INTERNATIONAL MONETARY FUND

# STAFF PAPERS

## CONTENTS



VOL. 36 No. 2 JUNE 1989

# STAFF PAPERS



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# STAFF PAPERS

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# CONTENTS

Vol. 36 No. 2 JUNE 1989

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# Growth-Oriented Adjustment Programs

## A Conceptual Framework

MOHSIN S. KHAN and PETER J. MONTIEL*

*A conceptual framework is proposed as an input to the design of growth-oriented adjustment programs. The two building blocks of the model are the well-known monetary approach to the balance of payments and a variant of the open-economy neoclassical growth model. The integrated model combines growth, inflation, and the balance of payments and links these objectives to government policies and the availability of foreign financing. The principal advantage of the framework is its simple structure, which enables it to be applied relatively easily to a variety of developing countries.* [JEL 113, 430]

THERE IS a broad consensus in both academic and policymaking circles that a healthy and sustained rate of economic growth is central to an adjustment strategy intended to achieve long-term viability in the balance of payments and a permanent reduction in the rate of inflation. Indeed, it can be argued that adjustment can only be judged successful if it brings about a rate of growth of output that allows for a steady improvement in per capita income and living standards. Although there may be general agreement on the concept of "growth-oriented adjustment," however, designing a policy package that will simultaneously eliminate the macroeconomic imbalances in the economy *and* raise the growth rate turns out to be no easy task. The desire to develop a frame-

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work for growth-oriented adjustment has, thus, begun to preoccupy researchers and practitioners alike. Evidence of this interest is reflected in, among others, a growing number of academic papers (see Khan (1987) and the references therein), the recent joint World Bank–International Monetary Fund symposium on the subject of growth-oriented adjustment programs (see Corbo, Goldstein, and Khan (1987)), and, at a more policy-related level, the approach suggested in the report of the Group of Twenty Four (1987).

The need for a consistent framework in which policies can be linked to growth, inflation, and the balance of payments becomes particularly pressing as one moves to make the concept of growth-oriented adjustment operational. There are, of course, several empirical models available that attempt to capture the relationships among the principal objectives of adjustment programs, but these models tend to be either too complicated or too country-specific to apply easily across countries.[1] The development of a conceptual framework that incorporates the most important macroeconomic policy instruments and targets, and at the same time can be tailored to the circumstances and the structural characteristics of the individual country, is now clearly one of the main priorities of research on developing countries.

This paper proposes a model that can serve as a starting point for the development of a generalized framework that can analyse issues in adjustment with growth. The two main building blocks of this model are the monetary approach to the balance of payments, used often in designing short-term stabilization programs geared toward balance of payments and inflation targets, and a simple version of the open-economy neoclassical growth model.[2] Because our intent is purely expositional—that is, to describe the properties of a model combining two well-known models—there is no pretense here of presenting a "new" macroeconomic model for developing countries.[3]

The model that is developed has several noteworthy features. First, it combines growth, inflation, and the balance of payments within an integrated framework; unlike the earlier model of Khan, Montiel, and Haque (1986), however, it does not utilize restrictive assumptions about

[1] See Khan and Knight (1985) for a survey of selected macroeconomic models for developing countries.

[2] The monetary approach to the balance of payments plays a key role in the formulation of the Fund's financial programs (International Monetary Fund (1977, 1987)), and the World Bank uses a two-gap growth model to establish external financing needs and consistent projections across countries (Khan, Montiel, and Haque (1986)).

[3] The model herein builds on the analysis of Khan, Montiel, and Haque (1986).

the growth process, foreign debt and debt service, or the endogeneity of exports. Second, the model is able to link these objectives of adjustment directly to a variety of government policies. Third, the model can be used to calculate the effects of changes in external financing on monetary and real variables in the economy. This last feature is of particular importance in present circumstances, in which developing countries are seriously constrained in the amount of foreign resources they can attract. Finally, because the model has a simple structure and requires a minimal amount of information, it can be applied in a fairly straightforward manner to a wide variety of countries. It thus has an operational advantage that more complex models tend to lack.

To analyze the properties of the model, we examine the impact effects on growth, inflation, and the balance of payments of a variety of exogenous and policy-induced shocks. The policy shocks include changes in domestic credit, the exchange rate, fiscal policies, and structural policies that alter the private savings rate and the efficiency of investment. Other shocks considered are changes in the income velocity of money and variations in foreign capital flows. The results obtained from this analysis turn out to be broadly consistent with widely held beliefs.

The remainder of the paper proceeds as follows. In Section I we briefly describe the structure of the model. Section II, which is the key component of the paper, presents comparative-static exercises undertaken to demonstrate the workings of the model. The concluding section summarizes the main points of the paper and highlights some of the directions in which the proposed framework could be extended.

## I. A Model of Adjustment and Growth

The model formulated in this section contains a growth block and a monetary block that together determine growth, prices, and the balance of payments. This section begins by describing a simple macroeconomic framework for a representative developing economy. The growth and monetary components of the model are specified separately and are then combined to yield the complete model. This model assumes continuous equilibrium; because the model is specified in discrete time, all adjustments take place in one period.

### The Macroeconomic Framework

Consider a small open economy that maintains a fixed exchange rate. In this economy the private sector is assumed to own all factors of pro-

duction. It receives income from production ($Y$) and uses it to pay taxes ($T$), to consume ($C$), and to save ($S_p$). The private sector's budget constraint is therefore:[4]

$$Y - T - C - S_p \equiv 0. \tag{1}$$

Private sector savings are devoted to the accumulation of physical capital,[5] to increasing money balances, and to reducing liabilities to the banking system:

$$S_p \equiv P_D dk + dM^d - dD_p, \tag{2}$$

where $P_D$ is the price of domestic output. Because the model is formulated in discrete time, the symbol $d$ is used to denote the change in a variable from the last period ($y_0$) to the present ($y$); that is,

$$dy = \Delta y = y - y_0.$$

Consequently, $dk$ is the change in the real private capital stock, $dM^d$ is the change in the nominal demand for money (hoarding), and $dD_p$ is the change in net domestic credit to the private sector extended by the banking system.

The government, in turn, consumes output ($G$), pays interest on its foreign borrowing ($ieF$), collects taxes from the private sector ($T$), receives the profits of the central bank ($T_B$), and finances its deficit by borrowing from the domestic banking system ($dD_g$) and from abroad ($edF$). We use $e$ to denote the nominal exchange rate and $F$ to represent the foreign-currency value of the government's foreign debt.[6] The government budget constraint is given by

$$edF + dD_g \equiv G + ieF - T - T_B. \tag{3}$$

Finally, the banking system, which is assumed to consist solely of the central bank, accumulates reserves with foreign-currency value $R$, extends credit to the government and the private sector, and issues liabilities in the form of money. With changes in the domestic-currency value of foreign reserves arising out of exchange rate movements being sterilized, the change in the money supply would have the form

$$dM^S \equiv e_0 dR + dD, \tag{4}$$

[4] For simplicity, we assume that the private sector cannot borrow abroad and that domestic interest rates are zero. Although the introduction of private capital flows and domestic interest payments would complicate the analysis, it is unlikely that it would alter the conclusions.

[5] We assume that there is no public investment, so that all investment in the economy is undertaken by the private sector.

[6] Because only the government can borrow abroad, $F$ is also the economy's foreign debt.

where $dM^S$ is the change in the nominal money supply, $dR$ is the foreign-currency value of the change in foreign reserves (the balance of payments), $e_0$ is the exchange rate in the previous period, and $dD$ is the change in total domestic credit, which is defined as

$$dD = dD_g + dD_p. \tag{5}$$

The portion of the central bank's profits that is transferred to the government is given by[7]

$$T_B = ieR. \tag{6}$$

Because this economy is open and both owns foreign assets ($R$) and owes liabilities to foreigners ($F$), gross national product (GNP), which we denote $\tilde{Y}$, will differ from the value of domestic production $Y$ by an amount equal to net interest payments abroad:

$$\tilde{Y} = Y - ie(F - R). \tag{7}$$

Given these budget constraints, balance-sheet relationships, and definitions, we can proceed to describe the analytical model.

## The Growth Component

Most of the modern literature on sources of growth in developing countries takes as its starting point the neoclassical production function.[8] Thus, growth of capacity depends on increases in total factor productivity, in the size of the labor force, and in the capital stock. Treating the first two of these as exogenous (albeit possibly responsive to efficiency-enhancing policies), we can formulate the expansion of capacity as a linear function of real investment:

$$dy = \alpha_0 + \alpha_1 dk, \tag{8}$$

where $y$ is real output (gross domestic product, GDP).[9] The coefficient of investment, $\alpha_1$, is the marginal product of capital, and the constant term, $\alpha_0$, captures the combined effects of increases in total factor productivity and the change in the size of the labor force. In empirical analyses of growth in developing countries, an even simpler form of equation (8) is sometimes used, in which $\alpha_0$ is set equal to zero. The result is the familiar "incremental capital output relationship" (ICOR)

[7] Capital gains from devaluation are assumed to be retained by the central bank.

[8] See, for example, Robinson (1971) and, more recently, Fischer (1987).

[9] Note that because $y_0$ is given, $dy$ is for all intents and purposes equivalent to the growth rate $dy/y_0$.

associated with, among others, Chenery and Strout (1966). The ICOR is also the key relationship in the Revised Minimum Standard Model (RMSM) used by the World Bank to calculate external financing needs for developing countries.[10] Here we will work with the less restrictive growth specification, described by equation (8), which allows for productivity changes. The marginal product of capital, however, can be taken as given for our purposes.[11]

The counterpart to equation (8) for GNP is given by

$$d\bar{y} = dy - \frac{P_{D0}[ie(dF - dR) + i(F_0 - R_0)de] - ie_0(F_0 - R_0)dP_D}{P_{D0}P_D} \tag{9}$$

$$= \alpha_0 + \alpha_1 dk - \frac{P_{D0}[ie(dF - dR) + i(F_0 - R_0)de] - ie_0(F_0 - R_0)dP_D}{P_{D0}P_D}$$

Thus, the change in real national income depends both on the change in domestic production and on the change in the real value of net interest payments abroad. If the external interest rate is held constant, the latter depends on changes in net international indebtedness and in the real value of foreign interest payments brought about by changes in the real exchange rate.

The second element in the simple growth model is the identity that relates aggregate investment to aggregate savings. In our framework, this can be written as

$$dk = s_p + \left[t - g - ie\left(\frac{F - R}{P_D}\right)\right] + e\left(\frac{dF - dR}{P_D}\right), \tag{10}$$

where $s_p$, $t$, $g$, and $ie(F - R)/P_D$ are the real values of private saving, taxes, government spending, and net foreign interest payments, respectively, measured in units of domestic goods.[12] The first term in equation (10) is, therefore, real private saving, the second is real public saving, and the third is the real current account deficit (that is, real foreign saving).

The third relationship in the model is that for private savings behavior. The simplest way of representing this relationship is to make real private saving proportional to real private disposable income:[13]

[10] See Khan, Montiel, and Haque (1986). In practice Bank programs go well beyond what is implied by the RMSM. For an extended discussion of the economics of Bank programs for adjustment and growth, see Michalopoulos (1987).

[11] From the standard neoclassical production function it follows that $\alpha_1$ would be a negative function of the previous period's stock of capital. Given that this is a one-period model, the marginal product of capital is predetermined.

[12] Lowercase letters denote real variables throughout the paper.

