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DEVALUATION CRISES AND THE MACROECONOMIC CONSEQUENCES OF POSTPONED ADJUSTMENT IN DEVELOPING COUNTRIES

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ABSTRACT

This paper develops our analytical model to explore the relationship between the dynamics of macroeconomic adjustment and the timing of the implementation of an adjustment program featuring an official devaluation. The effects of postponing adjustment depend on the source of the original shock. In the case of fiscal expansion, postponement implies a larger eventual official devaluation and greater deviations of macroeconomic variables from their steady-state values. For adverse terms of trade shocks, postponement does not affect the size of the eventual official devaluation, but does magnify the amount of post-devaluation overshooting by key macroeconomic variables.

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I. Introduction

An important issue in the design of stabilization programs refers to the *timing* of different policies. In particular, determining the consequences of alternative timings of devaluations has for a long time concerned policymakers in the developing countries. In spite of this policy interest the literature on stabilization and devaluation has not analyzed this issue in detail. The purpose of this paper is to develop a general equilibrium dynamic model to explore the relationship between the dynamics of macroeconomic adjustment and the timing of the implementation of a stabilization program that includes a nominal devaluation as its principal component. 1/ In particular, we explore the effects of postponing adjustment on the cumulative deviations of key macroeconomic variables from their steady-state values and on the degree of overshooting of these values following the implementation of adjustment measures.

The model is derived from well-articulated micro foundations and distinguishes between equilibrium and disequilibrium movements in real exchange rates. We investigate the characteristics of two different types of exchange rate crises: (a) those provoked by inconsistent fiscal policies and (b) those generated by exogenous terms of trade shocks. A central aspect of our discussion is determining conditions under which a *nominal* devaluation will be required to render the adjustment process effective.

1/ A number of authors have investigated the process of macroeconomic adjustment in developing countries. Most studies, however, have focused on a particular aspect of the adjustment process, without providing a general and integrated picture that "fits" (or is consistent with) the more salient stylized facts. See, for example, Blanco and Garber (1986), Connolly et al. (1987), Rodriguez (1978), Khan and Lizondo (1987), Krugman (1979) and Edwards (1983).

This is, indeed, an important policy issue, since the role of devaluations has for some time now been at the center of controversies surrounding the so-called orthodox adjustment programs. 1/ An important innovation of our analysis is that it relates the timing of adjustment to the size of the (corrective) devaluation, and thereby to the path of a number of key macroeconomic variables during the disequilibrium process and the adjustment period.

In developing our model we make a special effort to capture the more important stylized facts associated with balance of payments crises, devaluations and stabilization programs. For this reason, we start in Section II with a brief exposition of those facts. In Section III we present the model, while in Section IV we illustrate how the model works. Here we concentrate on two possible causes of devaluation crises: fiscal shocks and exogenous shocks to the international terms of trade. The central part of this section deals with the consequences of postponing adjustment and devaluation. Finally, Section V contains the concluding remarks, including some thoughts regarding directions for future research.

II. Macroeconomic Policy, Real Exchange Rates and and Devaluation Crises: The Stylized Facts

In this section we briefly analyze the circumstances preceding 20 major devaluation crises in developing countries. Our main interest is to provide a simple "list" of the most salient stylized facts that, we believe, should be captured by a unified model that deals with devaluation crises and macroeconomic adjustment processes. We focus both on policy induced disturbances --shocks to domestic credit as well as fiscal policy--and on external

1/ See, for example, Buira (1983).

shocks in the form of terms of trade changes. We then analyze the behavior of the following endogenous variables: (1) real exchange rates; (2) the current account; (3) the monetary system's foreign assets position; (4) the black market premium; and (5) real wages.

1. <u>The Sample</u>

Table 1 contains the list of the 20 devaluation episodes analyzed in this paper. The choice of countries in the sample was basically determined by data availability; only those major devaluation episodes for which data on (most) of the variables of interest were available were incorporated into the analysis. All these countries devalued their currencies by at least 15% after having maintained a fixed (official) exchange rate with respect to the U.S. dollar for two or more years. Thirteen of them implemented a stepwise devaluation, where after the nominal exchange rate adjustment they attempted to once again fix the parity (Panel A of Table 1). Many of them did not succeed and experienced recurrent devaluations. Seven of the countries adopted a crawling exchange rate after devaluing (Panel B). This table also contains data on the amount of each nominal devaluation measured as the percentage change of the <u>official</u> exchange rate with respect to the U.S. dollar. It is interesting to note that all of these devaluations were followed by some kind of predetermined regime (either fixed or passive crawl) and <u>not</u> by a freely floating nominal rate, as most theoretical models of exchange rate collapse have assumed (Krugman, 1979; Flood and Garber 1984; Obstfeld 1986). In the model we developed below we take this important stylized fact into account and deal with exchange rate crisis where the official exchange rate is fixed at a new (higher) level after the devaluation.

Table 1. Devaluation Crises in Selected Developing Countries: Rate of Devaluation (percentage) 1/

(Percentage of Devaluation)

Country	Year of Devaluation Crisis	Year of Devaluation	One Year After Devaluation	Two Years After	Three Years After
A. Stepwise Devaluations					
Colombia	1962	34.3	0.0	0.0	50.0
Colombia	1965	50.0	0.0	16.7	7.1
Costa Rica	1974	28.8	0.0	0.0	0.0
Cyprus	1967	16.6	0.0	0.0	0.0
Guyana	1967	15.9	0.9	0.6	0.2
India	1966	58.6	-0.3	1.0	-0.9
Israel	1962	66.6	0.0	0.0	0.0
Israel	1967	16.6	0.0	0.0	0.0
Israel	1971	20.0	0.0	0.0	7.1
Nicaragua	1979	43.0	0.0	0.0	0.0
Pakistan	1972	130.1	-10.2	0.0	0.0
Sri Lanka	1967	24.1	0.0	0.5	0.0
Yugoslavia	1965	66.6	0.0	0.0	0.0
B. Devaluations Followed by Crawling Peg					
Chile	1982	88.2	19.2	46.5	43.3
Colombia	1967	16.7	7.1	5.7	6.9
Kenya	1981	35.9	23.7	8.4	14.3
Korea	1980	36.3	6.1	6.9	6.2
Mexico	1976	59.6	13.9	-0.0	0.3
Mexico	1982	267.8	49.1	33.7	93.0
Pakistan	1982	29.6	5.1	13.7	4.0

Source: International Financial Statistics.

1/ Devaluation of the official rate with respect to the U.S. dollar. In the case of multiple rates the IFS reports the "most common" of them.

The data in Tab 1 refer to the official exchange rate. Many of these countries, however, had an active parallel market during the period surrounding the devaluations. In subsection II.5 below we discuss the behavior of the parallel market exchange rate. The existence of this parallel market is another important stylized fact not captured by traditional models, but explicitly incorporated in our unified model.

2 Fiscal and Credit Policies and Devaluation Crises

Table 2 summarizes the behavior of domestic credit and fiscal policies for the period immediately preceding the 20 devaluation crises. In addition, data for a control group of countries that maintained a fixed rate for 10 or more years are also presented. 1/ The following indicators can be found in this table: (1) rate of growth of domestic credit (Panel A); (2) rate of growth of domestic credit to the public sector (Panel B); (3) percentage of credit received by the public sector as proportion of total domestic credit (Panel C); (4) fiscal deficit as proportion of GDP (Panel D); and (5) growth of domestic credit to the public sector as a proportion of GNP. All these indicators have been constructed using data from various issues of the International Financial Statistics as well as several IFS tapes. For the devaluing countries these indicators are reported for 3 years, 2 years, and 1 year prior to the devaluation as well as for the year of the devaluation. While Panel A deals with monetary (or domestic credit) policy, the rest of the panels take us beyond the monetary

1/ Extreme care should be taken when using "control groups" to perform macroeconomic empirical studies. See Goldstein and Montiel (1986), and Edwards (1989b). See Appendix for the countries in the control group.

