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Fiscal Stabilization and Exchange Rate Instability

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Cuts in public spending can, in some cases, be inflationary and should be coordinated with appropriate exchange rate and monetary policies.

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FISCAL STABILIZATION AND EXCHANGE RATE INSTABILITY:
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I. 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, attempts to stabilize the government's fiscal situation have often focussed 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.¹ 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 GNP, of reductions in public spending. We will, in addition, attempt to derive welfare implications of these reductions. 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 macrovariables consistent with a sustainable foreign reserve position and tolerable consumer welfare? 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.² We will therefore focus on reductions in government spending.

1/ 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.

2/ 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.

In order to give some sense of the magnitudes involved, Table 1.1 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 the key variable that is, at least superficially, controlled by the government and that has growth dramatically is expenditure.

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, that 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 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, and the implications for the exchange rate and the balance of payments of these reductions. 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 than the rate is devalued. The current and capital accounts are fully endogenous in our model, and we will be able to derive certain analytic conclusions concerning whether or not a particular program of public expenditure cuts leads to unsustainable losses in foreign reserves. The model simultaneously incorporates both public infrastructure as well as public crowding out of the private sector. Government debt financing affects the domestic interest rate, and since private investment is debt-financed and interest sensitive, it can be crowded out by increased public spending.

The next section will give a brief review of background literature as well as provide an intuitive explanation of our model. Section III will formally derive the analytics of the model, while section IV will sketch a proof of the existence of an intertemporal equilibrium. Section V will give some policy simulations using Mexican data, while Section VI will be a conclusion.

Table 1.1: Mexico: Macro-Variables, 1973-85

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Real GDP <u>a/</u>	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 <u>b/</u>	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 <u>c/</u>	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	-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 <u>d/</u>	-1.2	-3.4	-5.0	-3.0	0.1	-0.5	-1.2	-0.9	-1.7	6.2	10.0	7.5	4.8
Inflation <u>e/</u>	16.0	22.4	10.4	22.4	41.2	15.8	18.3	24.5	25.5	57.5	89.3	63.6	55.2
Capital flight <u>f/</u>	668	755	784	2844	686	-66	231	-678	9733	8225	2415	2332	1917

a/ Percentage change. Source: Indicadores Economicos.

b/ Total revenues of the public sector as a percent of GDP. Source: ibid.

c/ Total expenditures of the public sector as a percent of GDP. Source: ibid.

d/ As percent of GDP. Source: ibid.

e/ Percentage change in the annual average of the wholesale price index. Source: ibid.

f/ In millions of US dollars. Source: Zedillo (1986).

II. 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, which will be developed in detail in the next section, assumes that the government provides infrastructure which enhances private productivity. This approach has been developed in Grossman and Lucas (1974), Barro (1981, 1984), Barro and Grossman (1976), Johansson (1982), and Negishi (1974).³ 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.⁴ 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 to examine the trade-offs between private production and government spending that we wish to consider.

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

4/ 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).

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, instead using a demand driven approach. There have been, on the other hand, a number of papers that examine the relation between government spending and private investment in developing countries.⁵ The results of these studies are quite mixed, however, and, in addition, none of them are 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

5/ 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).

extent to which government fiscal policy, in particular the reduction of spending, is constrained because of its interaction with the balance of payments. 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 is van Wijnbergen (1986), which specifically considers the 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.⁶ 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

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

more important, with the exception of a recent paper by Blanco and Garber (1986), none of them are empirical.

In the next section we will describe our model. It will incorporate non-traded goods, as well as being intertemporal with perfect foresight. Changes in government spending will simultaneously affect both private output as well as the foreign reserve position of the country. The changes in reserves will, in turn, trigger changes in the exchange rate that the government is attempting to maintain fixed. As in the balance of payments crisis literature, these changes, since they are perfectly anticipated, can trigger a collapse of the currency, essentially as capital flows respond more rapidly to changes in the exchange rate than does the capital account.

II. THE MODEL

In this section we will describe the formal structure of our model. It is fully intertemporal and has T discrete time periods, with an infinite time horizon future beyond the third period. 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.⁷ We will first describe the structure of production.

7/ 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 (1987) use a pure float.

A. 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 $y_{K_i}^j$, $y_{L_i}^j$ be the inputs of capital and labor to the j th sector in period i . Let Y_{G_i} be the outstanding stock of government infrastructure in period i . The production of value added is then given by

$$va_{ji} = va_{ji}(y_{K_i}^j, y_{L_i}^j, Y_{G_i}) \quad (3.1)$$

Here we are supposing 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 taxes on inputs of capital and labor, given by $t_{K_i}^j$, $t_{L_i}^j$, respectively, in 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

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

where $va(P, Y_G)$ is the vector of cost-minimizing value-added per unit of

output, subject to $P = (P_{K1}, P_{L1})$ and Y_G , and $t = (t_{K1}, t_{L1})$.

Private investment is assumed to respond to anticipated future returns on capital, as well as future interest rates. Suppose that $H_i = H_i(Y_{K1}, Y_{L1})$ is a neoclassical production function that produces capital using inputs of capital and labor. Let C_{H1} 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_{K1} is the price of capital in period i , r_i the nominal domestic interest rate, and δ the rate of depreciation of capital, then we must have:

$$C_{H1} = \sum_{i=1}^{T-1} \frac{P_{K,i+1}(1-\delta)^{i-1} H_i}{\prod_{j=1}^i (1+r_j)} + \sum_{i=1}^{\infty} \frac{(1-\delta)^{i-T} P_{KT}(1+\pi)^i H_i}{\prod_{j=1}^{T+i} (1+r_j)} \quad (3.3)$$

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 supposed that the investor expects the nominal rental price of capital to increase by the rate of inflation, π , which is taken to be constant, in the future after period T . If we define r_i , the nominal interest rate, as

$$r_i = \frac{P_{M,i+1}}{P_{B1}} - 1 \quad (3.4)$$

where P_{M1} is the price of money at time 1 and P_{B1} is the price of domestic bonds in period 1, equation (3.3) becomes

$$\frac{P_{M2}C_1}{P_{B1}} = P_{K2}H_1 + \frac{P_{B2}P_{K3}H_1(1-\delta)}{P_{M3}} + \frac{P_{B3}P_{K4}H_1(1-\delta)^2}{P_{M4}} + \dots \quad (3.5)$$

Combining equation (3.5) with the conditions for cost minimization we may derive an equation in one unknown.⁸

We will suppose 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 1, corresponding to period 1 investment, y^1_{BP1} as:

$$y^1_{BP1} = \frac{P_{K,i+1}H_1(1-\delta)^{i-1}}{P_{M,i+1}}; i=1, \dots, T-1 \quad (3.6)$$

As we will show later, 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

$$\frac{P_{M3}CH_2}{P_{B2}} = P_{K3}H_2 + \sum_{i=3}^T \frac{P_{B1}P_{K,i+1}H_2(1-\delta)^{i-2}}{P_{M,i+1}} + \dots \quad (3.7)$$

and the bond sales in period 1 to finance period 2 investment, y^2_{BP1} , are given by

$$y^2_{BP1} = \frac{P_{K,i+1}H_2(1-\delta)^{i-2}}{P_{M,t+1}}; i = 2, \dots, T \quad (3.8)$$

8/ Since both money and bonds are issued by the government in financing itself, equation (3.5) should indicate how public deficits that change domestic interest rates may crowd out private investment.