[13] A more realistic specification would involve the addition of the interest rate as an explanatory variable. As long as the interest rate was exogenous or a policy

$$s_p = s(y - t); \qquad 0 < s < 1. \tag{11}$$

We assume that $t$ and $g$ are exogenous in real terms and that $dF$ is exogenous in foreign-currency terms. Using equation (11), we can rewrite equation (10) as

$$dk = s(y - t) + \left[t - g - ie\left(\frac{F - R}{P_D}\right)\right] + e\left(\frac{dF - dR}{P_D}\right). \tag{10a}$$

Finally, because $y = y_0 + dy$ and $P_D = P_{D0} + dP_D$, and using the growth equation (8), we can derive the following relationship between real output growth and changes in the price level in the simple growth model:

$$dy = (1 - s\alpha_1)^{-1} \cdot \left\{\alpha_0 + \alpha_1\left[s(y_0 - t) + (t - g) + \frac{e[dF - dR - i(F - R)]}{P_{D0} + dP_D}\right]\right\}. \tag{12}$$

Since $\alpha_1 < 1$ and $0 < s < 1$, the term $(1 - s\alpha_1)^{-1}$ will be positive. This implies that if the trade balance is assumed to be in deficit—that is, $[dF - dR - i(F - R)] > 0$—an increase in $dP_D$ will *reduce* $dy$, given $dR$. The economic reason for this inverse relationship is that, since the supply of foreign savings is given in foreign-currency terms, an increase in prices ($dP_D > 0$) will result in a real exchange rate appreciation that will reduce the real value of foreign savings measured in terms of domestic goods. With reduced real savings—the other components of aggregate savings are unchanged—real investment falls, and, from equation (8), real output would decline.

Note however that, even after treating $t$, $g$, and $dF$ as exogenous, the simple growth model is underdetermined because equation (12) contains three endogenous variables ($dy$, $dR$, and $dP_D$).[14] Two additional restrictions on these three variables are necessary to close the model.

## The Monetary Component

The simple open-economy monetary model has proven to be a very useful device for analyzing balance of payments questions, and variants of this model are used to design financial programs to support the Fund's lending to its member countries (see International Monetary Fund (1977, 1987)). The basic monetary model, as described in Robi-

instrument, however, the basic conclusions reached here would not be altered significantly.

[14] Recall that $F = F_0 + dF$ and $R = R_0 + dR$.

chek (1967) and in the papers contained in Frenkel and Johnson (1976), involves three relationships.

The first relationship is the flow supply of money, as given by equation (4):

$$dM^S = e_0 dR + dD. \tag{4}$$

The second relationship defines the flow demand for money. In general this would be derived from a stock demand for money function that included as explanatory variables real income, expected inflation, expected changes in the exchange rate, and interest rates, among others. A restricted version of this model is the constant-velocity money demand specification, which in flow terms is given by[15]

$$dM^d = vPdy + vy_0 dP, \tag{13}$$

where $P$ is the aggregate price level, to be defined presently, and $v$ is the inverse of the income velocity of money.

The third key relationship in this model is the assumption of money market equilibrium, also in flow terms:

$$dM^d = dM^s. \tag{14}$$

Substituting the flow demand for money, given by equation (13), and the flow supply of money (4) into the equilibrium condition (14) and solving for the change in reserves, we have

$$edR = vPdy + vy_0 dP - dD. \tag{15}$$

Equation (15) is the fundamental equation of the monetary approach to the balance of payments (Frenkel and Johnson (1976)). In this model, given the flow demand for money, increases in the rate of domestic credit expansion will be exactly matched by a deterioration in the balance of payments.

The aggregate price level that appears in equation (15) can be expressed as a weighted average of the price of importables ($P_z$) and the price of domestic output ($P_D$). If the weight of importables is given by $\theta$, we can approximate the change in the aggregate price level as

$$dP = \theta dP_z + (1 - \theta) dP_D, \tag{16}$$

assuming that $\theta$ is constant and that $e_0 = P_{z0} = P_{D0} = 1$. Furthermore, if the law of one price holds and $P_z^* = 1$ is the (constant) foreign-currency price of importables, we also have

[15] Using a more general formulation for the demand for money would not alter the analysis appreciably as long as the function is stable with respect to the explanatory variables.

$$dP_z = P_z^* de = de. \tag{17}$$

Using equations (16) and (17) to substitute out $dP$ from equation (15), we obtain

$$dR = \nu dy + \nu y_0 \theta de + \nu y_0 (1 - \theta) dP_D + \nu \theta de dy + \nu (1 - \theta) dP_D dy - dD. \tag{18}$$

Equation (18) summarizes the monetary model. As was the case in the growth model, this model is also underdetermined. Even if $de$ and $dD$ are taken as exogenous policy variables, equation (18) contains three unknowns—$dR$, $dy$, and $dP_D$. Again, two additional restrictions among these endogenous variables are required to close this system.

## The Merged Model

With these two well-known models in hand, we can proceed to combine them into a merged model that will yield simultaneous solutions for growth, prices, and the balance of payments.

Because both the growth model and the monetary model are incomplete as they stand, they are supplemented by an additional relationship—common to both models—and an ancillary assumption specific to each of the models. The additional relationship is the balance of payments identity:

$$dR = X - Z - i(F - R) + dF, \tag{19}$$

where $X$ and $Z$ are the foreign-currency values of exports and imports, respectively.

Defining the balance of trade deficit in foreign-currency terms ($B$) as $B = Z - X$, we assume that the change in the trade balance (that is, $dB = B - B_0$) is a function of changes in the real exchange rate and income:

$$B = B_0 - a\left(\frac{de - dP_D}{P_D}\right) + bdy,$$

$$= B_0 - a(e/P_D - 1) + bdy. \tag{20}$$

In other words, the trade balance improves ($B$ falls) in foreign-currency terms when the real exchange rate depreciates ($e/P_D > 1$) and deteriorates ($B$ rises) when real output increases. Using equations (19) and (20), we can write the equation for $dR$ as

$$dR = (dF - B_0) + a(e/P_D - 1) - bdy - i(F - R). \tag{21}$$

Because $F = F_0 + dF$ and $R = R_0 + dR$, equation (21) can be rewritten as

$$dR = (dF - B_0') + a'(e/P_D - 1) - b'dy - i'(F_0 - R_0), \tag{21a}$$

where $a' = a/(1-i)$, $b' = b/(1-i)$, $i' = i/(1-i)$, and $B_0' = B_0/(1-i)$.

These equations can now be used to close the growth and monetary models. Note that capital flows in equation (21) are assumed to be exogenous. In a more realistic setting one would expect that capital flows would also be affected by the exchange rate. But if one assumes that capital flows have an autonomous component—corresponding, say, to $dF$—then the analysis will carry through even if a part of the capital flows is endogenous and responds to exchange rate changes.

Consider first the growth model. We can use equation (21) to eliminate $dR$ from the growth equation (12). The result is

$$dy = (1 - s\alpha_1 - \alpha_1 be/P_D)^{-1} \cdot \left(\alpha_0 + \alpha_1\left\{s(y_0 - t) + (t - g) + \frac{e}{P_D}[B_0 - a(e/P_D - 1)]\right\}\right). \tag{22}$$

By adding an ancillary assumption about $dP_D$, this model is able to explain $dy$. It can be seen that an increase in the private savings rate, government savings, or in the exogenous component of the current account deficit would increase real output growth, in each case by increasing aggregate saving and, therefore, investment.[16] The effect of a devaluation is, however, ambiguous. Evaluated at $dy_0 = 0$, it is given by

$$\frac{\delta(dy)}{\delta(de)} = \alpha_1 \eta/\beta, \tag{22a}$$

where

$$\eta = B_0 - a = ?$$

and

$$\beta = 1 - \alpha_1(s + b) > 0.$$

Devaluation simultaneously increases the real value of the initial level of foreign saving and, by discouraging imports and encouraging exports, reduces that level. The first effect increases real investment, whereas the second decreases it. If substitution effects dominate (that is, if the parameter $a$ is sufficiently large), the effect of devaluation on growth will be negative ($\eta < 0$) in this model.[17] This result is a property of any

[16] This relationship assumes that the factor $\alpha_1(s + b)$ is less than unity, a condition that is unlikely to be violated empirically.

[17] This is simply a slightly modified version of the familiar Marshall-Lerner condition.

open-economy Harrod-Domar model in which devaluation improves the trade balance. In essence, a real devaluation causes private agents to accumulate assets other than domestic capital, thereby reducing the growth rate of domestic output.

Equations (12) and (21) can be used, together with an assumption about prices, to apply the growth model in a "policy mode." Given a target value for the balance of payments, say $dR^*$, equations (12) and (21) can be solved simultaneously to determine the output growth rate ($dy$) associated with each level of external financing ($dF$). The World Bank's RMSM model is usually applied in this way to calculate the foreign exchange and financing gaps.

Combining the balance of payments equation (21a) with reserve change equation (18), and assuming that the change in real output is exogenous ($dy = \overline{dy}$) the monetary model can be solved for $dR$ and $dP_D$. The result is a variant of the solution obtained in the well-known Polak (1957) model.[18] The model's implicit solution for the change in the price of domestic output can be determined from

$$dP_D - \frac{[dF - B_0' - i'(F_0 - R_0) + dD] - (b' + \nu)\overline{dy} - \nu y_0 \theta de - \nu \theta de\overline{dy} + a'(e/P_* - 1)}{\nu(1 - \theta)(y_0 + \overline{dy})} = 0. \quad (23)$$

It can be shown that the domestic price level increases with an increase in the flow of bank credit and decreases with an increase in output. The decrease follows from flow money market equilibrium. A one-unit increase in $dy$ produces an incipient flow excess demand for money, since it both increases demand (by $\nu$) and (through an increase in net imports of $b'$) reduces the supply of money. Equilibrium requires a reduction in the price of domestic output, which creates a flow excess supply of money both by reducing money demand (by $\nu(1 - \theta)y_0$) and by increasing money supply (by the amount $a'$) through an improved trade balance. The effect of a devaluation on the price level is ambiguous. If initial balance of payments equilibrium is assumed and if $dy$ is for simplicity set equal to zero, a devaluation will at the same time raise the flow supply of money by improving the trade balance and also the flow nominal demand for money by increasing the domestic-currency price of importables, and thus the aggregate price level. The net result on the flow excess supply, and therefore on $dP_D$, will depend on the sign of the expression $(a' - \nu y_0 \theta)$.

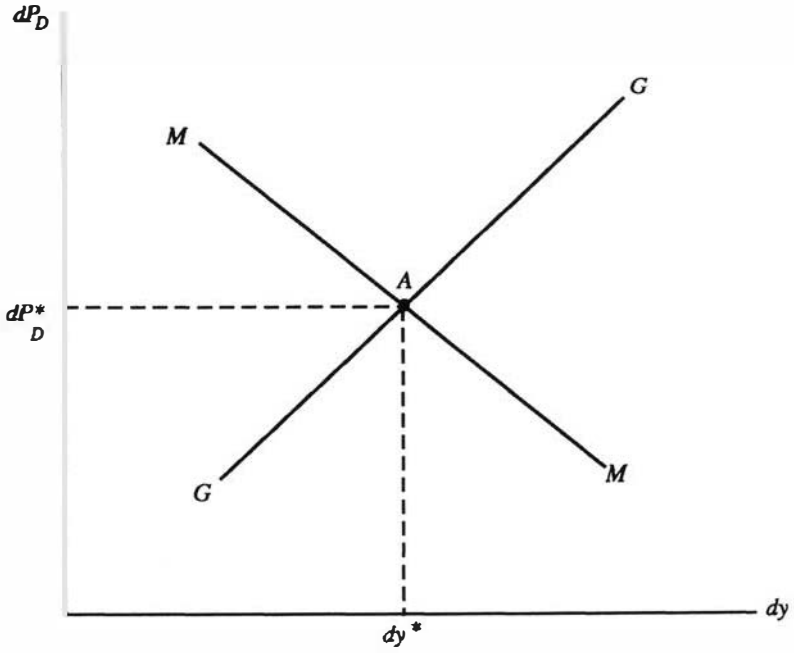
[18] In the Polak model the endogenous variables are the balance of payments and nominal output. With real output assumed to be exogenous, the Polak model then determines the change in reserves and prices.