Table 2. Indicators of Macroeconomic Policy In Devaluing Countries During Year of Devaluation and 3 Years Preceding Devaluation: Comparison to Control Group of Fixers

	Three Years Prior to Devaluation	Two Years Prior to Devaluation	1 Year Prior to Devaluation	Year of Devaluation	Control Group
A. Annual Rate of Growth of Domestic Credit (Percentage)					
First Quartile	11.9	13.8	12.3	15.7	14.4
Median	22.1	16.8	17.8	22.9	17.4
Third Quartile	34.8	39.9	30.1	40.6	29.9
Mean	23.5	22.8	21.2	35.4	19.3
B. Annual Rate of Growth of Domestic Credit to Public Sector (Percentage)					
First Quartile	7.8	0	0	11.2	0
Median	24.4	14.8	10.2	31.0	22.7
Third Quartile	66.5	51.4	33.9	69.2	33.2
Mean	43.1	28.3	29.8	58.9	5.7
C. Ratio of Domestic Credit to Public Sector to Total Domestic Credit (Ratio x 100)					
First Quartile	11.3	12.0	12.5	7.8	0
Median	26.0	24.7	24.7	25.5	11.4
Third Quartile	46.5	45.6	46.0	49.1	27.9
Mean	27.6	27.1	28.1	27.3	14.0
D. Fiscal Deficit as Percentage of GDP (Percentage)					
First Quartile	0.00	0.13	0	0.01	0.7
Median	3.30	0.84	1.34	3.66	1.6
Third Quartile	5.89	5.85	5.90	6.49	2.7
Mean	3.5	3.1	2.3	3.15	1.9
E. Growth of Credit to Public Sector as Proportion of GNP (Percentage)					
First Quartile	0.7	0.09	-0.5	1.3	0.03
Median	1.7	1.09	1.1	2.7	0.76
Third Quartile	3.9	2.6	2.9	5.3	1.6
Mean	2.4	1.5	1.5	3.9	.75

Source: See text.

realm and into the fiscal side of the economy. Indeed, these panels provide four different ways of looking at fiscal pressures.

A number of revealing facts emerge from this table. First, macroeconomic--and in particular fiscal--policies became increasingly expansive in the devaluing countries immediately preceding the year of the devaluation. Second, the devaluing countries as a group behaved quite differently than the control group of fixers. This is particularly clear for the fiscal policy indicators. For example, during the year prior to the crisis half of the devaluing countries allocated one quarter or more of total domestic credit to the public sector; the median for the control group countries, on the other hand, was only slightly more than 10 percent. Formal χ^2 tests indicate that the probability of these policy indicators for the devaluing countries coming from the same population as the control group is very low. 1/ This strong empirical evidence suggests a third feature that any model that attempts to capture the dynamics of crisis and stabilization should possess, i.e., it should have a well developed fiscal side.

3. Terms of Trade and Devaluation Crises

Of course, balance of payments difficulties are not always the result of inconsistent domestic macroeconomic policies; historically, exogenous shocks have sometimes been the sources of serious external imbalances. In our sample there is a wide variety of experience. While in some episodes the terms of trade did not change in the period preceding the exchange rate

1/ The values of the χ^2 statistics ranged from 9.1 to 14.6. This statistic has two degrees of freedom.

collapse, in others there was a substantial change. In six of the sixteen episodes for which there are data there was a significant worsening in the terms of trade before the devaluation (see Appendix, Table A.1). 1/ Existing models of exchange rate collapse, however, have ignored the possibility of terms of trade shocks being the generating cause of devaluations. This possibility is explicitly taken up in our model.

4. Real Exchange Rates, The External Sector and Devaluations

In the vast majority of our 20 devaluation episodes the external sector experienced a serious deterioration in the period leading to the crisis. In 16 out of the 20 episodes the ratio of net foreign assets to money experienced a steep decline during this two year period (see Appendix, Table A.2). This, of course, is in accord with the traditional models of exchange rate crises developed by Krugman (1979) and others, where the devaluation takes place when the level of international reserves hits a lower threshold. 2/ Also, in 14 of the 20 episodes the current account ratio experienced a worsening in the two years before the crisis. In fact, in some of these episodes the current account to GDP ratio reached remarkable levels. In Kenya and Israel 1971 the deficit was approximately equal to one-fourth of GDP! An important characteristic of these devaluation episodes is the tendency, present in most countries, for the ratio of net foreign assets to return to its pre-crisis level following the devaluation. This suggests that countries have a well-established desired level of reserves to which

1/ We have arbitrarily defined "significant" as a decline in the terms of trade of at least 5%.

2/ Notice that these are net foreign assets of the monetary system; thus, its evolution includes private capital movements including capital flight.

they seek to return. This characteristic, which has been ignored in the literature, is explicitly incorporated in our model.

Regarding real exchange rates, in 15 out of the 19 countries with relevant data the bilateral real exchange rate experienced a real appreciation in the three years prior to the devaluation; in 13 out of the 19 cases there also was a real appreciation of the multilateral RER during the period immediately preceding the crisis. The average real appreciation during the 3 years preceding the devaluation crisis was almost 9.2 percent, while the real multilateral appreciation was 9.0% (see Appendix, Table A.3). 1/ These real appreciations were the result of domestic rates of inflation that increasingly exceeded the world rate of inflation. A set of χ^2 tests, in fact, indicate that as the crisis date approached the rate of CPI inflation in the devaluing countries became more distinct from that of the fixed rate control group. This evidence is particularly important for determining our modelling strategy. What these data suggest is that devaluation decisions are based on the behavior of (at least) two indicators: foreign reserves and the real exchange rates. It is possible to think of some devaluations as undertaken in order to improve a country's competitive position rather than because reserves have disappeared (Indonesia in 1978 comes to mind). This means that, contrary to the traditional literature, a model that attempts to capture the stylized facts surrounding crises in the LDCs should

1/ Naturally, to the extent that there have not been changes in the equilibrium RERs, this appreciation reflects a disequilibrium situation (i.e., real overvaluation). Notice that the extent of real exchange rate appreciation before the crisis not only varied across countries, but also was more marked in recent years (i.e., in the 1980s). This has been particularly the case for the countries that after the devaluation became crawlers.

explicitly incorporate nontradable goods and, thus, the possibility of domestic inflation exceeding world inflation.

A particularly interesting feature of these data is that in many episodes the authorities postponed the implementation of the adjustment measures, even after it had become evident that the economy was facing a severe macroeconomic disequilibrium. Moreover, in a number of cases in its effort to postpone the adjustment the government resorted to exchange and capital controls (Edwards 1989a).

5. Devaluation Crises and Black Market Premia

We could obtain information on the black market rate for foreign exchange for most of the countries in our sample. These data are, in fact, extremely suggestive, showing a marked increase in the premium in the period leading to the exchange rate collapse. In all but one of the episodes the black market premium was higher one month before the devaluation than 3 years prior to the devaluation (see Appendix, Table A.4). It is interesting to note that in every country immediately following the devaluation the parallel market premium experienced a sudden downward jump. This type of behavior is, in fact, consistent with perfect foresight models of the type developed by Lizondo (1987a) and Kiguel and Lizondo (1986). In the model we developed below we also incorporate this feature of the parallel market behavior.

6. Devaluation Crises and Real Wages

Critics of orthodox stabilization programs have argued that devaluations result in important reductions in real wages. 1/ In order to analyze this issue we collected data on the evolution of real wages in the

1/ See, for example, Pastor (1986).

manufacturing sector in the period surrounding our devaluation crises (see Appendix, Table A.5). Since these data have not been corrected by productivity gains, they should be analyzed with care. These figures show no clearcut behavior of real manufacturing wages in the period surrounding the devaluation crises. In only 8 out of 18 episodes for which there are data, real wages increased in the period preceding the crisis. In all of these eight cases real wages dropped after the devaluation. In the other 10 episodes for which there are data, real wages did not decline after the crisis. Thus, the popular belief that all devaluations are followed by a wage reduction is not sustained by our data.

7. Summary

The data discussed in this section provide a fairly clearcut pattern regarding the stylized facts surrounding a large number of devaluation crises in the developing countries. These facts--which we believe an adequate model of devaluation crises should capture--can be briefly summarized as follows:

a. Historically the vast majority of devaluation crises have been preceded by loose and inconsistent macroeconomic policies. In particular, the evidence shows that fiscal policy in the devaluing countries as a group was significantly more expansive than in a control group of fixers.

b. In a nontrivial number of episodes we detected a significant worsening in the international terms of trade immediately before the crisis. This suggests that historically some collapses may have been caused by exogenous external shocks.

c. In the period preceding the devaluations we observed (a) a significant real exchange rate appreciation; (b) the depletion of the stock of international reserves; (c) a deterioration of the current account deficit and; (d) a decline in the ratio of <u>net</u> for .gn assets of the monetary system.

d. Devaluations crises have been preceded by very steep increases in the black market premium. Moreover, the evidence shows that immediately following the devaluation the premium experienced a significant decline.

e. Regarding real wages, the evidence is less clear. There are some indications, however, that in some countries real wages followed an inverted U path. They increased in the years preceding the crisis, and dropped in the years that followed.

III. The Model

In this section we develop a model of a typical developing country which is designed to trace the dynamic response of certain key macroeconomic variables to a variety of shocks that eventually culminate in a devaluation episode. The model is able to generate dynamic responses which mimic quite closely the stylized facts described above. It turns out that, for a given shock which eventually results in adjustment-cum-devaluation, the primary determinants of the path followed by domestic macroeconomic variables are the nature of the eventual macroeconomic adjustment to the shock and the magnitude of the associated devaluation.