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, which produces both current and capital output. We interpret capital output as being spending on infrastructure, so that the government has two production functions, one for current output and the other for the production of infrastructure. Infrastructure, in turn, enters private production as a productivity increase. At this stage we will make no distinction between current and capital expenditure. Infrastructure is produced via neo-classical production functions, $g_i(y_{K_i}, y_{L_i})$, in period i which use capital and labor in the current period. The government is also assumed to attempt to maximize a weighted average of consumers' utilities. If we suppose that there are $I > 0$ consumers with intertemporal utility functions U_i , to be discussed shortly, then the government's problem is:

$$\max \sum_{i=1}^I \alpha_i U^i(x^i), \quad (3.9)$$

where (α_i) is a set of arbitrarily given weights, and U^i and x^i are the i th consumer's utility function and intertemporal consumption vector, respectively. We will discuss the government's financial constraints in Section 3C, where its budget identity is derived.

B. Consumption

There are $I > 0$ consumers in our model who have perfect foresight in all markets. They maximize intertemporal utility functions subject to their expectations of future exchange rate changes which are incorporated into their budget constraints.

Let $x_i = (x_{i1}, \dots, x_{iN})$ be the consumers' consumption vector in period i and let x_{Li} be his consumption of leisure.⁹ We will suppose that the consumer receives utility only from 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 $(t_i) = (t_{i1}, \dots, t_{iN})$ on consumption of goods in period i . In order to derive a simple analytical expression we will also suppose that the consumer's utility function is of the form

$$\prod_{i=1}^T \alpha_i \prod_{j=1}^n x_{ji} \quad (3.10)$$

His problem is thus to maximize (3.10) subject to

$$(1+t_i)P_i x_i + P_{Li} x_{Li} + P_{Mi} x_{Mi} + P_{Bi} x_{Bi} + e_i x_{BFi} \leq \bar{Y}_i \quad (3.11)$$

where

$$\bar{Y}_1 = P_{K1} K_0 + P_{L1} L_0 + P_{M1} B_0 + e_1(1 + r_{F1})B_{F0} + TR_1$$

$$\bar{Y}_j = P_{Kj}(1-\delta)^j K_0 + P_{Lj} L_0 + TR_j$$

9/ We should, to be more precise, refer to x_{ji} for the consumption of the j th consumer in the i th period. In order to avoid illegible notation we will suppress the superscript j .

and:

$$(1 + t_j)P_j x_j + P_{Lj} x_{Lj} + P_{Mj} x_{Mj} + P_{Bj} x_{Bj} + e_j x_{BFj} \leq \bar{Y}_j + P_{Mj} x_{M,j-1} \quad (3.12)$$

$$+ P_{Mj} x_{B,j-1} + e_j(1 + r_{Fj}) x_{BF,j-1} \quad \text{for } j = 2, \dots, T,$$

The consumer is assumed to face a cash constraint which connects his holdings of money to his consumption and the interest rate. Accordingly, we define β_j as:

$$\beta_j = \frac{P_{Mj} x_{Mj}}{(1+t_j)P_j x_j} - a \bar{r}_j^b \quad ; \quad j = 1, \dots, T; a, b \geq 0 \quad (3.13)$$

In addition, we suppose 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 defined γ as:

$$\gamma = \frac{P_{Bj} x_{Bj}}{e_j x_{BFj}} - c \frac{1 + r_j}{(1+r_{Fj}) \frac{e^{j+1}}{e_j}}^d \quad ; \quad j = 1, \dots, T; c, d \geq 0 \quad (3.14)$$

Finally, we close the consumer's problem by assuming that his savings rate in period T is given by an exogenous constant dollars. If savings are given by domestic plus foreign assets, then: ¹⁰

$$P_{BT} x_{BT} + e_T x_{BFT} = s(1+t_T)P_T x_T \quad (3.15)$$

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

Here we define x_{M_i} , x_{B_i} , x_{BF_i} as the consumer's demands 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 , B_{F_0} are his initial allocations of capital, labor, money, domestic and foreign bonds. Our use of a money constraint, although apparently ad hoc, could be replaced by an equivalent formulation which incorporates money in the utility function. Our current formulation, however, permits direct estimation, which will be important later. The expenditure elasticity of the demand for money is taken to be unity in order to correspond to the requirement of the general equilibrium model that demands be homogeneous of degree zero in prices. We notice that since domestic bonds are short term, $P_{M,i+1}x_{B_i}$, reflects both principle 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 equation (3.14) on the holdings of different assets, the ratio of the Lagrange multipliers of the j th to $(j+1)$ th budget constraint is:

$$\lambda_j = \frac{\gamma_j \frac{P_{M(j+1)} + \frac{e^{j+1}}{e_j} (1 + r_{F_j})}{P_{B_j}}}{1 + \gamma_j} \quad (3.16)$$

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

$$N_j = \prod_{i=j}^{T-1} \lambda_j.$$

Now if

$$Y^* = \sum_{j=1}^T N_j Y_j \text{ and}$$

$$\bar{\alpha} = \sum_{j=1}^T \alpha_{Lj} \sum_{i=1}^n \alpha_{ij}$$

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

$$x_{Lj} = \frac{\alpha_{Lj} Y^*}{\bar{\alpha} N_j - P_{Lj}}, \quad j = 1, \dots, T \quad (3.17)$$

Restriction (3.17) and the demand for money gives a total coefficient on spending in consumption, K_j , of

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

Restriction (3.15) implies

$$K_T = 1 + \beta_{j+s} + s$$

Now:

$$x_{ij} = \frac{\alpha_{ij} Y^*}{\alpha P_{ij} (1 + t_{ij}) K_j} \quad i=1, \dots, T; \quad j = 1, \dots, n \quad (3.18)$$

$$x_{Mj} = \frac{\beta_j Y^* \sum_{i=1}^n \alpha_{ij}}{\bar{\alpha} P_{Mj} K_j} \quad j = 1, \dots, T \quad (3.19)$$

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

$$Y_1 = \bar{Y}_1 - P_{L1} x_{L1} - (1 + t_1) P_1 x_1 - P_{M1} x_{M1}$$

$$Y_j = \tilde{Y}_j + P_{Mj}[x_{M,j-1} + x_{B,j-1}] + (1 + r_{Fj})e_j x_{BF,j-1} - P_{Lj}x_{Lj} \\ - (1 + t_j)P_j x_j - P_{Mj}x_{Mj}; \quad i = 2, \dots, T$$

Then

$$x_{Bj} = \frac{\gamma_j}{1+\gamma_j} \frac{Y_j}{P_{Bj}}$$

and

(3.20)

$$x_{FBj} = \frac{1}{1+\gamma_j} \frac{Y_j}{P_{Mj}e_j}$$

C. 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:

$$D_i = G_i + P_{M1}y_{BG_{i-1}} + e_i r_{F1} \sum_{j=1}^{i-1} (D_{F0} + C_{Fj} - AM_j) - T_i \quad (3.21)$$

where C_{Fi} is the gross foreign borrowing of the government in period i , AM_i is its amortization of foreign debt and D_{F0} is its initial foreign debt. Accordingly the term in parenthesis 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.¹¹ 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} , y_{Bi} is given by¹²

$$P_{Mi}y_{Mi} = (1 - s_{Bi})(D_i - C_{Fi}).$$

(3.22)

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

11/ Clearly it would be incorrect to claim that Mexico's current foreign debt has been forced upon it by foreign lenders. In Section V 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.

