Groenewold, N., 1984, The short run effects of fiscal policy with useful government expenditure, *Bulletin of Economic Research* 36, 85–95.
- Grossman, H.I. and R.F. Lucas, 1974, The macroeconomic effects of productive public expenditures, *The Manchester School* 42, 162–170.
- Heller, P.S., 1975, A model of public fiscal behavior in developing countries: Aid, investment, and taxation, *American Economic Review* 65, 429–445.
- Indicadores Economicos, 1986, Banco de Mexico (Mexico, DF).
- Informe Annual, 1985–1986, Banco de Mexico (Mexico, DF).
- International Financial Statistics (various issues).
- Johansson, P.O., 1982, Cost–benefit rules in general disequilibrium, *Journal of Public Economics* 18, 121–137.
- Johansson, P.O., 1986, The macroeconomic effects of productive public expenditures: A review of the literature (World Bank) unpublished manuscript.
- Krugman, P., 1979, A model of balance-of-payments crisis, *Journal of Money, Credit and Banking* 11, 311–325.
- Marchand, M., J. Mintz and P. Pestieau, 1984, Shadow pricing of labour and capital in an economy with unemployed labour, *European Economic Review* 25, 239–252.
- Marchand, M., J. Mintz and P. Pestieau, 1985, Public production and shadow pricing in a model of disequilibrium in labour and capital markets, *Journal of Economic Theory* 36, 237–256.
- Matriz de Insumo-Producto Ano, 1978–1983, Secretaria de programacion y presupuesto (Mexico).
- Moore, M.J. and J.P. Neary, 1984, Intertemporal disequilibrium in an open economy, Working paper no. 23 (Warwick University).
- Musgrave, R., 1959, *Theory of public finance* (McGraw-Hill, New York).
- Neary, J.P. and J.E. Stiglitz, 1983, Towards a reconstruction of Keynesian economics: Expectations and constrained equilibria, *Quarterly Journal of Economics* 98, 199–228.
- Negishi, T., 1979, *Microeconomic foundations of Keynesian macroeconomics* (North-Holland, Amsterdam).
- Obstfeld, Maurice, 1984, Balance-of-payments crises and devaluation, *Journal of Money, Credit, and Banking* 16, 208–217.
- Obstfeld, Maurice, 1986, Rational and self-fulfilling balance-of-payments crises, *American Economic Review* 76, 72–81.
- Salant, S.W. and D.W. Henderson, 1978, Market anticipation of government policy and the price of gold, *Journal of Political Economy* 86, 627–648.
- Samuleson, P.A., 1954, The pure theory of public expenditure, *Review of Economics and Statistics* 36, 1–22.
- Seade, J., 1987, Subsidized prices and indirect taxes in Mexico: Effective distortions and reform alternatives (World Bank) unpublished.
- Sistema de Cuentas Nacionales de Mexico, 1981, Volumes I–IV (Banco de Mexico, DF).
- Stern, N.H., 1984, Optimal taxation and tax policy, *International Monetary Fund Staff Papers* 31, no. 2, June, 339–379.
- Sundarajan, V. and S. Thakur, 1980, Public investment, crowding out, and growth: A dynamic model applied to India and Korea, *International Monetary Fund Staff papers* 27, 814–855.
- Tun Wai, U. and C. Wong, 1982, Determinants of private saving in developing countries, *Journal of Development Studies* 19, 19–36.

- Van Wijnbergen, S., 1986, Fiscal deficits, exchange rate crises and inflation (World Bank) unpublished.
- Von Furstenberg, G.M. and B.G. Malkiel, 1977, The Government and capital formation: A survey of recent issues, *Journal of Economic Literature* 15, 835–878.
- Zedillo, E., 1986, Capital flight. Some observations on the Mexican case, Paper presented at the conference on capital flight and third world debt (Institute for International Economics, Washington, DC).