1. Supply

We consider a small open economy which produces exportables (X), importables (Z), and nontraded goods (N) using sector-specific capital and homogeneous labor. 1/ Labor is available in fixed supply, and all prices are flexible; full employment prevails continuously. The labor market equilibrium condition is:

$$(1) \quad L_X(w/\rho) + L_Z(w) + L_N(we) = L$$

where w is the real wage measured in terms of importables, ρ is the domestic price of exportables in terms of importables (i.e., the external terms of trade), and e is the real exchange rate, defined as the ratio of the domestic price of importables to that of nontraded goods; $e = sP_Z^*/P_N$, where s is the predetermined nominal exchange rate applicable to commercial transactions and P_Z^* is the world price of importables. L_i is the demand for labor in sector i, and L_i' 0. Equation (1) implies a relationship between ρ, e, and the equilibrium real wage:

$$(2) \quad w = w(\rho, e),$$

$$w_1 = (L_X'w/\rho^2)/(L_X'/\rho + L_Z' + L_N'e) > 0; \quad w_2 = -(L_N'w)/(L_X'/\rho + L_Z' + L_N'e) < 0$$

Since each sector employs only one variable factor, conventional sectoral supply functions that relate output in each sector to the two relative prices ρ and e can be derived.

$$(3) \quad y^X = y^X(\rho, e); \quad y^Z = y^Z(\rho, e); \quad y^N = y^N(\rho, e).$$

Consequently, an improvement in the terms of trade increases output of exportables while reducing that of importables and nontraded goods. A real exchange rate depreciation, on the other hand, increases output of importables and exportables while reducing that of nontraded goods.

1/ This model is partially based on Khan and Montiel (1987). It differs from Khan and Montiel in that it incorporates a dual exchange rate market and ignores the bond market. Kiguel and Lizondo (1986) and Edwards (1988) present models somewhat similar to that developed here.

2. Demand

a. Household Sector

We assume that households consume only importables and nontradable goods. To simplify the analysis we suppose that households' utility functions are Cobb-Douglas. This implies constant expenditure shares (denoted θ for importables and $1-\theta$ for nontradable goods) and permits us to write an "exact" price index P as:

$$(4)\quad P = P_Z^{\theta} P_N^{1-\theta} = P_Z e^{\theta - 1},$$

where P_Z and P_N are the domestic-currency prices of importables of non-tradables. Letting c denote real consumption measured in units of the consumption bundle with price P, the household demand functions for importables and nontradable goods can be written as:

$$(5a)\quad c^Z = \theta Pc/P_Z = \theta e^{\theta - 1} c$$

$$(5b)\quad c^N = (1-\theta) Pc/P_N = (1-\theta) e^{\theta} c$$

Real household consumption, in turn, is taken to depend on real disposable factor income and real financial wealth:

$$(6)\quad c = c(y-t, a); \quad c_1 > 0, \quad c_2 > 0$$

where y is real factor income, t is real (lump sum) taxes, and a is real financial wealth, all measured in terms of the consumption bundle. Real taxes on households are taken to be exogenous.

Real factor income can be expressed as the product of the relative price of imports measured in terms of the consumption bundle and real factor income in terms of importables:

$$(7)\quad y = e^{1-\theta}(\rho y^X + y^Z + e^{-1} y^N) = y(\rho, e).$$

From equation (7) it follows that an improvement in the terms of trade increases real factor income, while a real exchange depreciation has an ambiguous impact on this variable. 1/

Household financial wealth consists of domestic money and foreign exchange. The economy is assumed to operate under a dual nominal exchange rate system, consisting of a predetermined official exchange rate for current transactions and a freely-fluctuating rate which governs transactions in foreign exchange among private citizens. 2/ Consequently changes in the desired stock of foreign money will result in changes in the freely floating rate without accompanying capital flows. In that sense the stock of foreign exchange in private hands at any one time reflects past central bank intervention in the dual exchange market, i.e., it is exogenous when measured in foreign currency units. Letting M denote the stock of money, F the foreign-currency value of the stock of foreign exchange held by the private sector and d the dual exchange rate, real household financial wealth is: $a = (M+dF)/P$. It is convenient to write this as:

$$(8) \quad a = e^{1-\theta}(m+v),$$

where $m = M/P_Z$ and $v = dF/P_Z$. Finally, we assume that households continuously maintain their financial portfolios in their desired composition, which is specified in conventional fashion as a function of the nominal rate of return on the money substitute and of income:

$$(9) \qquad \frac{m}{v} = m(\hat{d},y); \quad m_1 < 0, \ m_2 > 0,$$

1/ The initial steady state around which the model will be solved below will have the property that $y_2 = 0$. This will be the case when the country is initially neither a net international debtor nor creditor, since in this case $(1-\theta)y = y_N/e$ (see Khan and Montiel (1987)).

2/ The literature on dual exchange markets in developing countries is now quite extensive. For recent expositions, see Lizondo (1987a,b) and Dornbusch (1986).

where $\hat{d}$ is the expected rate of depreciation of the dual exchange rate, which under the assumption of perfect foresight is equal to the actual rate of devaluation.

To complete the description of household behavior, the accumulation of domestic money is given by the household budget constraint:

$$\frac{\dot{M}}{P} = y - t - c,$$

or equivalently:

$$(10)\quad \dot{m} = e^{\theta-1}(y-t-c) - \hat{P}_Z m.$$

b. Public Sector

The government levies taxes on households and purchases both importables and nontradable goods. It finances any resulting deficit by borrowing from the central bank. Its budget constraint is given by:

$$(11)\quad def = g^Z + e^{-1}g^N - e^{\theta-1}t,$$

where g^Z and g^N denote government spending on importables and nontradable goods respectively and def is the government deficit measured in terms of importables. Initially, the government is assumed to allocate its spending in the same proportions as households:

$$(12a)\quad g^Z = \theta e^{\theta-1} g$$

$$(12b)\quad g^N = (1-\theta)e^{\theta} g,$$

where g is total real government spending measured in units of the consumption bundle.

The final agent in the model is the central bank, which issues money to finance government deficits and to purchase foreign exchange in the official market generated by trade balance surpluses. The balance of trade measured in terms of importables, denoted b, is given by:

(13) $b = \rho y^{X} + y^{Z} - c^{Z} - g^{Z}$

Thus, at any instant the stock of money in domestic currency units (M) is given by:

(14) $M_t = \int_{-\infty}^{t} (b(u) + def(u))\, P_z(u) du.$

The domestic-currency value of the stock of international reserves (which we denote R) depends on the current official exchange rate, rather than on the rate that prevailed at the time the foreign exchange was purchased by the central bank:

(15) $R_t = s \int_{-\infty}^{t} b(u) P_z^{*}(u) du.$

3. Equilibrium

Since the economy in question is small, domestic-currency prices of exportables and importables are governed by the law of one price:

(16) $P_X = sP_X^{*};\quad P_Z = sP_Z^{*},$

as we abstract from world inflation and assume that the exchange rate for current account transactions is fixed, the domestic currency prices of X and Z are constant.

Equilibrium in the nontradable goods market is given by:

$y^{N} = c^{N} + g^{N}$

Using (3), (5b), (6), (7) and (8), this becomes

(17) $y^{N}(\rho, e) = (1-\theta)e^{\theta}\, c[y(\rho, e) - t, e^{1-\theta}(m+v)] + g^{N}.$

This equation can be solved for the real exchange rate that clears the market for nontradable goods. To do so, it is convenient to assume that the initial equilibrium is characterized by trade balance equilibrium. In this case, it can be shown that $y_2 = 0$. 1/ The solution for e is given by:

(18) $e = e(\rho, g^N, t, m+v)$

with the following expressions for the partial derivatives:

$$e_1 = [y^N - (1-\theta)e^{\theta}c_1y_1] / \phi \quad 0; \quad e_2 = -1/\phi < 0;$$

$$e_3 = (1/\theta)e^{\theta}c_1 / \phi \quad 0; \quad e_4 = -(1-\theta)ec_2 / \phi < 0,$$

$$\text{where} \quad \phi = \theta(1-\theta)e^{\theta-1}c + (1-\theta)^2c_2(m+v) - y_2^N > 0.$$

The model is solved by combining equation (18) with equations (9) and (10) to yield a system of two differential equations in m and v. To do so, notice first that, since F and P_z are both exogenous, and since we will be considering only discrete changes in these variables, the definition of v implies that $\hat{d} = \hat{v}$. Making use of this property, equation (9) can be written as:

(19) $\hat{v} = h(\rho, m/v)$, where

$$h_1 = -m_2y_1/m_1 > 0; \quad h_2 = 1/m_1 < 0.$$

Similarly, substituting (18) in (10) produces:

(20) $\dot{m} = g(\rho, g^N, t, m+v)$, where

$$g_1 = y_1(1-c_1) - c_2e^{-1}(1-\theta)(m+v)e_1 > 0; \quad g_2 = -c_2(1-\theta)e^{-\theta}(m+v)e_2 > 0$$

$$g_3 = -(1-c_1) - (1-\theta)c_2e^{-1}(m+v)e_3 < 0; \quad g_4 = -c_2[(1-\theta)e^{-1}(m+v)e_4+1] < 0,$$

where all derivatives are evaluated at $\dot{m} = \dot{v} = 0$. 2/

The equilibrium defined by $\dot{m} = \dot{v} = 0$ can be shown to be saddle-point stable. The determinant of the system consisting of the linearized versions of (19) and (20) is given by:

1/ See Khan and Montiel (1987).