12/ 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.

If, on the other hand, D_i is negative, i.e., a surplus, then D_i is paid out as transfer payments to consumers. Thus the j^{th} consumer receives an exogenously given share α_{ji} , in period i , so that $\alpha_{ji}D_i$ corresponds to TR_i in equation (3.12).

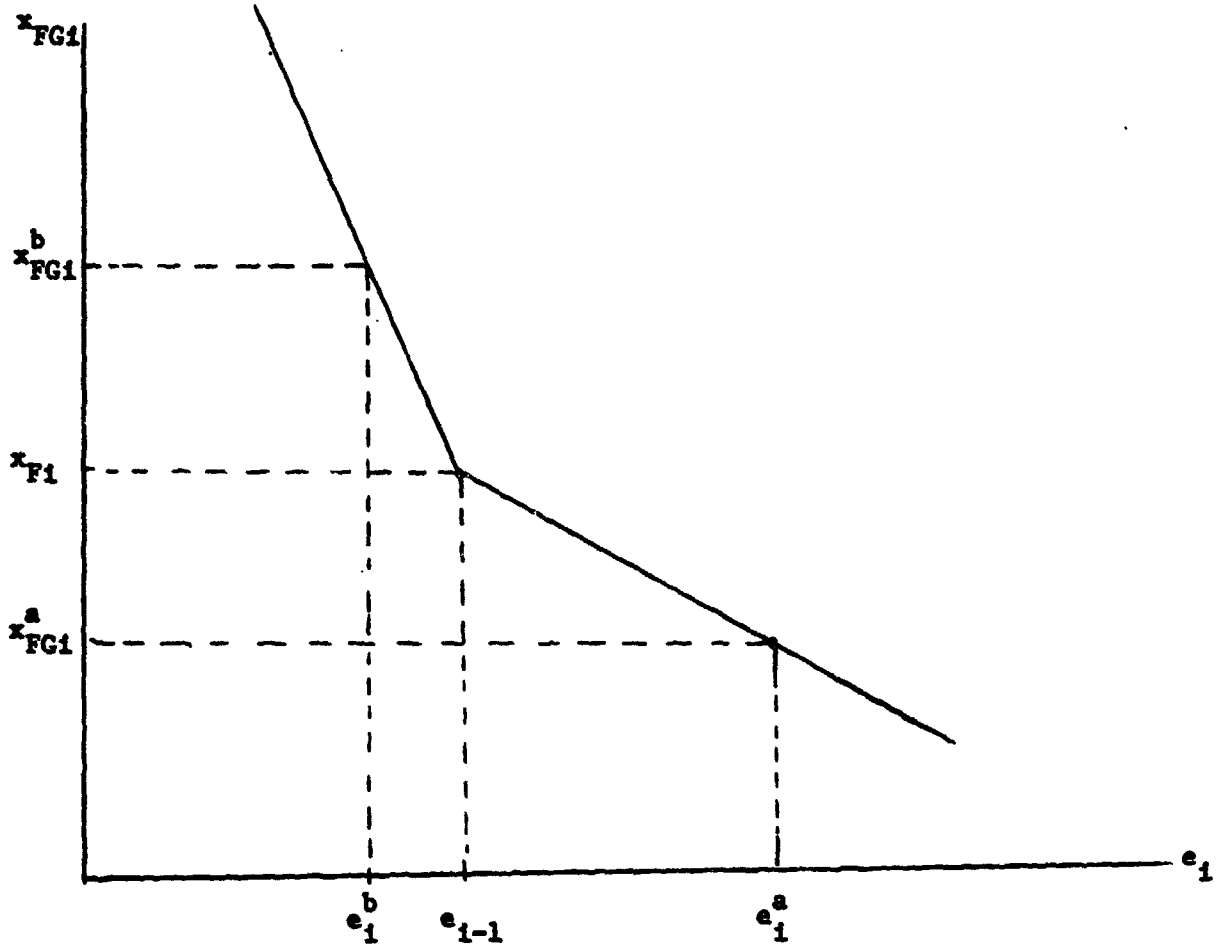
Apart from producing infrastructure, collecting taxes, and financing the budget deficit, the government also attempts to adjust the exchange rate. The supply of foreign reserves Y_{FGi} , available to the government in period i is given by

$$Y_{FGi} = Y_{FG(i-1)} + X_i - M_i + x_{F(i-1)} - x_{Fi} + C_{Fi} \quad (3.23)$$

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.

All terms on the right hand side of equation (3.23) are solved from the maximization problems of the domestic and foreign consumer. What is the demand of the government for foreign assets? Consider Diagram 1 representing the government's exchange rate policy rule 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 V it is arbitrarily taken to be equal to three months of imports.

Diagram 1
Government Demand for Foreign Reserve



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

$$x_{FGi}^a = f_i(e_i^a) \quad (3.24)$$

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. Recall that the exchange rate is in Pesos/\$. We may then construct excess demand by the government for foreign reserves, D_i , as

$$D_i = x_{FGi} - y_{FGi} \quad (3.25)$$

In particular, we see that if $e_i^a > e_{i-1}$, then large increases in e_i^a cause only small decreases in x_{FGi}^a . If, in equation (3.23) 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_i in equation (3.25). Thus, in particular, increases in e_i^a above e_{i-1} tend to increase the supply of foreign assets for the government, thereby driving e_i^a down toward e_{i-1} . Suppose, on the other hand, that $e_i^b < e_{i-1}$. In this region small changes in e_i cause

large shifts in x_{FG1}^b . Thus, in a particular, a decrease in e_1^b , i.e., an appreciation, will cause a sharp increase in x_{FG1} , leading to an increase in D_{F1} . Hence the peso price of dollars increases and the exchange rate tends to move back toward e_{1-1} .

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 Diagram 1 becomes horizontal at x_{F1} , 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 II, which thus may be viewed as a special case of our model. A graph that is close to horizontal below x_{F1} may be taken as representing the policy of a nervous government, while a graph that is closer to vertical reflects a relatively unconcerned policy.