The policy mode of the monetary model would be implemented by using equations (18) and (21a), as well as the assumptions about the change in real ouput ($dy$) and a balance of payments target ($dR^*$). One would then be able to solve for the domestic price level and the implied rate of domestic credit expansion.

Because the growth model assumes exogenous prices and the monetary model keeps real output exogenous, a natural alternative closure for the two models is to dispense with the ancillary assumptions made for each model (about the respective exogeneity of $dP_D$ and $dy$) and to combine the two models to solve for $dP_D$ and $dy$ simultaneously. This is readily done by combining equations (22) and (23), which already incorporate equations (12), (18), and (21). The resultant "merged" model is described graphically in Figure 1. Equation (22), corresponding to the growth model, traces a positively sloped locus in $dP_D - dy$ space (labeled $GG$ in Figure 1), on the assumption that substitution effects are dominant. The slope of $GG$ at the point $dy = dP_D = 0$ is

$$\left.\frac{\delta(dP_D)}{\delta(dy)}\right|_{GG} = -\beta/\alpha_1\eta > 0.$$

Figure 1. *Macroeconomic Equilibrium in the Merged Model*



Increases in the domestic price level tend to be associated with increases in output in the growth model because higher domestic prices increase the trade deficit, and the associated increase in foreign saving results in increased investment.

Equation (23), which relates to the monetary model, traces out a negatively sloped locus, labeled $MM$ in Figure 1. The slope of $MM$ at $dy = 0$ and $dP_D = 0$ is given by

$$\left.\frac{\delta(dP_D)}{\delta(dy)}\right|_{MM} = -(b' + \nu)/\gamma < 0,$$

where $\gamma = a' + \nu(1 - \theta)y_0 > 0$. In the monetary model, increases in $dP_D$ and $dy$ are negatively associated because both tend to increase the flow excess demand for money. It follows that an increase in $dP_D$ must be offset by a reduction in $dy$ to maintain flow money market equilibrium.

The intersection of the $GG$ and $MM$ loci at point $A$ in Figure 1 determines the equilibrium values of output changes $dy^*$ and domestic inflation $dP_D^*$. The model can be condensed into four equations—equations (22) and (23) as well as the GNP and balance of payments equations (9) and (21a). As summarized in Table 1, the model contains four endogenous variables—the growth of output and GNP, inflation, and the balance of payments. There are nine exogenous and predetermined variables. The five policy instruments include fiscal policy variables ($t$ and $g$), monetary policy variables ($dD$ and $dD_p$), and the exchange rate ($de$). Finally, the model contains seven parameters.

## II. Properties of the Merged Model

Even though the merged model has a fairly rudimentary structure, particularly in terms of its behavioral content, it nevertheless has some interesting properties. This section will examine the impact effects of

Table 1. *Structure of the Merged Model*

| Endogenous Variables | Exogenous and Predetermined Variables | Policy Instruments | Parameters |
|---|---|---|---|
| $dy$ | $y_0$ | $t$ | $a_0$ |
| $d\bar{y}$ | $F_0$ | $de$ | $a_1$ |
| $dP_D$ | $R_0$ | $g$ | $s$ |
| $dR$ | $P_{D0} = P_{z0} = e_0 = 1$ | $dD$ | $\nu$ |
| | $B_0$ | $dD_p$ | $\theta$ |
| | $dF$ | | $a$ |
| | $i$ | | $b$ |

changes in policy instruments (domestic credit, the exchange rate, government spending), changes in key parameters (the private savings rate, total factor productivity, velocity), and, finally, changes in capital inflows. It is worth stressing that the results obtained from the comparative-static exercises are conditional on the underlying structure of the model and are not necessarily general propositions. Nevertheless, they do yield useful insights into the relationships among growth, inflation, and the balance of payments that one would need to take into account in designing adjustment programs in which growth is an explicit objective.

## Changes in Domestic Credit

An increase in the rate of domestic credit expansion creates an excess flow supply of money. At a given level of output, this excess can only be absorbed by an increase in the price level, which induces an offsetting flow excess demand for money through two channels: first, there is an increase in demand for money through the constant-velocity relationship; second, as net imports rise there is a fall in reserves and a consequent reduction in the rate of monetary expansion. In the context of Figure 2 the $MM$ schedule shifts upward to a position such as $M'M'$. If it is assumed that the increase in the supply of domestic credit leaves the government deficit unaffected,[19] the $GG$ schedule would remain stationary. However, the real exchange rate appreciation at point $B$, by creating a current account deficit, induces an increased use of foreign saving, which increases investment. But the associated rise in output increases the demand for money, thereby reducing the increase in the price level required to restore flow equilibrium in the money market. The end result is that *both* growth and inflation rise as a consequence of the increase in the rate of domestic credit expansion; that is, we move from $A$ to $C$ in Figure 2.

Formally, the increase in the rate of inflation is given by

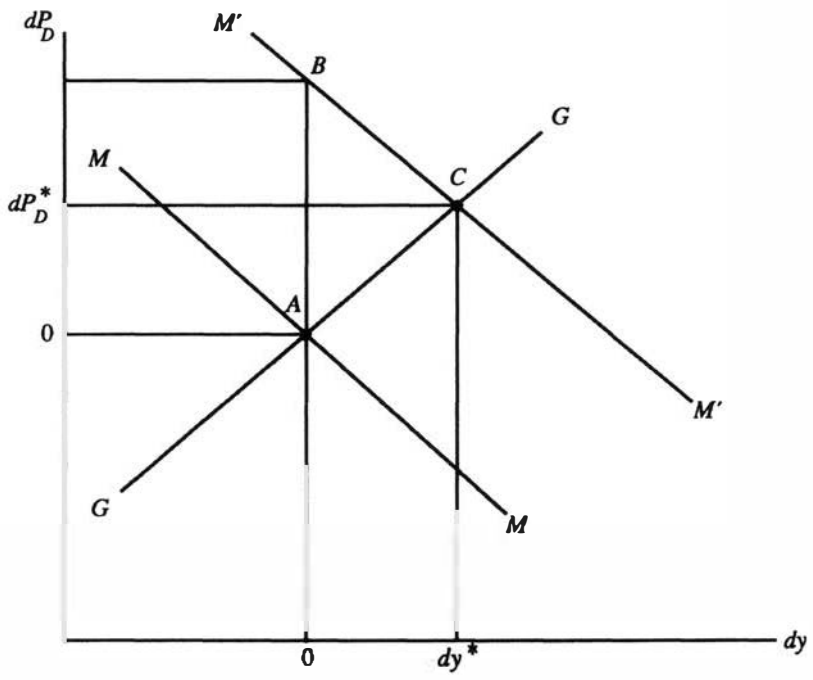
$$\frac{\delta(dP_D)}{\delta(dD)} = (\Omega\gamma)^{-1} > 0, \tag{24}$$

where

$$\Omega = 1 - \frac{\alpha_1\eta(b' + \nu)}{\beta\gamma} > 0$$

[19] All the increase in domestic credit therefore goes to the private sector.

Figure 2. *Effects of an Increase in Domestic Credit*




and, as previously defined,

$$\beta = 1 - \alpha_1(s + b) > 0$$

$$\eta = B_0 - a.$$

The change in the growth rate is given by

$$\frac{\delta(dy)}{\delta(dD)} = -\eta \frac{\alpha_1}{\beta}(\Omega\gamma)^{-1} > 0. \tag{25}$$

To solve for the change in the balance of payments, notice from equation (21a) that

$$\frac{\delta(dR)}{\delta(dD)} = -a' \frac{\delta(dP_D)}{\delta(dD)} - b' \frac{\delta(dy)}{\delta(dD)}$$

$$= \left(b' \frac{\alpha_1}{\beta} \eta - a'\right)(\Omega\gamma)^{-1} < 0. \tag{26}$$

As is well known, in the monetary model of the balance of payments a credit expansion must cause the balance of payments to deteriorate.

Overall, the results are consistent with the standard view that an expansion in domestic credit will raise prices, increase output, and worsen the balance of payments.

## Devaluation

A devaluation has conflicting effects on the money market. Given the initial price of domestic goods, a devaluation will create a flow excess demand for money by increasing the aggregate price level as the price of imported goods rises, and a flow excess supply as the higher relative price of imports and exports discourages the former and encourages the production of the latter, thus leading to an improvement of the balance of payments.[20] The net result will depend on the share of importables in the aggregate price index ($\theta$), on the velocity of money ($v$), and on the substitutability between home and traded goods ($a$). If the degree of substitutability is high, the reduction in net imports will dominate, and an excess flow supply of money will result. If, in contrast, import prices have a large weight in the aggregate price index and the income velocity of money is low, there would be an excess flow demand for money. In Figure 3, which analyzes the effects of a devaluation, it is assumed that there is an excess flow supply of money, which is eliminated by an increase in $dP_D$, causing the $MM$ schedule to shift upward to $M'M'$. It is important to notice that the upward shift in $MM$ must be *less* than $de$. This can be verified from equation (23). If $P_D$ rises by $de$, an excess demand for money will result. Only if $dP_D < de$—and substitution effects dominate—will the implied real exchange rate depreciation generate a sufficient flow supply of money (through the trade balance) so as to restore money market equilibrium.

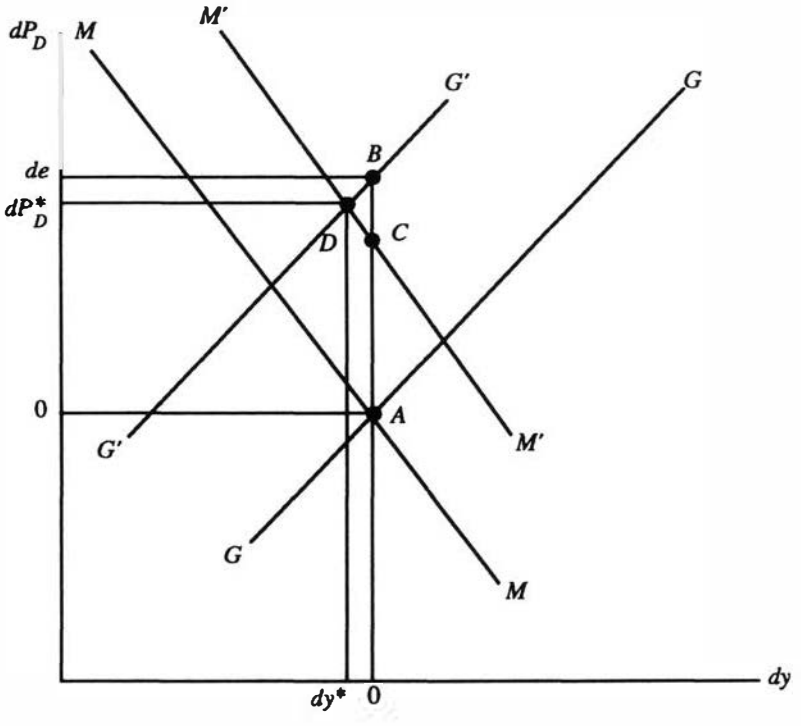
Inspection of equation (22) verifies that if the real exchange rate is unchanged by a nominal devaluation—that is, if $dP_D = de$—output growth will be unchanged. Thus, at a given $dy$, a nominal devaluation will shift $GG$ upward by $dP_D = de$, to a point such as $B$ in Figure 3.