2/ The sign of g_4 is derived after substituting for e_4 from equation (18).

(21) $\Delta = -h_2 g_4(1+m/v) < 0$,

so the roots are indeed of opposite sign. The phase diagram for this system is depicted in Figure 1. The equations $\dot{m} = 0$ and $\dot{v} = 0$ trace out a pair of loci in m-v space with slopes given by:

$$\left.\frac{dv}{dm}\right|_{\dot{m}=0} = -1, \quad \text{and} \quad \left.\frac{dv}{dm}\right|_{\dot{v}=0} = v^*/m^* > 0.$$

The signs of the arrows are derived from the partial derivatives in (18) and (20), and the saddle path SS through the equilibrium point A must have a positive slope. 1/ Thus, along stable paths the real money supply and the premium in the dual exchange market will tend to move in the same direction.

IV. The Role of Devaluation

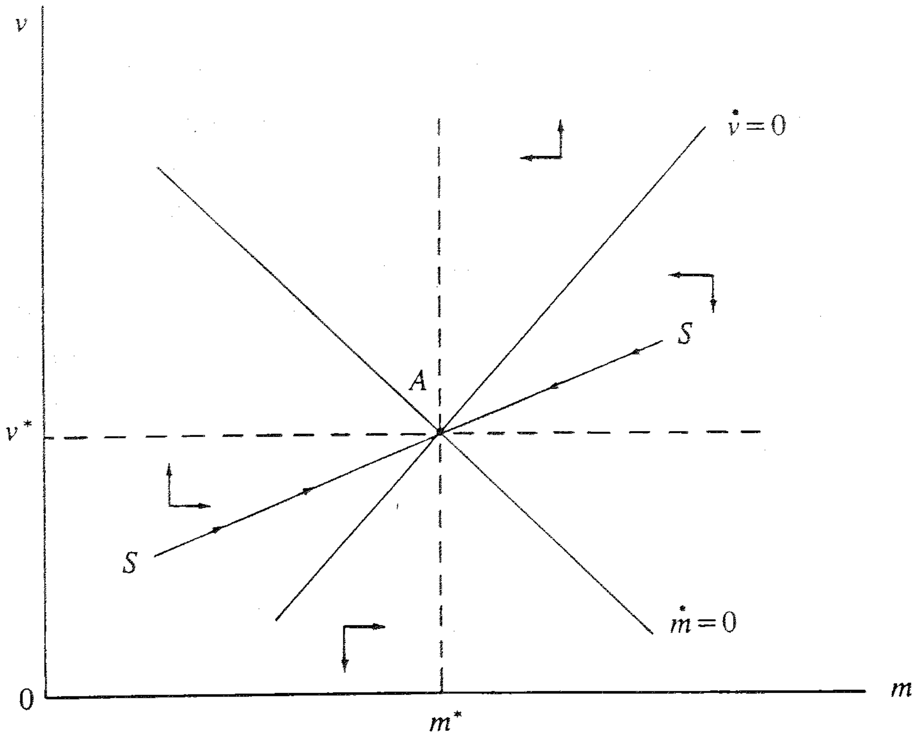
To analyze the workings of the model, we consider the effects of the two types of shocks which in Section II we associated with a devaluation crisis--an expansionary fiscal shock consisting of an increase in government spending on nontradable goods, and an adverse terms of trade shock. We begin this section by analyzing the role of a nominal official devaluation in our model. We then analyze the effects of an expansionary fiscal shock and of a permanent adverse terms of trade shock in consecutive subsections.

1/ The slope of the saddle path SS is given by:

$$\left.\frac{dv}{dm}\right|_{SS} = \frac{h_2}{\lambda_1 + h_2 \frac{m}{v}} > 0,$$

where λ_1 is the negative root.

Figure 1. Steady State Equilibrium



1. The Role of Devaluation

A steady-state configuration such as A in Figure 1 is characterized by $\dot{m} = 0$. By differentiating equation (14), this can be shown to imply that $b = -def$. However, this condition is not sufficient to ensure that a point like A will be sustainable. Assuming that the authorities are unwilling to permit their stock of foreign exchange reserves to fall outside some prescribed range of values, equation (15) suggests that nonzero values of def are not sustainable, since such values of def must eventually drive the stock of international reserves held by the Central Bank (R/s) to its upper or lower bounds. Sustainability of a fixed nominal official parity thus requires def = 0 in steady state.

Although a balanced government budget is a necessary condition for sustainability in our model, not all paths that satisfy the steady-state condition def = 0 are feasible. This condition will indeed guarantee convergence of (R/s), but not necessarily to a value which lies inside the authorities' preferred range. For a given time path of the fiscal variables, the role of a nominal devaluation in this model is to alter the steady-state value of (R/s). To see this, suppose that a devaluation of the official rate takes place at time t_0, at which the economy may or may not be in steady state, but at which time the condition def = 0 is fulfilled. From (14), (16b), and the fact that a nominal devaluation does not alter the steady-state value of m(m*), we have

$$(22) \qquad m^* = M_0/sP_z^* + \int_{t_0}^{\infty} [b(u)+def(u)]du$$

(recall that P_z^* is constant). From (15) and (22) and since d(def(u))/ds = 0, we have that a nominal devaluation will affect the stock of international reserves as follows:

$$(23) \qquad \frac{d(R/s)}{ds} = \frac{d}{ds}\int_{t_0}^{\infty} b(u)P_z^* du = M_0/s^2 P_z^* > 0.$$

That is, since the path of the fiscal deficit is unaltered, and since capital gains on reserves are not monetized, the original real money supply can be restored only by running cumulative trade surpluses--in other words, by reserve accumulation. It follows that, in the case of a public spending shock, a path rendered infeasible by reserve inadequacy may be sustainable if the eventual fiscal adjustment is accompanied by a sufficiently large devaluation of the official rate. The reason for this is that such a devaluation will reduce the cumulative loss of reserves during the transition to the new steady state. A similar analysis applies to the case of a terms of trade shock. We now examine the effects of fiscal and terms-of-trade shocks under adjustment-cum-devaluation.

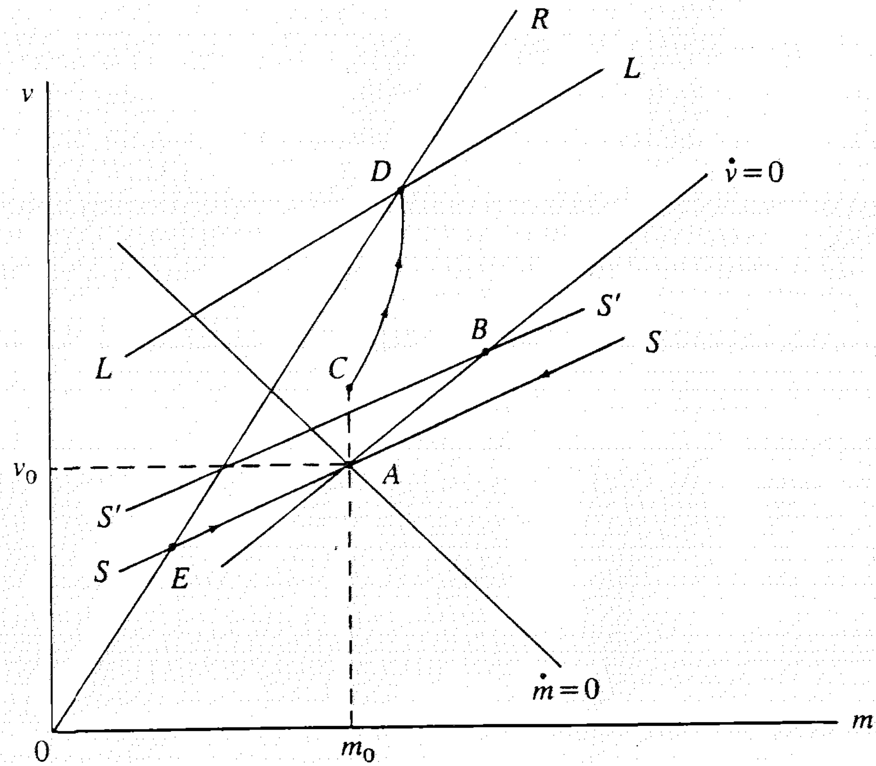
2. Fiscal Shocks and Devaluation Crises

The effects of an increase in government spending on nontraded goods are depicted in Figure 2. An increase in g_N shifts the $\dot{m} = 0$ locus to the right, by:

$$\left.\frac{dm}{dg^N}\right|_{\dot{m}=0} = -\frac{(1-\theta)e^{-\theta}(m+v)e_2}{(1-\theta)e^{-1}(m+v)e_4+1} > 0.$$