D. Excess Demands

We may now, in particular, calculate excess demands for goods and domestic financial assets. Given $x^i = (x^i_1, \dots, x^i_T)$, the i th consumers demand for intermediate and final goods in each period, we calculate aggregate demand

$$x = \sum_{i=1}^I x^i, \quad (3.26)$$

and hence activity levels z for the intertemporal input-output matrix are given by

$$z = (I - A)^{-1}x$$

We may thus derive inputs of capital and labor in private production. Let Y_{Kj1} , Y_{Lj1} be the inputs of capital and labor per unit of output in the j th sector in period 1, given cost minimization of equation (3.1). Total

inputs of capital and labor y_{Kp_i} , y_{Lp_i} to private production are then given by:

$$y_{Kp_i} = \sum y_{Kj_i} z_{j_i}, \quad y_{Lp_i} = \sum y_{Lj_i} z_{j_i} ; \quad i = 1, \dots, T \quad (3.27)$$

Let y_{Kg_i} and y_{Kh_i} be the government's and the private investment sector's respective inputs of capital in period i , while y_{Lg_i} and y_{Lh_i} are the corresponding inputs of labor. The aggregate inputs of capital and labor in each period may then be derived as

$$\begin{aligned} \bar{y}_{K_i} &= y_{Kp_i} + y_{Kg_i} + y_{Kh_i} \\ \bar{y}_{L_i} &= y_{Lp_i} + y_{Lg_i} + y_{Lh_i} \end{aligned} \quad (3.28)$$

Excess demand for capital in period i , D_{K_i} , is then given by

$$D_{K_i} = \bar{y}_{K_i} - (1 - \delta)y_{K(i-1)} - H_{i-1} \quad (3.29)$$

where δ is the rate of depreciation of capital and y_{K_i} is the stock of capital at the end of period i . The excess demand for labor, D_{L_i} , is given by

$$D_{L_i} = x_{L_i} + \bar{y}_{L_i} - L_0$$

where x_{L_i} is the aggregate demand for leisure in period i . Demands for money and bonds are derived from the consumers maximization problems, while their supply is derived from equations (3.6) and (3.8) giving sales of bonds by private investors, and equation (3.22), giving issuance of money and bonds by the government. Thus excess demands may be derived.

IV. THE EXISTENCE OF AN EQUILIBRIUM

The proof of the existence of equilibrium depends upon proving certain properties for the excess demand functions, namely that they are homogeneous in prices, that they are continuous and convex, and that they satisfy Walras' law. Accordingly, let us define $y(p)$, the augmented supply vector, as

$$y(p) = (y_1, \dots, y_T, u(D_1), \dots, (D_T)), \quad (4.1)$$

where

$$u(D_i) = D_i: D_i \leq 0$$

$$u(D_i) = 0: D_i > 0.$$

and where D_i is the government budget deficit in period i , and y_i , aggregate supply in period i , is given by

$$y_i = (Y_{K_i}, Y_{L_i}, Y_{M_i}, Y_{B_i}, Y_{F_i}).$$

Similarly, we define $x(p)$, the augmented demand vector, as

$$x(p) = (x_1, \dots, x_T, -TR_1, \dots, -TR_T)$$

where

$$x_i = (0, x_{L_i}, x_{M_i}, x_{B_i}, x_{F_i}).$$

We need to show that there exists some price vector p^* , such that

$$x(p^*) - y(p^*) = 0.$$

The demonstration that Walras' law holds in each period is given in the Appendix. Let us note the government's demand for foreign assets enters as an expenditure into its budget constraint and, accordingly, requires a corresponding domestic financing. Typically this would be monetization, although we could also allow bond sales. Similarly, foreign borrowing by the government enters as a revenue, reducing its domestic financing requirement.

In order to complete the demonstration of an existence of an equilibrium we must show that excess demand functions are convex and bounded. The problem of boundedness, which arises in the government's supply of money and bonds, has been discussed in Feltenstein (1986). A solution was derived which essentially requires the government to decrease its spending on real goods and services as the interest or inflation rates rise. Convexity is somewhat more difficult, however.

Our problem arises from the fact that 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. We will circumvent this problem in the following way. We will suppose that the government has a fixed target, \bar{y}_{BGi} , for the sales of bonds in each period. The nominal value of the government's bond sales

$PB_i \bar{Y}BG_i$, of course depends upon the market price of bonds. Let us define a price index, CPI_i , in period i as:

$$CPI_i = \sum_{j=1}^N \alpha_j P_{N(i-1) + j} \quad (4.2)$$

where α_j are a set of fixed consumption weights,¹³ and $P_{N(i-1) + j}$ is the price of the j th good in period i . (Recall that there are N goods). Let \bar{g}_i be the government's target output of real goods and services in period i . We will suppose that the government sets a new target, g_i , that depends upon the price level as

$$g_i = \frac{\bar{g}_i}{CPI_i / PM_i}$$

Hence as the money priced level rises the government reduces real spending.

Let \bar{G}_i be the nominal cost of producing \bar{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

$$D_i = \frac{\bar{G}_i}{CPI_i / PM_i} + PM_i \bar{Y}BG(i-1) + e_i (D_{F0} + \sum_{j=1}^{i-1} C_{Fj} - \sum_{j=1}^{i-1} A_{Mj}) - T_i. \quad (4.3)$$

13/ We take these to be weights in the consumer price index.

Hence the portion of the deficit left to be financed by monetization after foreign borrowing and bond sales is given by

$$PM_i Y_{M_i} = \frac{\bar{G}_i}{CPI_i / PM_i} + PM_i \bar{Y}_{BG}(i-1) + e_i r_i (D_{F0} + \sum_{j=1}^{i-1} C_{Fj} - \sum_{j=1}^{i-1} AM_j) \quad (4.4)$$

$$- T_i - PM_i \bar{Y}_{BG}_i - e_i C_{F_i}$$

Hence

$$Y_{M_i} = \frac{G_i}{CPI_i} + \bar{Y}_{BG}(i-1) - \frac{(T_i + PM_i \bar{Y}_{BG}_i + e_i C_{F_i} - e_i r_i (D_{F0} + \sum_{j=1}^{i-1} C_{Fj} - \sum_{j=1}^{i-1} AM_j))}{PM_i} \quad (4.5)$$

Thus we have that y_{M_i} , the change in the money supply is convex in PM_i , the price of money if:

$$T_i + PM_i \bar{Y}_{BG}_i + e_i C_{F_i} \geq e_i r_i (D_{F0} + \sum_{j=1}^{i-1} C_{Fj} - \sum_{j=1}^{i-1} AM_j)$$

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, leading to a non-convexity and a non-existence of equilibrium.

A further problem in proving the existence of an equilibrium comes from the interaction between changes in foreign reserves and the exchange rate. Let us refer to equations (3.23) and (3.25). Here we note in equation (3.23) that if an exchange rate devaluation causes the current

account to improve less rapidly than the capital account deteriorates, then there will be a decrease in the supply of foreign reserves available to the government, y_{FG1} . If we refer to Diagram 1 we see that the government's demand for foreign assets, x_{FG1} , also falls with the devaluation. Thus, in this case, if the fall in the supply of foreign assets, y_{FG1} , is more rapid than the reduction in the government's demand for assets, then the devaluation will have led to an increase in excess demand for foreign assets, and will thereby be destabilizing. This could, in particular, happen in a floating exchange rate regime where the government fixes its demand for reserves. In the numerical work reported in the next section, this instability has not proven to be a problem. In general, the closer to being perfect substitutes are domestic and foreign assets, the more likely will be non-convexity in equation (3.27), and hence unstable behavior of the model. A mechanical, and possibly economically unsatisfactorily way of coping with this situation would be to impose restriction on capital flows, which in this case would consist in imposing a ceiling on the net increase in holdings of foreign assets permitted to consumers.