Under these circumstances a devaluation will unambiguously increase domestic prices while reducing real output.[21] Intuitively, this is because growth can only increase if real savings increase. Since substitution ef-

[20] We assume that, in the absence of the devaluation, the balance of payments would have been in equilibrium. If not, the change in the domestic currency value of the flow of foreign exchange reserves would also exert monetary effects.

[21] The result that devaluation is stagflationary is, of course, model specific. In the more general case there is a deal of ambiguity about whether devaluation would raise or lower output on impact. See Lizondo and Montiel (1989).

Figure 3. *Effects of a Devaluation*




fects are dominant in foreign trade, this requires that domestic prices increase *more* than in proportion to the devaluation. But if this were the case, there would be a flow excess demand for money. Thus, domestic prices must rise *less* than in proportion to the devaluation (the real exchange rate must depreciate); with the improvement in the trade balance, real domestic saving, and thus investment, must decrease. In terms of Figure 3, there must be a flow excess demand for money at point *B*, since the domestic price level has risen by $dP_D = de$ and no other variables affecting the market have changed. Consequently, the new *M'M'* curve must pass below *B*. At point *C*, for example, the money market clears both because the increase in the flow demand for money is less than at *B* and because the depreciation in the real exchange rate at this point causes an improvement in the trade balance, which increases the flow supply of money. Since the upward shift in the *MM* curve is therefore smaller than that of the *GG* curve, the new equilibrium must be to the left of *AB*, implying that $dy^* < 0$.

The above assertions can be formally verified by inspecting the derivatives of $dP_D$ and $dy$ with respect to a change in the exchange rate. For the change in prices, the derivative is

$$\frac{\delta(dP_D)}{\delta(de)} = (\Omega\gamma)^{-1}[a' - \nu y_0\theta - \alpha_1\eta(b' + \nu)/\beta] > 0. \tag{27}$$

For growth, the derivative is

$$\frac{\delta(dy)}{\delta(de)} = \frac{\alpha_1\eta}{\beta}(\Omega\gamma)^{-1}\nu y_0 < 0. \tag{28}$$

Finally, the effect of devaluation on the balance of payments is given by

$$\begin{aligned}\frac{\delta(dR)}{\delta(de)} &= a' - a'\frac{\delta(dP_D)}{\delta(de)} - b'\frac{\delta(dy)}{\delta(de)} \\ &= \left(a' - b'\frac{\alpha_1}{\beta}\eta\right)(\Omega\gamma)^{-1}\nu y_0 > 0.\end{aligned} \tag{29}$$

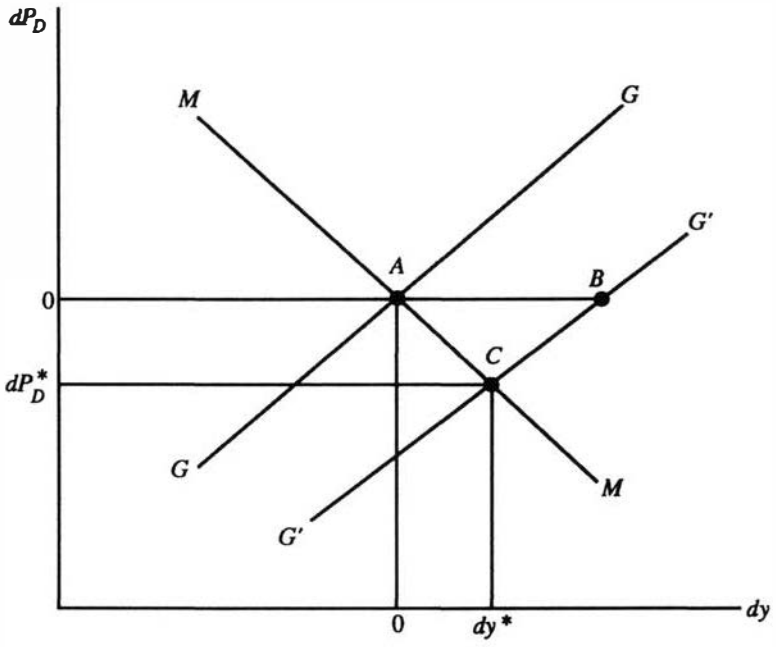
The balance of payments improves both because the real exchange depreciates and because real output falls. Because prices are fully flexible in this model, aside from a constant factor (given by $\nu y_0$) the effects of devaluation are equivalent to those of a decrease in domestic credit (equation (26)).

## Changes in Government Spending

We now consider the effects of a reduction in real government spending, with real tax revenue and total domestic credit expansion held constant. This implies a reduction in the fiscal deficit, with the supply of credit freed up by the government being rechanneled to the private sector. Because domestic saving rises as a result of the increase in public sector saving, investment and output would rise.[22] In Figure 4, therefore, the $GG$ schedule would shift to the right to $G'G'$. Because domestic credit expansion remains constant, the money market is unaffected, and the $MM$ schedule remains stationary. The increase in output puts downward pressure on domestic prices, and at the new equilibrium—at point $C$—growth is higher and inflation lower.

[22] This outcome follows from the assumption that all government spending is devoted to consumption. It is certainly possible that, if we included government investment as well, a decline in government spending could reduce output.

Figure 4. *Effects of a Reduction in Government Spending*




The precise impact effects of a change in real government spending on inflation and growth are

$$\frac{\delta(dP_D)}{\delta g} = \Omega^{-1}\alpha_1\left(\frac{b' + \nu}{\beta\gamma}\right) > 0, \tag{30}$$

so that a reduction in $g$ *decreases* $dP_D$, and

$$\frac{\delta(dy)}{\delta g} = -\Omega^{-1}\alpha_1/\beta < 0, \tag{31}$$

so that $dy$ increases when $g$ falls. Because output increases and prices fall, the effect on the balance of payments is ambiguous:

$$\frac{\delta(dR)}{\delta g} = \frac{\alpha_1}{\beta}\Omega^{-1}[b' - a'(b' + \nu)/\gamma] = ? \tag{32}$$

If substitution effects on the trade balance are strong relative to income effects ($a'$ is large relative to $b'$) and price effects are large (the value of $(b' + \nu)/\gamma$ is large), the balance of payments will improve.

A reduction of the fiscal deficit through an increase in taxes would operate in a similar manner, except that the impact effect on domestic saving would be $1 - s$ rather than unity because there is a reduction in private saving as private disposable income declines.

## Changes in the Private Savings Rate

The effects of an increase in the private savings rate in this model are quite similar to those resulting from an increase in public sector saving.[23] A rise in the private savings rate increases domestic saving, thereby creating an excess of saving over investment. As investment rises output would be increased, shifting the *GG* curve in Figure 4 to the right. As the increased investment leads to higher output, however, a further increase in private saving is induced. This multiplier effect causes the shift in the *GG* schedule to be larger than would be the case when public saving is increased. If it is assumed that the increase in private saving is matched by investment and does not go into hoarding—leaving *MM* unaffected—there will be a higher rate of growth and a lower rate of inflation.[24] The new equilibrium would be at a point such as *C* in Figure 4, but (as mentioned above) this point would lie further to the right than would be observed when government spending is reduced.

The effects of an increase in the private saving rate are given by

$$\frac{\delta(dP_D)}{\delta s} = -\Omega^{-1}\alpha_1(b' + \nu)(y_0 - t)/\beta\gamma < 0 \tag{33}$$

and

$$\frac{\delta(dy)}{\delta s} = \Omega^{-1}\alpha_1(y_0 - t)/\beta > 0. \tag{34}$$

The balance of payments outcome is ambiguous, since prices and output move in opposite directions:

$$\frac{\delta(dR)}{\delta s} = \Omega^{-1}\alpha_1\left(\frac{y_0 - t}{\beta}\right)\left[a'\,\frac{(b' + \nu)}{\gamma} - b'\right] = ? \tag{35}$$

[23] This increase in the private savings rate could be brought in various ways—for example, by an increase in interest rates or in financial development.

[24] This description ignores changes in the slope of *GG*, which are, however, captured in equations (30) and (31).

## Changes in Total Factor Productivity

Consider the effects of an improvement in total factor productivity—that is, an increase in $\alpha_0$. Because at the original level of investment a larger amount of output would be forthcoming, an incipient excess of saving over investment would ensue. This new saving would be channeled into investment, and output would rise still further. The *GG* schedule would shift rightward, as in Figure 4, and once again the *MM* schedule would be unaffected. Thus a rise in factor productivity, like an increase in saving, is in effect a positive supply shock. Again, the increase in output exerts downward pressure on prices and the economy moves from *A* to *C* in Figure 4. (We again ignore the changes in the slope of *GG*.) The price and output effects are

$$\frac{\delta(dP_D)}{\delta\alpha_0} = -\Omega^{-1}(b' + \nu)/\beta\gamma < 0 \tag{36}$$

and

$$\frac{\delta(dy)}{\delta\alpha_0} = (\Omega\beta)^{-1} > 0, \tag{37}$$

but the balance of payments effect is ambiguous:

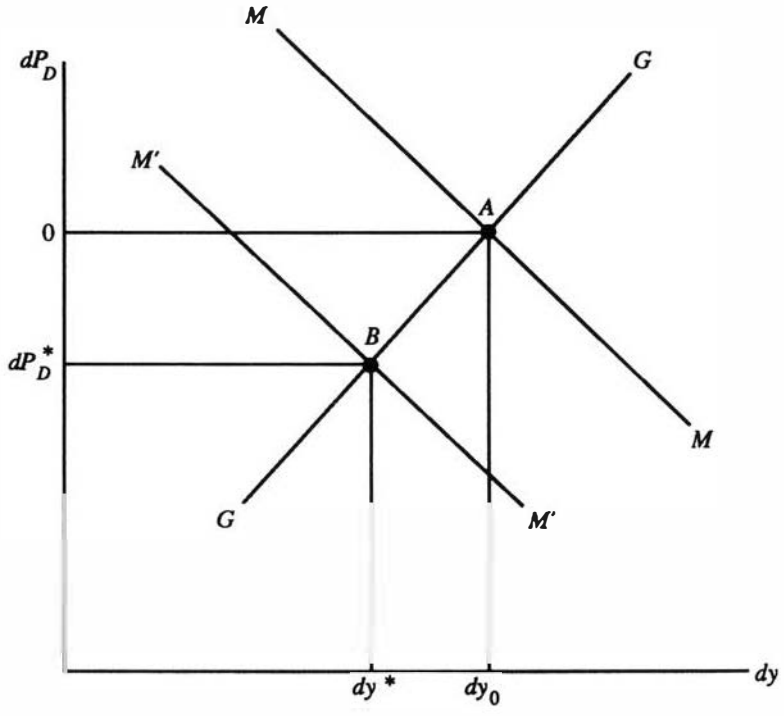
$$\frac{\delta(dR)}{\delta\alpha_0} = (\Omega\beta)^{-1}\left[a'\left(\frac{b' + \nu}{\beta}\right) - b'\right] = ? \tag{38}$$

## Changes in Velocity

Suppose there is an exogenous increase in the demand for money, in the form of a reduction in the income velocity of money, given a positive initial output growth rate $dy_0$. This increase would give rise to flow excess demand in the money market so that, at a given $dP_D$, the *MM* curve would shift to the left, say to *M'M'* in Figure 5. In other words, growth must fall to reduce the flow demand for money and to restore flow equilibrium in the money market. The *GG* curve is unaffected, and the economy moves to a new equilibrium on this curve with lower growth and reduced inflation, as at point *B* in Figure 5. The formal effects of a change in velocity on prices, output, and the balance of payments are

$$\frac{\delta(dP_D)}{\delta\nu} = -\Omega^{-1}\, dy_0/\gamma < 0 \tag{39}$$

Figure 5. *Effects of Reduced Velocity*




$$\frac{\delta(dy)}{\delta\nu} = \Omega^{-1}\alpha_1\eta dy_0/\beta\gamma < 0 \tag{40}$$

$$\frac{\delta(dR)}{\delta\nu} = -\Omega^{-1}dy_0\left(b'\frac{\alpha_1\eta}{\beta} - a'\right)/\gamma > 0. \tag{41}$$

Because domestic prices and output both fall in this case, an increase in the demand for money causes the balance of payments to improve.