The $\dot{v} = 0$ locus is undisturbed. If the increase in government spending were perceived to be permanent, the dual rate would depreciate on impact by

Figure 2. Effects of an Expansionary Fiscal Shock



an amount such as to place the new short-run equilibrium at a point directly above A on the saddle path S'S', from then on, the new steady state B would be approached.

Whether such a path is feasible, however, depends on how the increase in spending is financed. Notice that, since t has been held constant in (20), tax financing has implicitly been ruled out. The alternatives are a reduction in spending on importables or central bank financing. We will examine the case in which the latter option is initially chosen, consistent with the pre-devaluation stylized facts presented in Section II. 1/

Since we are explicitly examining a devaluation crisis, at the moment that government spending increases the private sector is assumed to know not only that adjustment will eventually be necessary (i.e., that the spending increase is temporary), but also that the eventual adjustment in spending will be accompanied by an official devaluation. Since the eventual official devaluation is assumed to be anticipated at the time of the initial shock, the exchange rate in the dual market cannot jump when the official exchange rate is actually devalued. Recalling that $v = dF/sP_Z^*$ and $m = M/sP_Z^*$, this means that at the instant of devaluation, v and m must decrease in inverse proportion to the change in s. Thus, at the moment the devaluation takes place the economy must move inward along a ray from the origin such as OR in Figure 2. From a point such as D, at the instant of adjustment the economy jumps to E. The point E must be on SS, which governs the economy's post-adjustment trajectory. The location of D, on the other hand, is determined by the condition that $DE/EO = \Delta s/s$, i.e., by the size of the

1/ Of course, in this case the increase in g_N will have to be temporary.

devaluation. To see how the position of D is determined, suppose $\Delta S/S$ takes on some known value, say π. Consider the family of rays from the origin of which OR is a member. Each such ray will contain a point such as E where the ray intersects SS and a point like D with the property DE/EO = π. The set of all such points D traces out a locus LL located above SS and with slope given by:

$$\left.\frac{dv}{dm}\right|_{LL} = (1+\pi) \left.\frac{dv}{dm}\right|_{SS}.$$

Notice that there will be one such locus for each rate of devaluation π. If it is known that the fiscal expansion will last for t periods and that its termination will coincide with a π percent official devaluation, then the location of the point D will be determined by the intersection of the locus LL and a path such as CD which takes exactly t periods to reach LL from some initial point C. The point C must lie directly above A and above the saddle path S'S'--which passes through the supposed long-run equilibrium B--as well as below LL. The reason for this is that from points below S'S' or above LL there are no continuous trajectories that would take the economy to LL. In the case under discussion, therefore, the dual rate will depreciate on impact, causing v to jump to point C. From this point, v will continue to depreciate, and at least temporarily, m will rise. Notice that the dual rate depreciates continuously and eventually must do so at an increasing rate (since v/m rises as the economy approaches D and, from equation (19), an increase in this ratio increases $\hat{v}$) in anticipation of the eventual devaluation, which is consistent with the stylized facts presented in Section II. At the moment of adjustment the economy jumps from D to E along OR, then gradually returns to A along SS. We can now analyze the behavior of other key macro variables under the adjustment-cum-devaluation path CDEA.

To examine the nature of reserve behavior, use equations (3), (5a), (6), (7), and (8) in the trade balance equation (13). The result is:

(24) $b = b(e, \rho, g^z, t, m+v)$

with:

$b_1 = \rho y_2^x + y_2^z + \theta(1-\theta)e^{-1}[e^{\theta-1}c - c_2(m+v)] > 0,$

$b_2 = (1-\theta c_1)y^x + y_1^x + y_1^z > 0,$ 1/

$b_3 = -1,$

$b_4 = \theta e^{\theta-1}c_1 > 0,$

$b_5 = -\theta c_2 < 0.$

The sign of b_1 assumes that the term in square brackets is positive, which will be the case if the substitution effects of a real devaluation on household demand for importables exceed wealth effects.

Using equations (18) and (24), and noticing that $m+v$ rises continuously along the range CD, we can show that the trade balance moves into deficit on impact and the deficit increases over time until adjustment is undertaken, at which point a surplus must emerge (point E in Figure 2). Similarly, the price level jumps on impact and continues to rise in the period leading up to the devaluation. Thus the pre-devaluation period is characterized by a high and rising premium in the dual market, a trade deficit, and inflation, all of which were common features in the sample of devaluation episodes described in Section II.

1/ Although $y_1^z < 0$, using (2) and (3) we can show that $y_1^x > -y_1^z$.

Notice that, given that the price level rises continuously during the predevaluation period, the real exchange rate simultaneously appreciates. Since there have been no changes in the determinants of the equilibrium real exchange rate, this real appreciation represents a misalignment situation. By equation (2), the real wage in terms of tradables rises. Moreover, if the share of tradables in the consumption bundle is sufficiently large, the real wage measured in terms of the consumption bundle will also rise in the period leading up to the devaluation. Under this assumption, the devaluation of the official rate results in a sharp decrease in the real wage which causes it to fall below its pre-shock level. This is followed by a gradual increase in the real wage until its original level is restored. Finally, as can be shown from equations (6), (7), and (8), the same condition (a large value of θ) ensures that private real consumption also rises over this period. 1/

3. Devaluation Postponement and Macroeconomic Adjustment

We now examine how the dynamics of adjustment are affected by postponing the eventual measures. Consider first a postponement of adjustment which holds constant the size of the devaluation. We can show that as the fiscal expansion is prolonged, the point C in Figure 2 moves closer to the saddle path S'S'--i.e., the initial depreciation in the dual rate is dampened. 2/ Moreover, since the ratio v/m is smaller at points

1/ Notice that m+v rises up to point D. Although e falls, if $1-\theta$ is small, equation (8) indicates that a will increase. Since by (7), y is unaffected by changes in e, the behavior of c will depend on that of a.

2/ Notice that, if the economy jumped above C, the new path would intersect LL to the southwest of D. Since the increase in v along this path (call it C'D') is smaller than that along CD, and since for each value of v on this path $\hat{v}$ exceeds its value along CD (because the ratio v/m is greater), such paths must be traversed in less time than CD, which is contrary to the assumption of delayed adjustment.

below C, the initial rate of depreciation of the dual rate is also smaller in this case. However, since paths that begin below C must intersect LL to the northeast of D, the peak values of both v and m, as well as of v+m, in this case exceed those in the case of more rapid adjustment. The larger peak value of v+m (reached just prior to adjustment) means that the increase in the domestic price level--and thus the eventual degree of real exchange rate misalignment--is larger the longer adjustment is postponed. It follows from the arguments presented above that peak deviations of the current account, the real wage, and real consumption from their steady-state values are also larger the more that adjustment is postponed.

Moreover, postponing adjustment also diminishes the steady-state stock of foreign-exchange resources. To see this, use (14) and (15) to write:

$$(25) \qquad m = \frac{R/s_1}{P_z^*} + (s_0/s_1)P_z^* \int_{-\infty}^{t} def(u)du,$$

where s_0 and s_1 denote the pre- and post-devaluation official exchange rate. Since m and P_z^* are unchanging across steady states, for a given value of s_0/s_1, the larger the cumulative fiscal deficit (which depends only on how long devaluation is postponed), the smaller must R/s_1 be.