V. AN APPLICATION TO MEXICO

In this section we shall 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 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. It should be noted that the model is not fully estimated, so the results we

report should be considered only to be illustrative. Our data is as follows.

The Mexican input-output data is given by a 72x72 matrix representing the year 1978.¹⁴ Since our current aim is to explain certain macroeconomic phenomena, we have aggregated this intermediate and final production to give a 7x7 matrix, the sectors of which are:

- | | |
|-------------------|---------------------------------|
| (1) Agriculture | (4) Commerce |
| (2) Manufacturing | (5) Transportation |
| (3) Petroleum | (6) Communications and services |
| | (7) Imports |

For each of these sectors we have estimated shares of capital and labor in Cobb-Douglas production functions. We have not estimated the elasticities of government infrastructure, but have carried out simulations with alternative parameter values. The shares are:

Table 5.1. Factor Shares in Private Production a/

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

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

14/ See Matriz de Insumo-Producto Año 1978, (1983). We aggregated the matrix by simply adding corresponding rows and columns.

The shares are assumed to remain constant over the three years of the model.

We have also estimated shares of 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. They are:

Table 5.2. Factor Shares in Government Production a/

	Share of Capital	Share of Labor
1983	0.463	0.537
1984	0.461	0.539
1985	0.447	0.553

a/ See Informe Annual. 1985 (1986), p. 163.

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 0.709.¹⁵

We constructed initial allocations of factors and financial assets in the following way. We took the total returns to capital and labor in

15/ See Sistema de Cuentas Nacionales de Mexico (1981), Volume I, Table 16, p. 94.

1982 as representing their initial stocks. Thus a unit of labor, for example, is that which earned one peso in 1982.¹⁶ The initial stock of money is taken to be the end of 1982 stock M₂.¹⁷ 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).¹⁸ Holdings of foreign assets by Mexican 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 holding of foreign assets by Mexicans. The resulting allocations are:

Table 5.4. Initial Allocations

Capital <u>a/</u>	Labor <u>a/</u>	Money <u>a/</u>	Domestic Bonds <u>a/</u>	Foreign Bonds <u>b/</u>
5.202	3.828	3.311	2.328	2.189

a/ In 1000x billion pesos

b/ In 10x billion US \$

16/ The initial allocations of capital and labor are derived from, Sistema de Cuentas Consolidadas de la Nacion (1985). Table 1, page 1 and Table 20, p. 9.

17/ See International Financial Statistics (1985).

18/ See Indicadores Economicos (1986), Table I-H-24.

We need also 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.¹⁹ Government current and capital expenditures for 1983-85 were taken to be their actual amounts.²⁰

Foreign borrowing, which were the actual values for 1983-85 of foreign borrowing by the banking system (Pasivos no monetarios con el sector externo),²¹ while amortization was also given its actual values. Government tax rates on capital and labor were taken as the effective rate of revenue collection on the respective factors in each year, 1983-85.²²

19/ 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.

20/ These are taken from Sistema de Cuentas Consolidadas de la Nacion (1985), Table 65, p. 20; (1986), Table 16, p. 16.

21/ See Indicadores Economicos (1986), Tables I-4, 6,8 an I-H-24.

22/ See CIEMEX-WHARTON (1986), Tables 4, 15 and Sistema de Cuentas Consolidadas de la Nacion (1985), Table 3.

Similarly, effective rates were determined for PEMEX,²³ for the agricultural sector,²⁴ and for the remaining four sectors in the economy.²⁵ 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 were:

Table 5.5. Indirect Tax Rates

	Sector						
	1	2	3	4	5	5	7 a/
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

a/ The tariff rate for sector 7, imports, is derived from CIEMEX-WHARTON (1986) Tables 8, 9, 15.

23/ See CIEMEX-WHARTON (1986), Table 15; Sistema de Cuentas Consolidadas de la Nacion (1985), Table 26; (1986), Table 41.

24/ See Sistema de Cuentas Consolidadas de la Nacion, Table 5.

25/ See Sistema de Cuentas Consolidadas de la Nacion (1985), Tables 3, 5-9; (1986) Table 21.

In order to generate the necessary parameters in the Mexican consumer's maximization problem we have assumed there to be a single domestic consumer, and have derived consumption weights from the aggregation of the original input-output matrix.²⁶ We did not directly estimate an elasticity of demand for leisure, but experimented with various values. The foreign consumer is represented by an export equation which 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.²⁷ The aggregate export equation was estimated by OLS using annual data for non-oil exports over the period 1950-1985 with the following results.

$$\begin{aligned} \log E = & -0.88 - 0.12 \log RP + 0.12 \log RP_{.1} - 0.22 \log RP_{.2} + 1.75 \log U \\ & (0.69) \quad (-0.04) \quad (0.31) \quad (-0.64) \quad (2.13) \\ & - 0.77 \log U_{.1} - 0.88 \log U_{.2} + 0.95 \log E_{.1} \quad (5.1) \\ & -(0.65) \quad (-1.18) \quad (14.05) \\ R^2 = & 0.99 \quad H - \text{Statistic} = 1.48 \end{aligned}$$

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

27/ These shares are derived from Sistema de Cuentas Consolidadas de la Nación (1985), Table 69, where we have used 1982 shares in exports.

Here we make the following definitions.

- (a) E = Mexican non-oil exports in US\$.
- (b) RP = Relative US\$ price index of Mexican exports to the US price index.
- (c) US nominal GNP.

The figures in parenthesis are t-statistics. We notice that US GNP 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 US GNP is 2.0.²⁸ Finally, we did not attempt to estimate an oil export equation, and oil exports were taken to be exogenous.

Two other equation estimations are needed to close the determination of consumption. A money demand equation was estimated using annual data for the period 1950-1985. We wish to estimate an equation of the form:

$$\log M^d = a_0 + a_1 \log C + a_2 r \quad \text{where:} \quad (5.2)$$
$$\log M - \log M_{-1} = \beta(\log M^d - \log M)$$

Here we define:

- (a) M^d = desired stock of money
- (b) M = money supply
- (c) C = nominal consumption
- (d) r = domestic interest rate
- (e) β = an adjustment parameter representing the speed of adjustment of actual to desired money stocks.

28/ Thus in estimation we treat the relative price index as being exogenous, although in the general equilibrium model it is an endogenous variable.

In order to maintain homogeneity in consumption, as required in the general equilibrium model,²⁹ we set $a_1 = 1$ and obtain:

$$\log M/C = \beta a_0 + \beta a_2 r + (1-\beta) \log M_{-1}/C \quad (5.3)$$

Equation (5.3) was estimated over the period 1950-1985 using M_1 for money and replacing r by π , the inflation rate in the wholesale price index.³⁰ The results are

$$\log M/C = -0.37 - 0.23 r + 0.83 \log M_{-1}/C$$

(-0.41) (-3.71) (7.21)

(5.4)

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

We may then identify the underlying parameters as:

$$a_0 = -2.18, \quad a_1 = 1, \quad a_2 = -1.35, \quad \beta = 0.17 \quad (5.5)$$

so that the demand for money function given in equation (3.13) is:

$$M = 0.113 r^{-1.35} C \quad (5.6)$$

29/ 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.