## Changes in Capital Inflows

An increase in capital inflows, with the exogenous components of the current account held constant, must in the first instance be transformed into accumulation of reserves. Thus, such inflows will exert their impact on the domestic economy through the money supply—that is, they give rise to a flow excess supply of money. As long as these capital inflows go

into international reserves, the economy's use of foreign saving is unchanged. Thus, the *MM* curve in Figure 5 would shift to the right and the *GG* curve would remain stationary. Both qualitatively and quantitatively, this case is identical to that of an increase in domestic credit to the private sector (Figure 2). The reason for this equivalence is that both the increase in domestic credit and the increase in capital inflows function as money supply shocks, with the former operating through an increase in the central bank's domestic assets and the latter through an increase in its foreign assets.

A more interesting exercise is one in which a new capital inflow is matched by an increase in imports—that is, $d(dF) = dB_0^*$. Because such an inflow has no immediate monetary consequences, the *MM* curve remains stationary. The *GG* curve, in contrast, shifts to the right because the increased supply of foreign saving increases investment and thus output. The results are increased output and lower prices. The equilibrium is similar to that illustrated in Figure 4. Quantitatively, the effects on domestic prices, output, and the balance of payments are identical to those of a reduction in government spending, since both represent an infusion of savings. In this case, it is also of interest to investigate the effects on real national income (GNP). Using equation (9) and assuming initial current account balance ($dF_0 - dR_0 = 0$), we have

$$\frac{\delta(d\tilde{y})}{\delta(dF)} = \frac{\delta(dy)}{\delta(dF)} - i\left[1 - \frac{\delta(dR)}{\delta(dF)}\right] + i(F_0 - R_0)\frac{\delta(dP_D)}{\delta(dF)}. \tag{42}$$

Using equations (30)–(32), we obtain

$$\frac{\delta(d\tilde{y})}{\delta(dF)} = \alpha_1\frac{\Omega^{-1}}{\beta} - i\left\{1 - \alpha_1\frac{\Omega^{-1}}{\beta}\left[a'\frac{(b'+\nu)}{\gamma} - b'\right]\right\}$$
$$- i(F_0 - R_0)\alpha_1\frac{\Omega^{-1}}{\beta}\left(\frac{b'+\nu}{\gamma}\right). \tag{43}$$

These results can readily be given an intuitive interpretation. A one-unit capital inflow used for investment increases output on impact by $\alpha_1$ (the marginal product of capital). But, as equation (43) shows, the total effect on domestic output differs from $\alpha_1$ in this model by a factor of $(\Omega\beta)^{-1}$, which consists of two parts, corresponding to the *induced* effects on saving generated by the initial capital inflow. First, the term $\beta^{-1}$ indicates that the original inflow of saving will be magnified by the effects of positive marginal propensities to save and to import (recall that $\beta = 1 - \alpha_1(s + b) < 1$), so that a one-unit increase in saving increases *total* saving by $\beta^{-1}$, at a given $dP_D$. Second, since domestic prices fall, this will also affect real saving (this corresponds to the movement from *B* to

$C$ in Figure 4). This effect is captured by the factor $\Omega^{-1}$, which is less than unity in absolute value. Thus the increase in domestic output may exceed or fall short of the marginal product of capital $\alpha_1$.

According to equation (43), the change in national income is derived by subtracting from the change in output the change in real factor payments abroad, which is the product of the interest rate and the change in real net international indebtedness. The change in real net international indebtedness, in turn, consists of the difference between the additional capital inflow and any induced changes in foreign exchange reserves, plus the change in the real value of interest payments. The *induced* balance of payments effect of the capital inflow may be positive or negative. To clear the flow money market, the increase in output must be accompanied by a decrease in prices. These changes have conflicting effects on the balance of payments, however, with the former reducing the overall surplus and the latter increasing it. The balance of payments surplus is likely to increase the larger are substitution effects ($a'$) relative to income effects ($b'$). To the extent that the balance of payments goes into deficit, net international indebtedness will increase by *more* than the one-unit capital inflow. If a surplus results, however, net indebtedness will increase by less than one unit. Finally, because domestic prices fall, the real value of the original level of interest payments must rise. This increases the real burden of servicing the debt and thus reduces real national income, accounting for the final term in equation (43).

Equation (43) thus represents a generalization of the familiar result that a capital inflow devoted to investment will only increase national income if the marginal product of capital ($\alpha_1$) exceeds the interest rate charged on the loan ($i$). The generalization involves taking into account

Table 2. *Impact Effects of Changes in Policy Instruments, Behavioral Parameters, and Exogenous Variables*

| Change (Increase) in: | Impact Effect on: Domestic prices ($dP_D$) | Real output ($dy$) | Balance of payments ($dR$) |
|---|---|---|---|
| Domestic credit ($dD$) | $>0$ | $>0$ | $<0$ |
| Exchange rate ($de$) | $>0$ | $<0$ | $>0$ |
| Government spending ($dg$) | $>0$ | $<0$ | ? |
| Private saving rate ($ds$) | $<0$ | $>0$ | ? |
| Factor productivity ($d\alpha_0$) | $<0$ | $>0$ | ? |
| Velocity of money ($dv$) | $>0$ | $>0$ | $>0$ |
| Capital inflows ($dF$)[a] | $<0$ | $>0$ | ? |

[a] Matched by an offsetting change in imports.

induced effects on saving and on real net international indebtedness implied by the model.

### Summary of Results

To obtain an overall perspective on the properties of the merged model, the results obtained from the comparative-static experiments are summarized in Table 2. This table shows the signs of the impact effects that changes in the various policy instruments, behavioral parameters, and exogenous variables have on prices, real output, and the balance of payments.

## III. Conclusions

The objective of this paper has been to outline a simple analytical framework—combining two popular models—that could prove useful in designing growth-oriented adjustment programs. This framework allows for the treatment of economic growth as an explicit policy objective, along with the objectives of balance of payments improvement and price stability that are usually parts of an adjustment strategy. The integrated model is thus able to address many of the issues that would arise in formulating a growth-oriented adjustment program. For example, given targets for growth, the balance of payments, and inflation, the model can be used to determine a set of demand management policies (domestic credit ceilings and reductions in the fiscal deficit), exchange rate policies, structural policies (policies to increase savings and the level and efficiency of investment), and external financing policies that would achieve these targets. The model outlined in this paper can also be used to evaluate the impact effects of certain domestic and foreign shocks on the economy.

The type of framework developed here should not, however, be interpreted as a comprehensive model of growth and adjustment, or as a completely realistic representation of the behavioral and structural characteristics of a developing economy. Although the model is internally consistent and includes many of the principal policy targets and policy instruments, there are several areas where further work is both necessary and desirable in order to introduce more realism into the analysis.

First, the behavioral equations in this model are rudimentary, amounting in some cases (for example, private savings and the demand for money) to simple rules of thumb. Furthermore, the institutional framework is extremely simplified. The monetary sector of the model,

for example, does not cover demand for and supplies of different types of domestic and foreign financial assets, and more important, domestic interest rate determination. By excluding the interest rate, the model leaves out a potentially important channel through which monetary policy could affect the economy, as well as an important policy instrument to change savings and thus output. In addition, no attempt was made to formalize the interaction of the central bank, the fiscal sector, and the banking system. This is an area where further work would yield significant payoffs. Although it would obviously be desirable to incorporate behavioral and institutional relationships that are more realistic and analytically defensible, each such innovation would involve sacrifices in transparency and ease of application. The model described here does provide a first step in the direction of increased realism—by integrating capacity growth (albeit in a very simple way) into a standard monetary framework—but even this first step has been taken at some cost in terms of complexity.

Second, the model is a one-period model, and no allowance is made for lags and dynamics. This feature is particularly striking in the case of prices, which continuously adjust to clear the flow money market. The addition of short-run dynamic behavior—say, through lags in adjustment of prices to monetary disequilibrium or through slow revision of expectations of future inflation—while perhaps not changing the overall conclusions, would nonetheless yield useful information on the time path of prices. A satisfactory treatment of dynamics is necessary, since policymakers are often as concerned with the time paths of the target variables as they are with the final outcomes. The model as presently formulated does not enable one to trace the transition of the economy from one equilibrium to another. Moreover, the model has an implicit long-run dynamic structure (through the accumulation of capital as well as financial assets) that implies that present actions have future consequences. Thus, a desirable extension of the present analysis would be to exploit the longer-term dynamics arising from asset and capital accumulation to determine if the impact effects obtained here hold up in both the transition and the steady state.

Third, growth in this model is entirely determined by supply factors, and the economy is assumed to be always operating at full capacity. As such, changes in aggregate demand have no effect, even in the short run, on the rate of capacity utilization. In a properly specified macroeconomic model, one would presumably wish to make distinctions among growth in productive capacity, growth of output resulting from more efficient use of productive capacity, and growth that results from increases in aggregate demand (when there is excess capacity in the

economy). In the present full-capacity framework, one cannot treat important issues of employment and wage determination, and it is certainly possible that if one relaxed the full-employment assumption some of the results we have obtained would be altered.

Fourth, capital flows would in general respond to expectations of interest rates and exchange rates, which in turn would likely be affected by policy actions. Assuming foreign financing to be exogenous, as is done in the model here, is quite restrictive and may well lead to incorrect policy recommendations. Although there can be no argument about the appropriateness of treating capital flows as endogenous to domestic policies, it must, however, be recognized that modeling such relationships is quite difficult. As yet there have been few successful attempts to do this, reflecting both a lack of theory on what drives capital movements and an inability to properly model unobservable variables such as expectations.

In conclusion, the present model can be viewed as a first step in the development of a conceptual framework within which to design growth-oriented adjustment programs. The simplicity of the model is certainly a virtue; it is easily understood and can be readily applied with a minimal amount of information. From an operational perspective, particularly in countries where data are limited and of uneven quality, this latter feature takes on considerable importance. It would seem pointless to design complex models that cannot be applied because they have extremely demanding information requirements. Before this model is used, however, it is necessary to test the dynamic properties and the empirical relevance of the simple model. If the model passes these tests, it could serve as a foundation on which more elaborate and realistic structures, possibly along the lines mentioned above, can be built.