If the authorities pursue a reserve target, the consequences of postponement are more dramatic. As can be verified from equation (25), for a given value of R/s_1, an increase in t requires a reduction in s_0/s_1--i.e., a larger official devaluation. Thus, in the presence of a reserve target, postponing adjustment implies a larger eventual official devaluation. To see the consequences of this for the economy's dynamic behavior, return to Figure 2. An increase in π causes the locus LL to shirt upwards and become steeper. Holding the duration of the fiscal expansion constant, this would in itself increase the initial value of C and the peak values of both v and v+m (at the point D). Thus an increase in the size of the eventual official devaluation increases the peak deviation of macroeconomic variables at the instant just preceding adjustment from their steady-state values. Moreover, since the ray OR rotates counterclockwise in this case, the point E moves to the southeast along SS. This implies that the peak post-adjustment deviations of v, v+m and the other macroeconomic variables from their steady-state values is also increased by a larger official devaluation.

Putting together the longer duration of the fiscal expansion and the larger official devaluation that it implies, the following picture emerges:

a. Since the longer fiscal expansion tends to lower the initial value of v (i.e., the point C) while the larger official devaluation tends to raise it, the impact effects of postponing adjustment in the presence of a reserve target are ambiguous.

b. Over time, however, the longer adjustment is postponed, the larger the cumulative deviations of the macroeconomic variables of interest from their steady-state values.

c. When adjustment is finally undertaken, these variables will tend to overshoot their steady-state values (i.e., the economy will be at E, rather than at A), and the degree of overshooting will be magnified by postponing the adjustment.

d. Finally, since postponement requires a larger official devaluation in the presence of a reserve target the legacy of postponement will be a higher steady-state price level.

4. Terms-of Trade Shocks and Devaluation Crises

The analysis of an adverse (permanent) terms of trade shock is slightly more complicated, since in this case both the $\dot{v} = 0$ and $\dot{m} = 0$ loci are affected. 1/ The shift in $\dot{v} = 0$ is given by:

$$-\left.\frac{dm}{d\rho}\right|_{\dot{v}=0} = \frac{h_1 v}{h_2} = -m_2 y_1 v < 0.$$

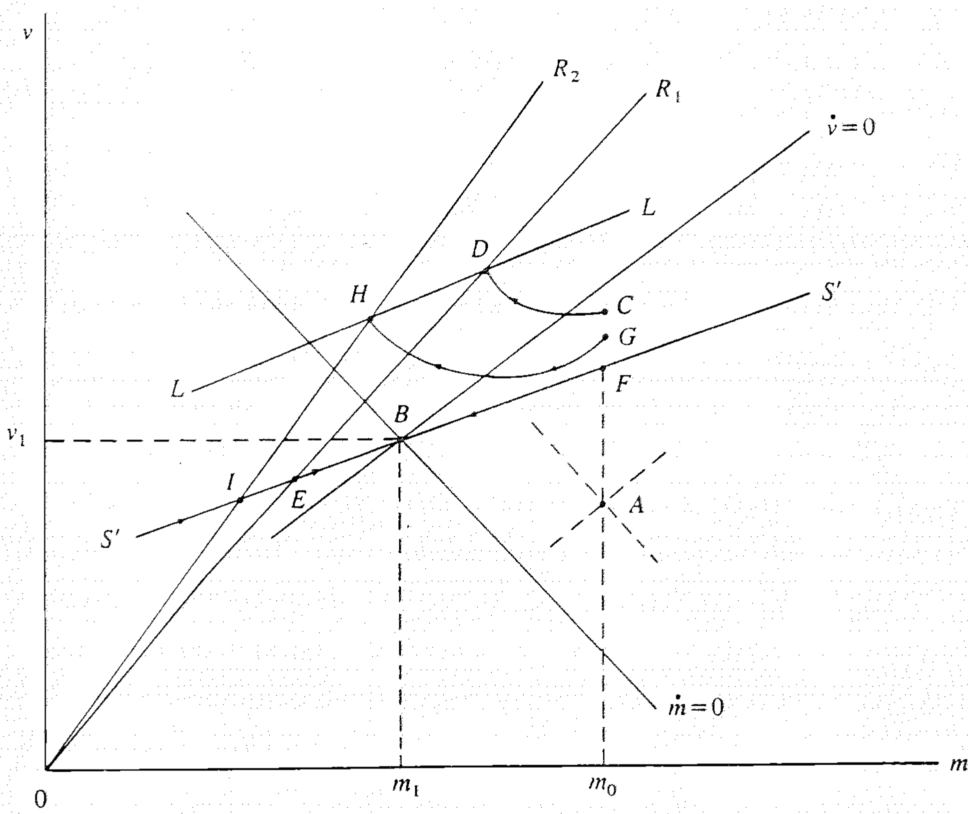
while that in $\dot{m} = 0$ is:

$$-\left.\frac{dm}{d\rho}\right|_{\dot{m}=0} = \frac{g_1}{g_4} < 0.$$

Since both loci shift to the left, in the new steady state m will unambiguously fall, but v may either increase or decrease. The reduction in real income attendant upon the terms of trade deterioration causes domestic agents to seek to shift their portfolios away from money and into foreign currency, thus increasing v. On the other hand, the reduction in real income reduces saving, and to restore saving to its steady state level of zero, wealth must fall. This is partly brought about through a reduction in v, leaving the net change in v ambiguous. In Figure 3, we illustrate the case in which the portfolio-composition effect on v dominates the wealth effect, so that v is higher in the new steady state at B. The steady state

1/ We are here considering an adverse terms-of-trade shock which takes the form of a reduction in P_x^*. The case of an increase in P_z^* is similar, except that the initial value of m will be affected in this case.

Figure 3. Effects of an Adverse Terms of Trade Shock



at B is in principle viable, since in this exercise no fiscal deficit exists at that point to generate continuous reserve depletion.

In the absence of devaluation, the economy would jump to a point such as F on the new saddle path S'S' and gradually converge to B. This path is characterized by trade deficits and serve depletion. Given a reserve target, the authorities may instead prefer a path which involves an official devaluation. However, unlike in the previous section, the size of the required official devaluation is unaffected by its timing. This can be verified from equation (25), recalling that in this case the fiscal deficit remains at zero during the entire transition path between steady states. Since the second term on the right hand side of (25) drops out, the reserve target will determine the size of the official devaluation, but the final reserve outcome will be independent of when the devaluation takes place. On the other hand, as will be shown below, the timing of adjustment (in the form of the official devaluation) again matters in determining the paths followed by the main macroeconomic variables.

Suppose, for concreteness, that the authorities choose the magnitude of the official devaluation such as to preserve the original level of reserves measured in terms of foreign currency. Then, if the terms of trade deterioration is accompanied by an immediate official devaluation of $(m_0-m_1)/m_0$ percent (Figure 3), the economy will immediately move from the original steady state at A to the new one at B, without undergoing an intervening sequence of trade deficits. If the exchange rate adjustment is postponed, however, again m and v must contract along a ray from the origin at the instant of devaluation, from a point such as D on the ray OR_1, to a point such as E on the new saddle path S'S'. For this to be possible, the initial jump in v must be to a point <u>above</u> this saddle path, and since this implies a sequence of trade deficits (because m is falling), it must be offset by eventual surpluses--i.e., the post-devaluation point must be located to the southwest of B along S'S'. The implied transition path is CDEB, with an initial depreciation of the dual rate. 1/ This is followed by gradual appreciation and then by an accelerating depreciation.

The behavior of the remaining macroeconomic variables that concern us over the range CD of the adjustment path cannot be determined unambiguously, since the terms of trade deterioration and the depreciation in the dual market have conflicting effects on the real exchange rate and therefore on variables such as the price level, the real wage, and real consumption. However, at the moment of devaluation, the real exchange rate undergoes a step depreciation, accompanied by a reduction in the real wage and real consumption, this again assuming a sufficiently large share of tradables in the consumption bundle. As the trade balance goes into surplus with a depreciating dual rate over the final segment EB, real exchange rate appreciation is accompanied by a rising real wage and rising real consumption.

In the event that devaluation is further postponed, the ray OR will rotate counterclockwise, to OR_2, say, as the point D moves along the locus LL (derived as in the previous section). In this case, the initial depreciation must be to a point between F and C, such as G, and the economy will follow the more prolonged adjustment trajectory GHIB. 2/ Thus the

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1/ The initial point C must be <u>below</u> $\dot{v} = 0$ to ensure convergence to a point D on the ray OR with the property $DE/DO = (m_0 - m_1)/m_0$.

2/ That the paths such as GH, located <u>below</u> CD require more time to traverse than CD follows from the fact that, for each m, the trade deficit on CD exceeds that on GH, yet the <u>cumulative</u> deficit along GH (the reduction in m) exceeds that along CD. It follows that, in the case pre-devaluation period is characterized by trade deficits and increasing premiums in the dual exchange market which increase at an accelerating rate (since v/m rises).