30/ 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 .

We must also estimate the portfolio balance equation given in equation (3.16). We used an equation of the form:

$$\log \frac{x_d}{x_f} = b_0 + b_1 (e - e_{-1}) + b_2 \log \frac{x_d}{x_f - 1} \quad (5.7)$$

where x_d , x_f represent the peso value of domestic and foreign asset holdings by Mexican consumers, respectively, and e is the peso/US\$ exchange rate. This was estimated over the period 1970-1985 with annual data, since there is no information on capital flight prior to 1970, with the results:

$$\log \frac{x_d}{x_f} = 0.28 - 0.72 (e - e_{-1}) + 0.45 \frac{x_d}{x_f - 1}$$

(2.79) (-3.00) (2.79)

(5.8)

$R^2 = 0.74$ 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 suppose 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 this would mean that the government's exchange rule, given in Diagram 1, would be a horizontal line. This

simulation is then assuming that the government allows the rate to freely 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 equation (3.1), is 0.05, a figure deliberately taken to be quite low. It is by no means necessary for government capital spending i.e., spending on infrastructure, to be productive. Indeed, in the final simulation reported in this section we have taken the elasticity of private production with respect to government infrastructure to be 0.0. It should thus be noted that the elasticity reflects the productivity of private output with respect to the stock of public infrastructure rather than with respect to government spending. Since only a portion of government spending goes to infrastructure, the productivity of total government spending would be considerably lower than the figure we have chosen for public infrastructure. We also have taken the government's domestic debt issuance, which our model requires to be fixed, to be equal to its actual values for 1983-85.

Table 5.6 reports the simulation outcomes of macroeconomic variables, with actual historical values in parenthesis.³¹

31/ 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 5.6: Base Simulation with Fixed Central Bank Reserves and Historical Government Spending

	1983	1984	1985
Change in real GNP: Δ GNP a/		2.5 (3.7)	0.3 (2.7)
Government spending: G b/ c/	17.1 (18.9)	14.7 (16.3)	11.2 (18.7)
Tax revenues: T b/ c/	8.6 (12.9)	9.3 (11.9)	9.2 (11.9)
Government budget deficit: D b/	-8.5 (-6.0)	-5.4 (-4.4)	-2.0 (-6.8)
Private investment: I b/	10.2 (9.7)	9.7 (9.2)	12.2 (10.1)
Exports: X b/	13.5 (15.4)	10.3 (14.2)	9.3 (12.5)
Imports: M b/	5.9 (5.4)	6.4 (6.7)	6.6 (7.6)
Trade balance: TB b/	7.6 (10.0)	3.9 (7.5)	2.7 (4.9)
Inflation rate: π d/	a/	62.3 (63.6)	35.6 (55.2)
Interest rate: i d/	70.0 (59.2)	72.1 (49.5)	72.7 (63.4)
Change in exchange rate: $\dot{\epsilon}$	a/	36.7 (39.2)	22.7 (52.3)
Reserves of the Central Bank: R e/	3.43	3.43	3.43
Change in the real exchange rate: \dot{E} f/		18.7 (17.5)	10.5 (1.9)

- a/ We cannot calculate the percentage change in the first year.
- b/ In percent of GNP.
- c/ We have re-calculated the actual values of G and T so that their components correspond to those included in our model.
- d/ percent.
- e/ In billions of US dollars. This simulation assumes a fixed stock of reserves, so there is no point in making comparison with actual reserves.
- f/ The change in the real exchange rate is calculated as the change in the US dollar price of Mexican goods, hence as π/e . Since, in reality, the Mexican government was actively devaluing during the time period, rather than floating as in our simulation, the real rate actually appreciated less than our prediction.

We notice that, in most cases, the direction of change of the macroeconomic variables has been correctly determined. The overall depreciation of the exchange rate is considerably lower than reality, probably corresponding to the fact that the net reserves of the Mexican Central Bank rose by about 25 percent from 1983 to 1985. Our simulation assumes that reserves are fixed and thus generates a less rapid devaluation than would a scenario in which the government increases its net reserves. It should also be noted that the model generates higher real interest rates than were actually observed, although their direction of change is correct. This is possibly because Mexico, by using capital controls, did not require the high real interest rates generated by our model in order to induce consumers to hold domestic assets. Finally, the government budget deficit declines in the simulated results, although in reality it realized a slight increase. Simulated private investment is thus higher than in reality, as the model tends to underestimate the extent to which crowding out has occurred.

Suppose that the government decides to carry out an exchange rate policy of "leaning against the wind." We will assume that, in Diagram 1, the slope of the line above x_{F1} is -6, while the right of x_{F1} it is -3. 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 before. When we re-simulate the model the results are:

**Table 5.7. Base Simulation with Active
Government Exchange Rate Policy a/**

	1983		1984		1985	
Δ GNP			3.5	(2.5)	-0.7	(0.3)
D	-10.3	(-8.5)	-5.4	(-5.4)	-2.6	(-2.0)
I	10.2	(10.2)	9.1	(9.7)	12.2	(12.2)
X	13.5	(13.5)	10.1	(10.3)	9.2	(9.3)
M	5.9	(5.9)	6.4	(6.4)	(6.6)	(6.6)
TB	7.6	(7.6)	3.7	(3.9)	2.6	(2.7)
π			60.2	(62.3)	35.5	(35.6)
i	69.0	(70.0)	72.6	(72.1)	72.7	(72.7)
e			33.1	(36.7)	24.3	(22.7)
R	4.22	(3.43)	1.97	(3.43)	2.00	(3.43)
E			20.4	(18.7)	9.0	(10.5)

a/ The numbers in parenthesis are the simulation outcomes reported in Table 5.8, while all footnotes of Table 5.8 apply here also.

We thus notice that this change in exchange rate policies of the government has relatively minor effects. There is a slight decrease in the aggregate growth of the economy, and there is an decrease in the reserves of the Central Bank, as the exchange rate devalues slightly less under the new regime than it did under the pure float. Finally, the utility of the domestic consumer in the floating rate case was 461.8, while under the new regime it was 463.0, so "leaning against the wind" seems here to be a Pareto improvement, primarily because the reduction in reserves adds to the consumer's utility.

Suppose we now turn to a somewhat more interesting example that reflects our initial concern with ways of reducing the size of the public sector. Accordingly, we carry out a simulation which fixes the government's demand for reserves, as in the example reported in Table 5.6, 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 5.8. Simulation with Fixed Central Bank Reserves and Reduced Government Spending a/

	1983	1984	1985
Δ GNP		3.0 (2.5)	-0.6 (0.3)
D	-10.6 (-8.5)	-6.5 (-5.4)	-3.2 (-2.0)
I	10.0 (10.2)	9.0 (9.7)	12.3 (12.2)
X	13.6 (13.5)	10.3 (10.3)	9.3 (9.3)
M	6.0 (5.9)	6.5 (6.4)	6.6 (6.6)
TB	7.6 (7.6)	3.8 (3.9)	2.7 (2.7)
π		68.8 (62.3)	37.7 (35.6)
i	77.1 (70.0)	74.9 (72.1)	72.4 (72.7)
e		41.1 (36.7)	25.1 (22.7)
R	3.43 (3.43)	3.43 (3.43)	3.43 (3.43)
E		(19.6) (18.7)	10.1 (10.5)

a/ The numbers in parenthesis are those of Table (5.6) while all footnote of Table (5.6) apply here also.