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# Theoretical Aspects of Growth in Developing Countries

## External Debt Dynamics and the Role of Human Capital

ICHIRO OTANI and DELANO VILLANUEVA*

*A simple aggregate growth model, capable of assessing the impact of macroeconomic policies on the long-term performance of a developing country, is formulated. The model emphasizes expenditures on the improvement of human capital and the dynamics of external debt, and it yields empirically testable hypotheses on the relative importance of various determinants of long-term growth performance. The analytical results have several implications relevant to strategies of economic growth.* [JEL 111, 121]

THE NEED for growth-oriented adjustment policies in developing countries, particularly those with structural rigidities and heavy external debt obligations, has become a focal point for discussion in government, banking, and academic circles. Such policies involve structural measures that take time to put in place and have their impact on growth with a long lag. Thus, growth-oriented adjustment policies must be formulated from a medium-term and long-term perspective.

Naturally, the formulation of appropriate structural adjustment policies with regard to both contents and priorities would have to be country specific. At the same time, it would also be useful to learn lessons and

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draw policy implications from the experiences of other developing countries. A thorough examination of these experiences would be a monumental task because they differ widely among countries and over time, are extremely complex, and involve developments at both the microeconomic and macroeconomic levels. At the macro level, an examination of the growth experiences of developing countries over the past decade and a half reveals certain interesting patterns. First, the average annual growth rate of real gross national product (GNP) per capita was nearly 5 percent for countries in the Middle East and about 4 percent for countries in Asia and Europe, whereas it was less than 2 percent for those in Africa and the Western Hemisphere. Second, over the period as a whole, investment expenditures exceeded domestic savings, and external debt grew rapidly in all the countries except certain oil-producing countries in the Middle East. Third, the nominal interest rate charged on external borrowing was high (about 10 percent a year) for countries in the Western Hemisphere and low for those in Africa (about 5 percent) and the Middle East (about 3 percent); the difference appears to be attributable in large part to the degree of country risk involved and the extent of commercial borrowing versus official development assistance. For countries in Asia and Europe, the nominal interest rate on external debt averaged around 7 percent a year. Fourth, in the developing world there appears to be a positive correlation among the level of per capita income, the rate of domestic savings, and the growth rate of exports, but a negative correlation among per capita income, external debt accumulation, and the growth rate of population. Finally, developing countries devoted, on average, about a fifth of their budgetary resources to the development of human resources.

This paper investigates the interrelations among the above macroeconomic developments in the context of the growth process of developing countries. The paper formulates an aggregative growth model that is capable of examining the effects of major macroeconomic structural policies on the long-term growth performance of an economy. This model emphasizes the critical role of expenditures on human capital and the dynamics of external debt. Key variables representing the unique characteristics of developing economies are featured. Thus, the model highlights the roles played by the private and public sectors in generating domestic savings and the fact that investment activity in many of these countries is often constrained by the availability of domestic savings.

The rest of the paper is organized into three parts. As motivation for the theoretical analysis, Section I surveys in more detail the growth performance and related developments in developing countries during 1970–85. Section II reviews neoclassical growth theory and builds on it

by specifying a model incorporating both the real and financial sectors of an open economy. Moreover, the development of human resources is highlighted and formally integrated into the model. The model's stability and equilibrium conditions are analyzed, and the dynamics of the adjustment of output growth and external debt to long-run equilibrium are discussed. Comparative dynamic exercises are then performed to determine the direction of responses of the equilibrium capital-labor ratio, the proportion of external debt to the stock of capital, and the growth rate of per capita income to changes in domestic policies and in the external environment. The final section draws some implications for the design of growth-oriented adjustment policies and outlines directions for further research. Mathematical derivations are presented in Appendix I; country groups, data sources, and definitions of variables are given in Appendix II.

## I. Growth Performance and Related Developments, 1970–85

The purpose of this section is to motivate the theoretical analysis by highlighting growth performance and related developments in developing countries over the past fifteen years. Table 1 summarizes, for different regions and income groups, the means and standard deviations for various growth and related indicators. Data for each group are based on individual countries' annual averages for the period 1970–85.

The average annual growth rate of per capita output ranged from nearly 5 percent in the Middle Eastern region to about 4 percent in Asia and Europe and to less than 2 percent in Africa. The high rate of per capita ouput growth in the Middle Eastern countries reflected a rapid expansion in oil production in the 1970s and the boom in investment activity that followed the two episodes of sharp increases in oil prices. In stark contrast, African countries suffered severe stagnation, aggravated by the oil shocks and external debt problems. The countries in the high-income group achieved an average annual growth rate of 4.0 percent, whereas those in the low-income group grew by only 1.4 percent.[1]

The above variations in per capita growth rates among countries in different regions and with different income levels have several intuitive

[1] High-income group: countries with average per capita nominal GNP of US$1,100 or above; middle-income group: countries with average per capita nominal GNP of more than US$560 but less than US$1,100; low-income group: countries with average per capita nominal GNP of US$560 or less. The selection of cutoff income levels was somewhat arbitrary; levels were chosen to achieve some balance in the number of sample countries in each group so that meaningful averages could be computed.

Table 1. *Long-Term Growth and Related Indicators for Selected Developing Countries, 1970–85*

| Indicator | Entire Sample | Region | | | | | Income Group | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Africa | Asia | Europe | Middle East | Western Hemisphere | High income | Middle income | Low income |
| Growth rate of per capita real income (annual average) | 2.7 (3.1) | 1.4 (3.3) | 3.7 (2.4) | 4.1 (1.9) | 4.6 (3.3) | 1.7 (3.1) | 4.0 (3.1) | 2.0 (3.3) | 1.4 (2.2) |
| Domestic savings ratio (percent of GNP) | 19.2 (9.2) | 18.2 (9.8) | 18.4 (5.4) | 22.8 (5.8) | 31.1 (15.1) | 15.2 (5.8) | 23.4 (11.0) | 16.0 (5.2) | 16.3 (7.1) |
| Gross capital formation (percent of GNP) | 21.9 (5.9) | 21.9 (7.6) | 22.7 (6.8) | 25.2 (4.7) | 22.8 (5.3) | 19.8 (4.2) | 24.6 (6.7) | 19.5 (5.0) | 20.1 (4.0) |
| External current balance (percent of GNP) | −2.6 (8.0) | −3.7 (4.9) | −4.3 (2.8) | −2.4 (4.2) | 8.3 (19.4) | −4.5 (3.9) | −1.3 (11.6) | −3.5 (2.8) | −3.7 (4.2) |
| Total government revenue (percent of GNP) | 25.5 (16.9) | 24.2 (8.3) | 19.3 (5.8) | 24.7 (9.5) | 57.4 (28.3) | 20.0 (12.5) | 32.9 (22.7) | 19.9 (9.4) | 20.3 (6.5) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Budgetary share of expenditure on human capital (percent of current revenue) | 16.4 (8.4) | 16.6 (6.1) | 13.8 (7.3) | 13.3 (4.9) | 9.3 (4.5) | 21.4 (10.0) | 14.5 (8.2) | 21.1 (9.3) | 14.8 (6.7) |
| Growth rate of export volume (annual average) | 7.1 (5.3) | 5.1 (5.4) | 9.9 (4.0) | 7.1 (3.1) | 10.6 (4.3) | 5.6 (6.0) | 8.1 (4.8) | 6.4 (6.4) | 6.5 (5.0) |
| Ratio of external debt to GNP | 17.4 (13.2) | 23.1 (13.0) | 15.0 (9.9) | 8.6 (3.9) | 20.7 (19.6) | 16.8 (13.8) | 10.8 (12.2) | 18.7 (11.7) | 25.2 (11.6) |
| Ratio of external debt to exports | 77.8 (74.8) | 83.5 (59.6) | 102.2 (121.2) | 52.8 (72.3) | 74.2 (61.2) | 66.8 (48.2) | 35.0 (32.6) | 85.9 (56.3) | 128.4 (96.1) |
| Nominal interest rate on external debt | 7.0 (3.8) | 4.7 (1.9) | 6.9 (3.6) | 7.5 (4.4) | 2.9 (2.6) | 9.8 (3.0) | 8.8 (4.1) | 6.2 (2.8) | 5.1 (3.1) |
| Real interest rate on external debt[a] | −3.5 (7.6) | −6.7 (5.4) | −1.8 (5.5) | 1.6 (3.9) | −13.6 (12.7) | −0.7 (5.4) | −2.6 (10.3) | −4.8 (5.4) | −3.7 (4.6) |
| Population growth rate (annual average) | 2.4 (1.0) | 2.9 (0.6) | 2.3 (0.6) | 1.0 (0.6) | 3.6 (1.4) | 2.3 (0.9) | 2.0 (1.3) | 2.7 (0.6) | 2.7 (0.5) |

Sources: See Appendix II.
Note: All values are means; figures in parentheses are standard deviations.
[a]The nominal interest rate adjusted for changes in export prices.

explanations. Besides sociological, cultural, and political factors, some basic economic parameters that may account for disparities in growth patterns might include: rates of financial resource mobilization and efficient use of physical and human capital, rates of growth of exports and of efficient import substitution, and other parameters surrounding the external environment (the terms of trade, interest rates, industrial country growth rates, and levels of protectionism). What follows is a brief quantitative description of several of these parameters.

The highest domestic savings ratio, 31 percent, was recorded by the Middle Eastern region and reflects the high savings ratio of oil-producing countries. The lowest rate, 18 percent, was observed in African countries, most of which were also in the low-income group. Thus, the data appear to provide considerable credence to the "vicious circle" hypothesis of poverty expounded by Nurkse (1953) and others. In other words, most of these countries were too poor to save sufficiently, resulting in low rates of investment with adverse impacts on the growth of real output and the level of per capita income.

The proportion of budgetary resources devoted to expenditures on human capital (through the provision of educational services and related infrastructure) ranged from about 21 percent in the Western Hemisphere to about 9 percent in the Middle East. The high proportion observed in the Western Hemisphere appears to reflect the region's emphasis on education, whereas the low proportion in the Middle East reflected the region's development strategy to improve the physical infrastructure of the economy. Governments in Africa and Asia, on average, devoted about one sixth of total revenue to improving human capital. Governments in the middle-income group spent about one fifth of revenue on human capital, whereas those in the high- and low-income groups allocated about one seventh.

The export performance varied across regions and income groups. The annual average growth of exports in real terms ranged from about 10 to 11 percent in Asia and the Middle East to only 5 percent in Africa. By income group, the variation in the export performance was rather small, with the annual growth rate between 6 and 8 percent.

The nominal interest rate on long-term external debt varied significantly across the regions. The highest rate was charged to countries in the Western Hemisphere, reflecting both high country risks and a large share of commercial borrowing in the total. The lowest interest rate, accorded to African countries, reflected the dominance of concessional loans. The real interest rate (the nominal rate less changes in export prices) was negative in all the regions except Europe; however, the real rate varied substantially across regions, reflecting large differences in

both nominal interest rates and changes in export prices. The variations in the real interest rate by income group were relatively small.