The effects of postponing adjustment on the deviations of macrovariables from their steady-state values is quite different in the present case from the case of a temporary fiscal expansion. Since LL has a positive slope, the peak values reached by both v and v+m in the period leading up to the official devaluation are smaller when the devaluation is postponed. Thus the peak deviation of the macrovariables from their steady-state values during this period is <u>diminished</u> when adjustment is postponed, in contract to what is observed under a temporary fiscal expansion. However, at the point H the cumulative reserve loss exceeds that at D (notice that m is smaller), so that larger cumulative trade surpluses are needed in the post-adjustment period. Thus the point I is to the southwest of E on S'S' in Figure 3, and the <u>post</u>-adjustment deviations of macrovariables from their steady-state values are magnified, as in the previous section.

In the case of a permanent terms of trade shock, in which "adjustment" consists of an official devaluation designed to meet a reserve target, we therefore conclude that:

a. Postponement of adjustment <u>mutes</u> the impact effect of the shock on macroeconomic variables.

b. Similarly, with the exception of foreign exchange reserves and the money supply, the cumulative deviation of macrovariables from their steady-state values prior to adjustment is <u>smaller</u> when adjustment is postponed.

(Contd. from page 29) of prolonged adjustment, the initial jump from point A must be to a path <u>below</u> CD, rather than to one above it.

c. However, as in the case of a temporary fiscal expansion, postponement magnifies post-adjustment overshooting.

d. In this case, postponement does not affect the steady-state values of domestic nominal variables.

V. Concluding Remarks

Adjustment programs in developing countries are usually the consequence of severe macroeconomic crises. These crises have tended to share a number of common features, such as an acceleration in the rate of inflation, continuous appreciation of the official real exchange rate, an increase in the current account deficit, the sustained depletion of foreign exchange reserves, and a continuously-increasing premium in the black market for foreign exchange. When adjustment is undertaken it usually includes a substantial devaluation of the official rate, following which the parallel market premium shrinks appreciably. The purpose of this paper has been to derive a dynamic model that is able to capture these common features of balance of payments crises. An important property of the model is that it allows us to analyze the consequences of different timings of adjustment.

The opening section of the paper contains a brief discussion of 20 major devaluation episodes in the developing countries. From this analysis we derive a list of "stylized facts" that we believe models of macroeconomic adjustment should account for. In Section III the model is presented. The model is based on fully articulated micro-principles and considers an economy that produces three goods. The public holds domestic and foreign money, and there are dual exchange rates. An important feature of the model is that the Central Bank has a well-defined demand for international reserves. In Section IV we use the model to analyze how the economy reacts to two types of shocks: (1) an increase in government consumption of nontradables financed with domestic credit creation; and (2) a negative shock to terms of trade. We show that in this model the adjustment path followed by inflation, the current account, the real exchange rate, wages, the parallel market premium and net foreign assets correspond closely to the stylized facts described in Section II of the paper.

A central result of our analysis refers to the consequences of postponing the adjustment when the Central Bank has a well-defined target for international reserves. We show that the effects of postponement will depend on the type of shock. If the disturbance is a fiscal expansion, postponing the adjustment will require a larger official devaluation. However, this relationship between the timing of the devaluation and its magnitude is not linear. If the postponement period is doubled the required magnitude of the devaluation will not double. 1/ Delaying the adjustment will affect the path followed by the endogenous variables. In particular, the longer adjustment is postponed, the larger will be the deviations of the macro variables from their steady-state values. When adjustment is finally implemented the macro variables will tend to overshoot their steady state values. The extent of overshooting will depend on the postponement period: a delayed adjustment magnifies the extent of the overshooting.

For the case of a negative terms of trade disturbance, the size of the official devaluation will be unaffected by the timing of the adjustment. Furthermore, the longer the adjustment is postponed, the smaller will be the peak deviation of the macrovariables (except for reserves and money) from

1/ This can be verified by implicitly differentiating equation (25).

their steady state values. However, as in the case of fiscal shock, following adjustment the required degree of overshooting of the macro variables will be magnified by postponement.

An important conclusion of our analysis on the effects of the timing of adjustment is that the observed pattern of continuously rising black market premia, rising inflation, and increasing current account deficits can be unambiguously inferred only in the context of sufficiently postponed adjustment. The suggestion is that "devaluation crisis" episodes in developing countries have resulted not so much from the occurrence of domestic or external shocks, but from a failure to adjust promptly in response to such shocks.

Although the model presented here goes a long way toward tying together the more salient features of devaluation crises in developing countries, it has some limitations. In particular, it fails to incorporate at least two important issues. First, since there is no capital mobility (the official rate is available only for current transactions and there are no leakages between markets) the role of capital flight is not investigated. Second, since our model exhibits continuous full employment, the dynamics of real output over the course of the crisis-adjustment period have been omitted. While both phenomena are of substantial empirical and analytical interest, their incorporation into our framework would add substantially to the model's complexity and they therefore remain topics for future research. 1/

1/ In particular adding endogenous capital flows triggered by perceived interest rate differentials would result in a system with three state variables.

Macro Data For 20 Devaluation Episodes

Table A.1 Terms of Trade in Period Preceding Devaluation Crises

Country	Year of Devaluation Crisis	3 Years Prior	1 Year Prior	Year of Crisis
A. Stepwise Devaluation				
Colombia	1962	100.0	100.1	94.0
Colombia	1965	100.0	109.3	111.4
Costa Rica	1974	-	-	-
Cyprus	1967	100.0	110.3	106.9
Guyana	1967	-	-	-
India	1966	100.0	99.5	103.2
Israel	1962	100.0	100.8	103.0
Israel	1967	100.0	106.1	104.1
Israel	1971	100.0	97.2	99.2
Nicaragua	1979	100.0	94.2	97.5
Pakistan	1972	100.0*	87.0	95.6
Sri Lanka	1967	100.0	102.3	95.6
Yugoslavia	1965	100.0	100.9	100.7
Average		100.0	100.7	101.1
B. Devaluation Followed by Crawling Peg				
Chile	1982	-	-	-
Colombia	1967	100.0	80.9	95.3
Kenya	1981	100.0	84.5	72.4
Korea	1980	100.0	102.5	89.0
Mexico	1976	-	-	-
Mexico	1982	-	-	-
Pakistan	1982	100.0	77.3	75.0
Average		100.0	86.3	82.9

Source: International Financial Statistics.

*This number refers to two, rather than three, years prior to the devaluation.

Table A.2 Evolution of Net Foreign Assets and Current Account In Period Preceding Devaluation

Country	Year	Ratio of Net[a] Foreign Assets -3 Years	Ratio of Net[a] Foreign Assets -1 Year	(Current Account/GDP) -3 Years	(Current Account/GDP) -1 Year
Colombia	1962	1.2	-1.8	0.016	-0.030
Colombia	1965	-10.7	-11.6	-0.022	-0.030
Costa Rica	1974	12.8	16.7	-0.119	-0.091
Cyprus	1967	49.8	55.0	-0.134	-0.072
Guyana	1967	62.6	33.0	-0.063	-0.142
India	1966	2.3	1.2	-0.025	-0.029
Israel	1962	20.7	30.6	-0.180	-0.179
Israel	1967	42.3	34.3	-0.236	-0.145
Israel	1971	29.4	3.5	-0.195	-0.259
Nicaragua	1979	16.8	-35.5	-0.028	-0.009
Pakistan	1972	7.5	3.9	-0.028	-0.029
Sri Lanka	1967	5.2	-0.5	-0.025	-0.039
Yugoslavia	1965	2.3	-0.9	-0.017	-0.031
Chile	1982	24.2	16.4	-0.062	-0.155
Colombia	1967	-11.6	-8.8	-0.030	-0.047
Kenya	1981	13.4	10.2	-0.156	-0.246
Korea	1980	13.2	1.8	-0.019	-0.072
Mexico	1976	14.3	9.5	-0.025	-0.044
Mexico	1982	7.5	6.8	-0.038	-0.052
Pakistan	1982	4.3	2.1	-0.030	-0.012

Source: Constructed from IFS data.

[a]Ratio of Net Foreign assets to the sum of net foreign assets plus domestic credit × 100. (Lines 31N over the sum of Lines 31N + 32 of IFS).