We thus notice that there has been a decline in the aggregate rate of growth of real GNP, from 2.8 percent to 2.4 percent over 1984-85, as might have been expected, given the lower government spending on infrastructure. What is not expected is that the rate of inflation has increased, as has the rate of devaluation of the domestic currency. In addition, and a probable cause for the above two outcomes, the government budget deficit has risen significantly as a percentage of GNP, as the tax base has eroded more rapidly than government expenditures have declined. There is, however, another important difference between the two simulations. In the base case the peso/\$ exchange rate was 1.23 by the third period, while in the case of reduced spending the rate is 0.99 in the third period.³² Thus the reduction in government spending caused there to be less pressure on the balance of payments than in the initial case, as the same level of reserves was maintained in both cases. As a result, the utility of the domestic consumer is 463.5 in the case of reduced government spending, higher than in the base case. This improvement is, caused primarily by the lower price of imports. Similarly, there is a slight increase in the aggregate rate of change in the real exchange rate.

As a final example, let us take a pessimistic view of government spending, namely that it has no direct impact on private output. Thus the elasticity of private output with respect to government infrastructure, as in equation (3.1), is 0. The government purchases capital and labor and produces nothing useful with them. We will return to our original example,

32/ These values should not be compared with actual data because of different unit definitions. Changes are the only relevant comparison.

Table (5.6), and assume that the government fixes its stock of reserves. The aggregate outcomes for real GDP, real private consumption and the price level are:

Table 5.9: Base Simulation with Government Spending not Entering Infrastructure a/

	1983		1984		1985	
Real GDP <u>b/</u>	318.6	(386.5)	324.1	(396.2)	334.6	(397.4)
Real private consumption	219.9	(267.2)	247.4	(302.6)	258.7	(307.3)
Price index <u>c/</u>	121.8	(100.0)	200.5	(162.3)	260.0	(220.1)

- a/ The numbers in parenthesis correspond to the results of Table (5.6).
- b/ Real GDP is based upon the price index for 1983 generated by the base case example of Table (5.6).
- c/ The price index in the base case example is set to be equal to 100 in 1983.

We thus notice that the assumption of nonproductive government leads to much lower levels of real GDP and private consumption than are evident in the base case. In addition, the overall price index is 18.1 percent higher by 1985 than before, indicating the impact on aggregate outcome caused by the incorporation of the infrastructure elasticity of 0.05. Finally, the domestic consumer's utility level, that was 463.5 in the original example, has fallen to 275.3, corresponding to the sharp decline in private consumption.

VI. CONCLUSION

We have constructed an n - 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 3-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.

i 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. If, for example, the elasticity was zero, then we would have the expected results that any increase in government spending would be welfare deteriorating. 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 is both inflationary and welfare improving. 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.

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We will first demonstrate that Walras' law holds in each period. Let E_i denote value of aggregate expenditure in period i and S_i the value of aggregate supply. We will show that Walras' law holds in 3 periods, as the generalization to T periods is straight-forward. In period 1 we have

$$\begin{aligned}
 S_1 = & [P_1(I-A) - P_1va(p)]Y_1 - G_1 + PK_1K_0 + PL_1L_0 + PM_1M_0 + PM_1B_0 + e_1B_{P0} \\
 & + e_1B_{FG0} + PB_1Y_{BP1} - PK_1Y_{KH1} - PL_1Y_{LH1} + PM_1\tilde{Y}_{M1} + PB_1Y_{BG1} \\
 & + e_1X_{F1} + e_1C_{F1} + e_1r_{F1}B_{FP0} \\
 = & \tau_{K1}PK_1Y_{KP1} + \tau_{L1}PL_1Y_{LP1} - G_1 \\
 & + PK_1K_0 + PL_1L_0 + PM_1M_0 + PM_1B_0 + e_1B_{FP0} + e_1B_{FG0} + PM_1\tilde{Y}_{M1} + PB_1Y_{BG1} \\
 & + e_1X_{F1} + e_1C_{F1} + e_1r_{F1}B_{FP0}
 \end{aligned}$$

$$\begin{aligned}
 E_1 = & PK_1 + PL_1L_0 + PM_1M_0 + PM_1B_0 + e_1(1+r_{F1})B_{FP0} + e_1X_{FG1} \\
 & + e_1r_{F1}D_{FO} + e_1AM_1 + e_1X_{F1} + TR_1 + \sum_{j=1}^N \tau_j x_{Lj}
 \end{aligned}$$

Here we define

- G_i - government spending on goods and services in period i .
- B_{FP0} - initial private holding of foreign assets.
- B_{FG0} - initial government holdings of foreign assets.
- \tilde{Y}_{Mi} - money issued to finance the government budget deficit in period i .
- Y_{BGi} - bonds issued to finance the government budget deficit in period i .

- X_{F1} - value of exports in period 1.
 C_{F1} - government foreign borrowing in period 1.
 r_{F1} - foreign interest rate.
 AM_1 - Amortization of foreign debt at time 1.
 D_{F0} - Outstanding foreign debt of the government at the start of period 1.

We thus have

$$\begin{aligned}
 E_1 - S_1 &= (G_1 - \sum t_j x_{Lj} - t_{K1} P_{K1} Y_{K1} - t_{L1} P_{L1} Y_{L1} + PM_1 B_0 + e_1(x_{FG1} \\
 &\quad + r_{F1} D_{F0} + AM_1) - e_1(B_{FG0} + C_{F1})) - PM_1 \tilde{Y}_M1 - PB_1 Y_{BG1} + TR_1 \\
 &= D_1 - PM_1 \tilde{Y} - PB_1 Y_{BG1} + TR_1,
 \end{aligned}$$

Hence,

$$x_1(p) - y_1(p) = D_1 - PM_1 \tilde{Y}_M1 - PB_1 Y_{BG1} + TR_1 - TR_1 - u(D_1) = 0$$

as

$$D_1 = PM_1 \tilde{Y}_M1 + PB_1 Y_{BG1}; D_1 > 0.$$

Here we have defined D_1 as the government's budget deficit, treating foreign borrowing as a revenue.