## II. The Model

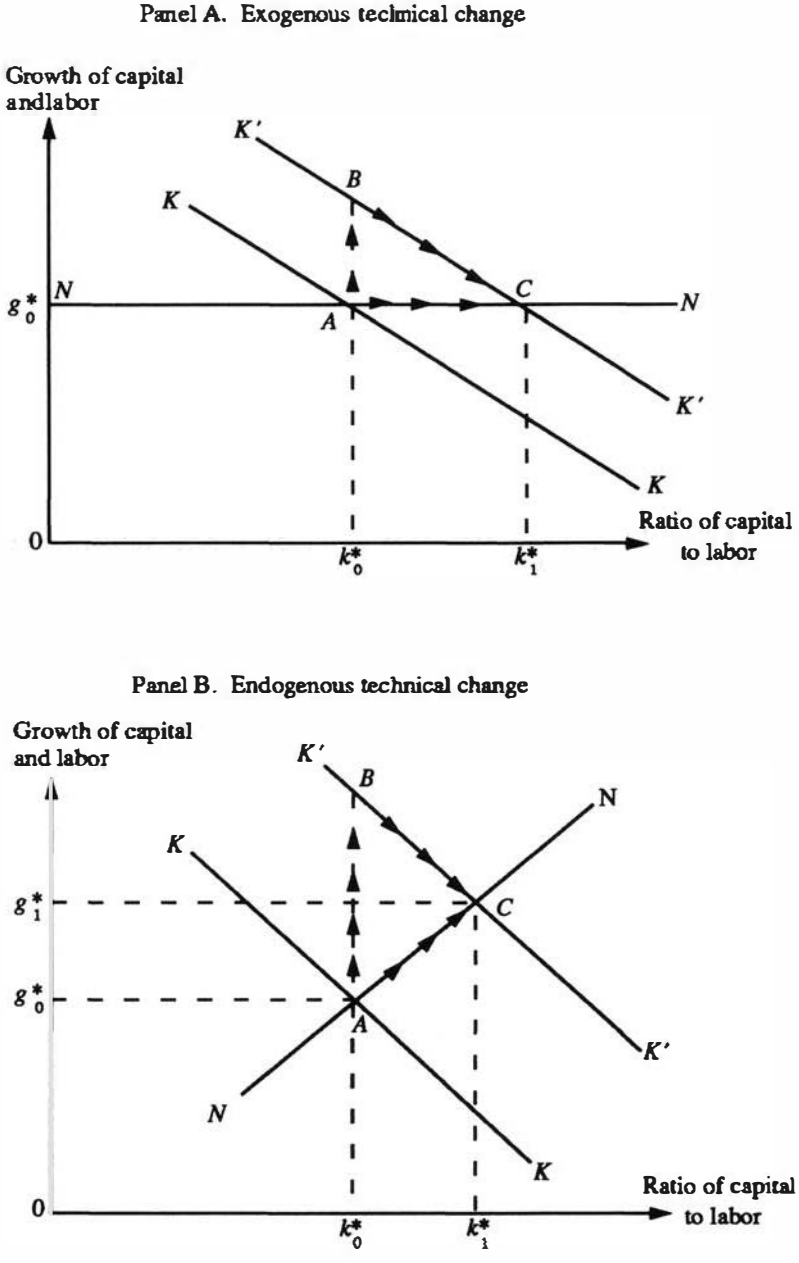
The macroeconomic landscape described above raises several questions of interest to policymakers. Are there well-defined causal relationships among macro developments? What factors can account for the different growth patterns experienced by different groups? What can be said about the process of accumulating physical capital and external debt? What role does human capital play in economic growth? Answers to these questions are by no means simple, but certainly an attempt to answer any of them would require a coherent analytical framework, which is explored in the next section.

### The Basic Neoclassical Growth Model

Neoclassical growth theory attaches considerable importance to domestic savings and exports in explaining the process of capital accumulation. Typically, a higher capital intensity is associated with a higher rate of domestic savings. Higher domestic savings can be achieved, for example, by strengthening the government's financial position and by mobilizing the private sector's financial resources.[2] The importance of export performance has also been highlighted in the literature, for several reasons. First, the export sector serves as a vehicle for technology transfer through the importation of capital goods, as elucidated by Bardhan and Lewis (1970), Chen (1979), and Khang (1987), among others. Second, by raising the capacity to service external debt, and thus by improving creditworthiness, the expansion of the export sector induces higher flows of foreign credits that make an even higher rate of investment obtainable. In addition, the transfer of efficient foreign technologies and the availability of foreign exchange have featured prominently in recent experiences of economic development. Third, countries with superior export performance in general show superior growth performance, as documented by Balassa (1978), Krueger (1978), and Bhagwati and Srinivasan (1979). As open economy extensions of the basic Solow-Swan growth model (Solow (1956) and Swan (1956)), however, the contribu-

[2] See McKinnon (1973) and Aghevli and Marquez-Ruarte (1985) for the experience of the Republic of Korea and Kopits (1987) for the Turkish experience in mobilizing domestic public and private savings.

Figure 1. *The Neoclassical Growth Model*



tions cited above yield the expected neoclassical result that, in the long run, per capita income will grow at an exogenously determined rate of labor-augmenting technical progress.

*With Exogenous Technical Change*

Most neoclassical growth models assume that labor-augmenting technical change is exogenously determined. To illustrate the workings of such models, consider panel A of Figure 1. The vertical and horizontal axes measure, respectively, the growth rates of capital and labor (in efficiency units) and the capital-labor ratio. The relationship between the rate of capital accumulation and the capital-labor ratio (the *KK* curve) is downward sloping because of the diminishing marginal productivity of capital. Labor growth (the *NN* curve) is horizontal at $g_0^*$ for all levels of the capital-labor ratio because, by assumption, it is independent of this ratio—that is, no resources are devoted to improving the quality of the labor force. Assume that the initial equilibrium is at point $A$ $(k_0^*, g_0^*)$.[3]

Now suppose that the domestic savings rate rises for some reason. The higher savings rate shifts the *KK* curve upward, to $K'K'$, and the new equilibrium is established at point $C(k_1^*, g_0^*)$, which is characterized by a higher capital-labor ratio but an unchanged growth rate of output. The dynamics of adjustment in this ratio is traced by the arrows from $A$ to $B$ to $C$. The growth rate of the capital stock (the warranted rate) initially jumps to point $B$, exceeding that of the labor force by an amount equal to $AB$. This rise in the growth of the capital stock is only temporary and cannot be sustained over time, since the labor input ultimately becomes a bottleneck in the production process. As the capital-labor ratio rises, the marginal productivity of capital declines, and firms will slow the rate of investment until the growth of the capital stock is brought down to the constant rate of growth of the labor force (the natural rate) at point $C$. The dynamic adjustment of the natural rate is traced by the movement from $A$ to $C$. Thus, in the long run, the rise in the savings rate raises capital intensity but leaves the growth rate of per capita output unaffected, the latter being fixed by the exogenous rate of labor-augmenting technical change.[4]

[3]Typically, $g_0^* = n + \lambda$, where $n$ is the rate of population growth and $\lambda$ is the exogenous rate of labor-augmenting technical progress.

[4]The *level* of output per unit of labor is higher, however, as a result of the increase in capital intensity. This is Solow's (1956) conclusion that changes in savings rates are level, *not* growth, effects.

*With Endogenous Technical Change*

In the real world, technological progress can be capital- and labor-augmenting. The latter typically requires resources to be channeled into education, training, and health services. The labor input, in efficiency units, can grow as the amount of resources spent on human resource development increases. The improvement of human capital, particularly through education, was highlighted in the 1960s by Denison (1962), Lewis (1962), and Schultz (1962), among others. Conlisk (1967) formally integrated the endogenous development of human resources by making the rate of labor-augmenting technical change depend on per capita income. More recent contributions by Romer (1986), Lucas (1988), Becker and Murphy (1988), and Grossman and Helpman (1988) have also highlighted the rate of human capital accumulation as a source of economic growth.

The workings of the modified model are illustrated in panel B of Figure 1. As before, the *KK* curve slopes downward. But now the *NN* curve, rather than a horizontal line, is drawn as an increasing function of the capital-labor ratio because society devotes a positive fraction of its per capita income to improving the quality of labor. The proportion itself may be an increasing function of the ratio of capital to labor—on the reasonable assumption that, as labor's productivity increases with a rise in capital intensity, the economy will devote a larger share of output to augment the effective labor force. As before, the rise in the domestic savings rate shifts the *KK* curve upward, intersecting the *NN* curve at point *C*. But, unlike before, the new equilibrium is characterized by a higher growth rate of output (with the growth rate increasing from $g_0^*$ to $g_1^*$).

The dynamic adjustment of the warranted rate is traced by the movement from *A* to *C* through *B*. As before, the higher savings rate will initially result in a higher capital-labor ratio, but the natural rate rises instead of remaining constant as in the standard model described in the preceding subsection. The dynamic adjustment of the natural rate is traced by the movement from *A* to *C*. An increase in the natural rate is the consequence of two factors. First, when the domestic savings rate is raised, the resulting increase in the rate of investment and, hence, in the level of capital intensity will lead to an increase in per capita output. Given that a portion of this increase in per capita output is devoted to the development of human resources, the rate of growth of the effective labor force increases. Second, an improvement in labor productivity, induced by a higher capital-labor ratio, provides an incentive to raise the share of resources spent on human capital. When the growth of the capital stock falls after an increase in the capital-labor ratio, the growth

of the labor input rises. After adjustments are completed, the warranted and natural rates converge at a point such as *C*. Therefore, in the model with endogenous technical change, both the capital intensity and the long-run growth of per capita output increase when the domestic savings rate is raised.

The present analysis endogenizes the long-run growth rate of per capita income by assuming that the rate of labor-augmenting technical change depends on expenditures on human capital. As the growth rate rises, financial resources necessary for such expenditures would become more readily available, reflecting increases in per capita income and in the tax base. In time, the contribution of the private corporate sector also increases as it sets up its own vocational training programs.[5]

## Model Specification

The economy to be modeled consists of four sectors: corporate, household, government, and banking. In broad terms, production of a composite noncapital good is carried out by the corporate sector, using an imported capital good and labor.[6] State enterprises are included in this sector. Receipts from the sale of output are used to pay wages to the household sector in exchange for labor services and rents to the corporate sector for capital services; in addition, part of output is used to service external debt. The corporate sector also pays income taxes and transfers dividends to the government, saving the remaining resources for investment purposes. Because investment requirements are typically larger than corporate savings, this sector relies heavily on domestic bank loans and foreign borrowing to finance imports of capital goods.

The household sector uses part of its income to pay taxes to the government, buys goods and services, and saves the remainder. Unlike the government and corporate sectors, whose entire savings are invested in physical capital, the household sector holds its savings in the form of domestic money balances because it is assumed to have no direct access to the international financial market.[7]

[5]For example, in many newly industrialized countries such as Korea and Singapore, some large firms began to establish their own training institutions to train their employees as the general level of income rose.

[6]This is a simplification of reality: most developing countries need to import capital goods because the availability of such goods in the domestic economy is extremely limited.

[7]It is also assumed that there are no domestic bond markets, although the presence of an unofficial money market may be allowed. This issue is discussed later in the paper.

The government sector collects taxes from the corporate and household sectors and receives dividends from state enterprises and other nontax revenues. After serving its external obligations, the government allocates part of the remaining resources to expenditures on human capital, such as education and health services, and other current expenditures and saves the remaining portion. Government savings, supplemented by borrowing from the domestic banking system and from sources abroad, are utilized to build infrastructure, which is used by the corporate sector in the production process. As payment for such use, taxes and dividends are remitted by the corporate sector.

The banking sector plays an intermediary role between the household and foreign sectors, on the one hand, and the government and the corporate sectors, on the other. Banks receive deposits from the household sector, borrow from abroad, and advance these funds to the government and corporate sectors for the importation of capital goods.