Table A.3 Evolution of Real Exchange Rate Indexes During Three Years Prior to Devaluation

(Index = 100 in Year Prior to Devaluation)

Country	Year	Bilateral Real Exchange Rate -3 Years	Bilateral Real Exchange Rate -1 Year	Multilateral Real Exchange Rate -3 Years.	Multilateral Real Exchange Rate -1 Year
Colombia	1962	108.1	100	105.7	100
Colombia	1965	155.7	100	123.8	100
Costa Rica	1974	101.6	100	93.9	100
Cyprus	1967	95.8	100	97.2	100
Guyana	1967	99.7	100	100.1	100
India	1966	121.2	100	119.7	100
Israel	1962	105.9	100	108.4	100
Israel	1967	107.0	100	112.0	100
Israel	1971	102.5	100	104.8	100
Nicaragua	1979	101.9	100	95.3	100
Pakistan	1972	105.1	100	97.9	100
Sri Lanka	1967	95.2	100	92.2	100
Yugoslavia	1965	117.7	100	120.5	100
Chile	1982	129.9	100	140.6	100
Colombia[a]	1967	(78.7)	100	(83.1)	100
Kenya	1981	93.5	100	93.1	100
Korea	1980	111.6	100	112.9	100
Mexico	1976	109.2	100	108.6	100
Mexico	1982	112.9	100	128.2	100
Pakistan	1982	100.6	100	115.2	100
Average		109.2	100	109.0	100

Source: Real exchange rates indexes constructed as described in the text.

[a]Colombia devalued in 1965. This explains the evolution of RER index before 1967.

Table A.4 Parallel Market Premia
In Period Prior to Devaluations

(Parallel Market Premium (percentage))

Country	Year	-3 Yrs.	-9 Mths.	-3 Mths.	-1 Month
Colombia	1962	11.1	33.4	34.7	58.0
Colombia	1965	37.5	42.8	110.6	114.4
Costa Rica	1974	0.5	42.2	34.7	30.2
India	1966	51.9	77.5	131.1	134.2
Israel	1962	-0.6	36.3	46.9	50.8
Israel	1967	7.8	5.6	13.9	9.9
Israel	1971	-5.0	26.9	7.7	6.9
Nicaragua	1979	0.2	27.1	78.6	92.9
Pakistan	1972	112.2	152.1	157.3	134.2
Sri Lanka	1967	163.2	180.3	173.1	152.1
Yugoslavia	1965	n.a.	39.5	41.9	54.7
Chile	1982	n.a.	10.3	12.8	17.9
Colombia	1967	35.9	19.2	46.3	48.1
Kenya	1981	n.a.	0.7	10.7	19.8
Korea	1980	4.4	14.0	19.2	42.3
Mexico	1976	0.0	0.0	0.0	0.0
Mexico	1982	0.0	5.4	11.7	12.5
Pakistan	1982	n.a.	33.8	48.5	40.9

Source: Picks Currency Yearbook, World's Currency Yearbook and IFS; various issues.

Table A.5 Manufacturing Real Wage Rate Indexes in Devaluing Countries (Year Prior to Devaluation = 100)

Year of Country	Year	-3 Yrs.	-2 Yrs.	-1 Yr.	Dev.	+1 Yr.	+2 Yrs.	+3 Yrs.
Colombia	1962	n.a.	94.2	100	112.0	117.9	114.1	122.3
Colombia	1965	98.1	103.3	100	107.1	101.6	103.7	108.1
Cyprus	1967	80.5	86.5	100	96.2	98.6	107.9	113.7
Guyana	1967	n.a.	n.a.	100	114.9	129.4	141.9	146.2
India	1966	105.6	97.9	100	97.7	92.5	97.1	100.9
Israel	1962	94.1	96.9	100	100.2	108.9	109.8	120.5
Israel	1967	85.7	94.0	100	102.1	107.8	107.8	112.9
Israel	1971	95.5	95.4	100	98.0	100.1	102.7	101.9
Nicaragua	1979	104.4	99.2	100	87.5	81.7	n.a.	n.a.
Pakistan	1972	116.3	109.2	100	101.2	145.2	122.5	118.4
Sri Lanka	1967	96.5	97.9	100	98.8	102.0	96.5	98.6
Yugoslavia	1965	74.0	85.8	100	103.7	112.8	116.5	122.1
Chile	1982	78.5	89.1	100	100.4	106.3	103.1	n.a.
Colombia	1967	98.3	105.3	100	102.0	106.3	105.7	115.7
Kenya	1981	100.8	98.5	100	99.4	91.6	88.9	n.a.
Korea	1980	78.3	91.9	100	95.3	94.4	101.0	109.6
Mexico	1976	91.9	95.2	100	108.0	109.8	107.6	106.5
Mexico	1982	101.5	97.5	100	99.5	72.4	69.8	n.a.
Pakistan	1982	126.4	105.5	100	n.a.	n.a.	n.a.	n.a.

Source: Constructed from data obtained from the International Labor Office and the International Monetary Fund.

Table A.6 Countries in Control Group

Country	IFS Country Code	Year of Study
Cote d'Ivoire	662	1965-1977
Dominican Republic	243	1960-1980
Ecuador	248	1971-1980
Egypt	469	1960-1971
El Salvador	253	1960-1980
Ethiopia	644	1960-1970
Greece	174	1960-1973
Guatemala	258	1960-1980
Honduras	268	1960-1980
Iran	429	1960-1971
Iraq	433	1960-1971
Jordan	439	1960-1971
Malaysia	548	1960-1970
Mexico	273	1960-1974
Nicaragua	278	1960-1977
Nigeria	694	1960-1970
Panama	283	1960-1980
Paraguay	288	1960-1982
Singapore	576	1960-1970
Sudan	732	1960-1976
Thailand	578	1960-1971
Tunisia	744	1960-1970
Venezuela	299	1965-1981
Zambia	754	1960-1971

References

Aizenman, J. (1985) "Adjustment to Monetary Policy and Devaluation Under Two Tier and Fixed Exchange Rate Regimes," Journal of Development Economics, 18,: 153-69.

Blanco, H. and P. Garber (1986) "Recurrent Devaluations and Speculative Attacks on the Mexican Peso," Journal of Political Economy 94(1): 148-66.

Buira, A. (1983), "The IMF and Conditionality," Journal of Development Economics, 120-139.

Connolly, M. et.al (1987) "Speculation Against the Preannounced Exchange Rate in Mexico: January 1983 to June 1985," in M. Connolly and C. Gonzalez-Vega (Eds.) Economic Reform and Stabilization in Latin America New York, Praeger Publishers.

Dornbusch, R. (1986), "Special Exchange Rates for Capital Account Transactions," World Bank Economic Review, 1(1): 3-35.

Edwards, S. "The Demand for International Reserves and Exchange Rate Adjustments: The Case of LDCs, 1964-1972" Economica 50: 269-80.

_____, (1986), "Are Devaluations Contractionary," Review of Economics and Statistics, 68(3): 501-508.

_____, (1988), "Real and Monetary Determinants of Real Exchange Rate Behavior: Theory and Evidence from Developing Countries," Journal of Development Economics (forthcoming).

_____, (1989a), "Exchange Controls, Real Exchange Rates and Devaluation: The Latin American Experience," Economic Development and Cultural Change (forthcoming).

_____, (1989b), Real Exchange Rates, Devaluation and Adjustment in Developing Countries, MIT Press (forthcoming).

______ and S. van Wijnbergen (1987), "Tariffs, the Real Exchange Rate and the Terms of Trade: On Two Popular Propositions in International Economics," Oxford Economic Papers, 39: 458-464.

Flood, R. and P. Garber "Collapsing Exchange Rate Regimes: Some Linear Examples," Journal of International Economics, 17: 1-16.

Goldstein, M. and P. Montiel (1986), "Evaluating Fund Stabilization Programs with Multicountry Data: Some Methodological Pitfalls," IMF Staff Papers, 33(2): 304-344.

Khan, M. and S. Lizondo (1987), "Devaluation, Fiscal Deficits and the Real Exchange Rate," World Bank Economic Review, 1(2): 22-55.

______ and P. Montiel (1987), "Real Exchange Dynamics in a Small, Primary Producing Country," IMF Staff Papers, 34(4): 681-710.

Kiguel, M. and S. Lizondo (1986), "Theoretical and Policy Aspects of Dual Exchange Rate Systems," World Bank Discussion Paper No. DRD201.

Krugman, P. (1979) "A Model of Balance of Payments Crisis," Journal of Money, Credit and Banking 11:311-325.

Lizondo, S. (1987a), "Exchange Rate Differentials and Balance of Payments Under Dual Exchange Markets," Journal of Development Economics (June).

______, "Unification of Dual Exchange Markets," Journal of International Economics 17.

______ and P. Montiel (1988), "Contractionary Devaluation in Development Countries: An Analytical Review," mimeo, IMF.

Obstfeld, M. (1986) "Rational and Self-Fulfilling Balance of Payments Crises," American Economic Review 87: 72-82.

Pastor, M. (1986), The International Monetary Fund and Latin America, Boulder: Westview Press, 1987.

Rodriguez, C. (1978) "A Stylized Model of the Devaluation-Inflation Spiral" IMF Staff Papers, 25: 76-89.