In period 2 we have

$$\begin{aligned}
 S_2 &= [p_2(I - A_2) - p_2 v_a(p)] y_2 - G_2 + PK_2(1 - \delta)K_0 + PL_2 L_0 + PM_2 u(x_{B1Y} - B_1) \\
 &\quad + PM_2 x_{M1} + (PB_2 y_{BP2}^1 - \frac{PM_2 PB_2 y_{BP2}^1}{PM_2}) + PK_2 H_1 + PB_2 y_{BP2}^2 - PK_2 Y_{KH2} \\
 &\quad + PL_2 \tilde{Y}_{LH2} + PM_2 Y_{M2} + PB_2 Y_{BG2} + e_2(1 + r_{F2})x_{BF1} + e_2 Y_{FG1} e_2 C_{F2}
 \end{aligned}$$

$$+ e_2 X_{F2}$$

$$= t_{K2} P_{K2} Y_{K2} + t_{L2} P_{L2} Y_{L2} - G_2 + P_{K2}(1 - \delta)K_0 + P_{L2}L_0$$

$$+ P_{M2} u(x_{B1} - Y_{B1}) + P_{M2} X_{M1} + P_{M2} \tilde{Y}^1_{BP1} + P_{M2} Y_{M2} + P_{B2} Y_{BG2}$$

$$+ e_2(1 + r_{FG})x_{BF1} + e_2 Y_{FG1} + e_2 C_{F2} + e_2 X_{F2}$$

$$E_2 = P_{K2}(1 - \delta)K_0 + P_{L2}L_0 + P_{M2} u(Y_{B1} - x_{B1}) + P_{M2} X_{M1} + P_{M2} x_{B1}$$

$$+ e_2(1 + r_{F2})x_{BF1} + e_2 X_{FG2} + e_2 r_{F2}(D_{F0} + C_{F1} - A_{M1}) + e_2 A_{M2}$$

$$+ e_2 X_2 + TR_2 - \sum_{j=1}^N t_j x_{Lj}$$

Thus

$$E_2 - S_2 = (G_2 - \sum_{j=1}^N t_j x_{Lj} - t_{K2} P_{K2} Y_{K2} - t_{L2} P_{L2} Y_{L2} + e_2 r_{F2}(D_{F0}$$

$$+ C_{F1} - A_{M1}) + e_2 A_{M2} + e_2 X_{FG2} - e_2(Y_{FG1} + C_{F2})$$

$$+ P_{M2} Y_{B1} - P_{M2} \tilde{Y}^1_{BP1}) - P_{M2} Y_{M3} - P_{B2} \tilde{Y}_{BG2} + TR_2$$

as

$$P_{K2} H_1 = P_{M2} \tilde{Y}^1_{BP1}$$

But

$$P_{M2} Y_{B1} - P_{M2} \tilde{Y}^1_{BP1} = P_{M2} Y_{BG1}$$

So

$$E_2 - S_2 = D_2 - P_{M2} \tilde{Y}_{M2} - P_{B2} Y_{BG2} + TR_2$$

and $x(p) - y(p) = 0$ as before. Note that in the definition of period 2 supply, we decrease the money supply by an amount corresponding to the rollover of period 1 private debt issuance.

Finally, in period 3

$$\begin{aligned}
 S_3 = & [p_3(I - A) - p_3va(p)]y_3 - G_3 + PK_3(1 - \delta)^2K_0 + PL_3L_0 \\
 & + PM_3u(x_{B2} - y_{B2}) + PM_3^*M_2 + [PB_3Y^1_{BP3} + \frac{PM_3PB_3Y^1_{BP3}}{PM_3}] \\
 & + [PB_3Y^2_{BP3} \frac{PM_3PB_3Y^2_{BP3}}{PM_3}] + PK_3(1 - \delta)H_1 + PK_3H_2 + PB_3Y^3_{BP3} \\
 & - PK_3Y_{KH3} - PL_3Y_{LH3} + PM_3Y_{M3} + PB_3\bar{Y}_{BG3} + e_3(1 + r_{F3})x_{BF2} \\
 & + e_3Y_{FG2} + e_3C_{F3} + e_3X_{F3} \\
 = & \tau_{K3}PK_3Y_{KP3} + \tau_{L3}PL_3Y_{LP3} - G_3 \\
 & + PK_3(1 - \delta)^2K_0 + PL_3L_0 + PM_3u(x_{B2} - y_{B2}) + PM_3^*M_2 \\
 & + PK_3(1 - \delta)H_1 + PK_3H_2 + PM_3\bar{Y}_{M3} + PB_3Y_{BG3} + e_3(1 + r_{F3})x_{BF2} \\
 & + e_3Y_{FG2} + e_3C_{F3} + e_3X_{F3} \\
 E = & PK_3(1 - \delta)^2K_0 + PL_3L_0 + PM_3u(y_{B2} - x_{B2}) + PM_3^*M_2 + PM_3^*x_{B2} \\
 & + e_3(1 + r_{F3})x_{BF2} + e_3x_{FG3} + e_3r_{F3}(D_{F0} + C_{F1} + C_{F2} - AM_1 - AM_2)
 \end{aligned}$$

$$+ e_3AM_3 + e_3X_3 + TR_3 - \sum_{j=1}^N t_j xL_j$$

Now,

$$PK_3(1 - \delta)H_1 = PM_3Y^1_{BP2}$$

$$PK_3H_2 = PM_3Y^2_{BP2}$$

Thus,

$$E_3 - S_3 = (G_3 - \sum_{j=1}^N t_j xL_j - t_{K3}PK_3Y_{KP3} - t_{L3}PL_3Y_{LP3} + e_3rF_3(DFo$$

$$+ C_{F1} + C_{F2} - AM_1 - AM_2) + e_3AM_3 + e_3x_{FG3} - e_3(Y_{FG2} + C_{F2})$$

$$+ PM_3Y_{B2} - PM_3\tilde{Y}^1_{BE2} - PM_3Y^2_{BP2}) - PM_3\tilde{Y}_{M3} - PB_3Y_{BG3} + TR_3$$

and

$$PM_3Y_{B2} - PM_3Y^1_{BP2} - PM_3Y^2_{BP2} - PM_3Y_{BG2}$$

Thus

$$E_3 - S_3 = D_3 - PM_3\tilde{Y}_{M3} - PB_3Y_{BG3} + TR_3$$

and $x(p) - y(p) = 0$ as before.

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A perfect foresight, intertemporal general equilibrium model can be used to analyze the fiscal impact of reductions in public spending. The model permits a consistent analysis of government spending, deficit financing, and exchange rate behavior.

It incorporates features important to analyzing public policy in Mexico, including the cost of producing government infrastructure, a tax system and government exchange rate policy similar to those in Mexico, and the estimated savings behavior of domestic consumers.

Mexican public spending increased from 25.6 percent of GDP in 1973 to 46.5 percent in 1982. This rise was accompanied by dramatic increases in inflation, the government deficit, and external debt.

Policymakers look at such a situation and automatically conclude that stabilization depends on reduced public spending. But when applied to Mexican data for 1983-85, the model shows that public spending cuts alone may be inflationary if they cause a reduction in the

productivity of private capital.

The model does not estimate the elasticity of private output to public infrastructure. But even if low elasticity is assumed, spending cuts may produce a reduction in private productivity that will have an undesirable effect.

A decline in productivity may outweigh the impact of falling monetary growth rates and reduced budget deficits. If it does, the benefit of spending on infrastructure outweighs its costs. If, however, government spending produces no useful infrastructure, a reduction in spending will have the desired result of reducing inflation.

Various simulations with the model indicate that dogmatic recommendations for spending cuts can at times be counterproductive.

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