A more formal presentation of this economy is as follows. The economy produces a composite noncapital good ($Q$), using an imported capital good ($K$) and labor ($N$). Foreign technology is embodied in $K$.[8] The economy produces output according to a neoclassical production function ($F$) with the usual properties—that is, the function is linearly homogeneous and twice continuously differentiable, with positive but diminishing marginal products:

$$Q = F(K, N); \qquad F_K, F_N > 0, F_{KK}, F_{NN} < 0. \tag{1}$$

In the labor market, the demand for labor is assumed to be always met by the supply at a given level of real wages. Nominal wage adjustments are institutionally determined, and real wages are assumed to be equal to the marginal product of labor. Similarly, real returns on capital are assumed to be determined according to the marginal product of capital. These flexible real returns on capital and real wages clear the commodity and labor markets.[9]

The purchase of $K$ is financed by domestic savings and foreign borrow-

[8]The feasibility of defining an aggregate capital stock even though capital goods are heterogeneous according to their vintages has been shown by Fisher (1965) for twice-differentiable production functions that are subject to constant returns to scale. Part of $K$ is imported by the private sector and the remainder by the government, as discussed above.

[9]These assumptions imply that variations in the price ($P$) of domestic output reflect the difference between nominal wage adjustments and changes in the marginal productivity of labor. The assumption of continuous market clearing assumes away short-term problems of relative price dynamics; our interest, however, is in the time path of the economy, the endogeneity of real output, and the long-term macroeconomic effects of government policies.

ing. Thus, real national income or real GNP ($Y$) is equal to ouput ($Q$) less the real value of interest payments on external debt ($reD^{f*}/P$):

$$Y = Q - reD^{f*}/P, \tag{2}$$

where $r$ is the average cost of net foreign credits (weighted by the various components of $D^{f*}$); $e$ is exchange rate expressed in local currency per unit of foreign currency; and $D^{f*}$ is the stock of net external liabilities (external debt minus claims on foreigners, including official international reserves), expressed in foreign currency.

The increase in $K$ is equal to gross investment ($I$) less depreciation, which is assumed to be a proportion ($\delta$) of the capital stock ($K$):

$$dK/dt = I - \delta K, \tag{3}$$

where $d/dt$ is a differential operator with respect to time. Gross investment ($I$) in real terms is financed by the real values of corporate savings $[(P/eP^*)S_c]$, government savings $[(P/eP^*)S_g]$, flows of domestic bank credit $[(P/eP^*)(dD/dt)/P]$, foreign borrowing by the corporate sector $[(dD^{fc*}/dt)/P^*]$, and foreign borrowing by the government sector $[(dD^{fg*}/dt)/P^*]$:

$$I = (P/eP^*)[S_c+S_g+(dD/dt)/P] + (dD^{fc*}/dt)/P^* + (dD^{fg*}/dt)/P^*, \tag{4}$$

where $P^*$ is the exogenously given price of the investment good in foreign currency; $S_c$ and $S_g$ are corporate and government savings, respectively, measured in real terms; $D$ is the nominal stock of domestic bank loans; and $D^{fc*}$ and $D^{fg*}$ are foreign currency-denominated stocks of outstanding external debt owed by the corporate and government sectors, respectively.

If it is assumed that capital is paid its marginal product, and that a constant fraction of corporate disposable income is saved, the savings behavior of the corporate sector is given by

$$S_c = s_c[(1 - \tau_c - tr)\Pi_k Q - (reD^{fc*}/P)], \tag{5}$$

where $s_c$ is the corporate savings rate; $\tau_c$ is the corporate income tax rate; $tr$ is the rate of corporate transfers to the government from the state-owned enterprises; $\Pi_k$ is the corporate sector's share in total gross income (output); and $eD^{fc*}/P$ is the real value of corporate external debt.

Labor (household) receives income equal to its marginal product, pays income tax to the government, saves a fraction of disposable income in the form of money balances, and has no external debt. Thus, household saving ($S_n$) behavior is expressed by

$$S_n = (dM/dt)/P = s_n(1 - \tau_n)\Pi_n Q, \tag{6}$$

where $(dM/dt)/P$ is monetary savings in real terms; $s_n$ is the household savings ratio; $\tau_n$ is the personal income tax rate; and $\Pi_n$ $(= 1 - \Pi_k)$ is the labor share in total gross income. In this economy it is assumed that the household sector holds its savings exclusively in the form of bank deposits.[10] The corporate sector is assumed to invest all of its savings in physical capital, since its marginal product is assumed to be greater than the real deposit interest rate, as often is the case in developing countries. Consequently, the corporate sector does not have deposits and has to borrow from the domestic banking system, from abroad, or both.

The simplified portfolio behavior described above is an attempt to capture the notion that a crucial element in the growth process is the ability of the government to divert the savings of wage earners away from current consumption and toward money balances, which are, in turn, used by the banking system to make advances to the government and corporate sectors for the importation of the capital good. A flexible interest rate policy is an essential instrument to accomplish this important task.[11]

The level of government resources available for the purchase of capital goods[12] is defined as the gap between total revenue (from both tax and nontax sources) and expenditures on servicing external debt, on human capital, and on other current spending:

$$S_g = (1 - c_g - h_g)\{[(\tau_c + tr)\Pi_k + \tau_n \Pi_n + ntx]Q - (reD^{fg*}/P)\}, \qquad (7)$$

where $c_g$ and $h_g$ are the budgetary shares of consumption expenditure and of spending on human capital, respectively;[13] $ntx$ is the sum of nonincome tax and all nontax revenues as a proportion of gross output; and $eD^{fg*}/P$ is the real value of government external debt.

Changes in aggregate real bank credit are equal to changes in the real money stock and in the real value of net foreign liabilities of the banking system:

[10] Direct claims on firms by lending to the unofficial money market (*UMM*) may be allowed; see van Wijnbergen (1983).

[11] When *UMM* assets are allowed, the effect of an increase in the deposit interest rates on the availability of funds to finance investment (equation (4)) would depend on the degree of substitutability among currency, deposits, and *UMM* assets in the portfolio of the household sector.

[12] Excluding schools, health facilities, and other infrastructural elements that improve the productivity of labor, which are included in expenditures on human capital.

[13] These budgetary shares may be allowed to vary with changes in the capital-labor ratio. For instance, the share of expenditures on human capital may increase with the marginal productivity of labor, which is a positive function of the capital-labor ratio. Such endogenous responses would serve to reinforce the stability of the model and would not affect its main conclusions.

$$(dD/dt)/P = (dM/dt)/P + e(dD^{fh*}/dt)/P. \tag{8}$$

Equation (8) restates the balance sheet identity between assets and liabilities of the banking system in flow terms.[14]

Changes in the availability of foreign capital to the domestic bank and nonbank sectors are assumed to depend on the marginal productivity of capital $(P/eP^*)(F_K)$, net of depreciation $(\delta)$, and on the marginal cost of funds $(r)$ in the international capital market. This relationship can be expressed as follows:

$$[d(D^{f*}/P^*K)/dt]/(D^{f*}/P^*K) = (P/eP^*)F_K - \delta - r. \tag{9}$$

The marginal cost of capital is equal to the world interest rate $(r^*)$ plus a risk premium $(\phi)$, which is assumed to be a positive function of the debt-export ratio.[15] The use of exports in lieu of GNP may be appropriate in an economy whose currency is not convertible; it is exports that ultimately determine the capacity to repay external obligations:

$$r = r^* + \phi(eD^{f*}/PX). \tag{10}$$

The labor input in the production function is measured in efficiency units and is defined as a product of the working population $(L)$ and a productivity or skill-augmentation factor $(T)$:

$$N = TL. \tag{11}$$

The working population $(L)$ is assumed to grow at an exogenous rate $n$:

$$dL/dt = nL. \tag{12}$$

Increases in $T$ depend on expenditures on human capital and on other factors.[16] For the time being, such expenditures are represented by the proportion of per capita government revenue spent on education:[17]

$$dT/dt = h_g[(\tau_c + tr)\Pi_k + \tau_n\Pi_n + ntx]Q/L + \lambda T. \tag{13}$$

[14]Note that we define this identity in terms of domestic assets and domestic and foreign liabilities. Consequently, the identity differs from the customary one in which domestic liabilities equal net domestic credit and net foreign assets.

[15]Khan and Zahler (1983) also include a risk premium in the function determining capital movements.

[16]That is, any kind of expenditure by the public and private sectors that would raise the skill level of the work force (for example, education, on-job training, computers, and the like).

[17]Total public and private spending on education is the appropriate variable. In most developing countries, however, the government sector bears the primary responsibility for educational expenditures, particularly at the primary and secondary levels.

As in the models that allow for endogenous technical change, reviewed in the preceding subsection, the development of human capital plays a key role in the growth model of this paper. As already mentioned, the variable input $N$ is measured in "quality-corrected" or "technical change-augmented" units. The growth of $N$ is derived by differentiating equation (11) with respect to time and substituting into the resultant differential equation the relationships (12) and (13):

$$dN/dt = \mu_1 Q + \mu_2 N,$$

where

$$\mu_1 = h_g[(\tau_c + tr)\Pi_k + \tau_p \Pi_n + ntx]$$

$$\mu_2 = n + \lambda.$$

The term $\mu_1 Q$ may be interpreted as an endogenous growth component, since it makes $dN/dt$ depend on output $Q$. The term $\mu_2 N$ may be interpreted as an exogenous growth component, since it does not depend on $Q$. If $\mu_1 = 0$ (that is, if no resources are devoted to improving labor skills and providing health services), then $(dN/dt)/N = \mu_2$ (that is, $N$ would grow exogenously at constant rate $\mu_2$). The general expression used in the model of this paper allows for both an endogenous and an exogenous growth component in $dN/dt$. The endogenous growth component captures any endogenous labor-augmenting technical change, whereas the exogenous growth component captures any exogenous technical change ($\lambda$) and exogenous population growth ($n$).

The remaining equations are definitions:

$$k = K/N \tag{14}$$

$$q = Q/N \tag{15}$$

$$y = Y/N \tag{16}$$

$$d^f = D^{f*}/P^*K \tag{17}$$

$$D^{fg*} = \alpha(1 - \beta)D^{f*} \tag{18}$$

$$D^{fb*} = \beta D^{f*} \tag{19}$$

$$D^{fc*} = (1 - \alpha)(1 - \beta)D^{f*}. \tag{20}$$

Equations (14)–(16) express the real stock of capital, output, and income in relation to the effective labor input, whereas equation (17) defines the ratio of external debt to the stock of capital. Equations (18)–(20) are expressions for simple rules that the government follows in managing external debt; it fixes certain proportions of total net exter-

nal debt ($D^{f*}$) held by itself ($D^{fg*}$), the banking sector ($D^{fb*}$), and the corporate sector ($D^{fc*}$). The symbol β denotes the share of bank debt in the total, and α represents the share of government debt in nonbank debt.

Because the focus of the analysis is on economic growth, no attempt is made to model the inflationary process. The price of domestic output adjusts to achieve equality between the marginal products of capital and labor and their respective factor prices in real terms. This by no means implies that inflation is unimportant or that it is unaffected by real and monetary developments. Inflation—in particular, inflationary expectations—would greatly complicate growth models of the type studied in this paper if it was introduced; nevertheless, it should be incorporated in a larger and more realistic model.[18]

## Reduced Model, Equilibrium, and Stability

The model comprises 20 equations in 20 endogenous variables and time.[19] Appendix 1 shows that this system can be reduced to two differential equations in the capital-labor ratio, $k$, and the real external debt-capital ratio, $d^f$:

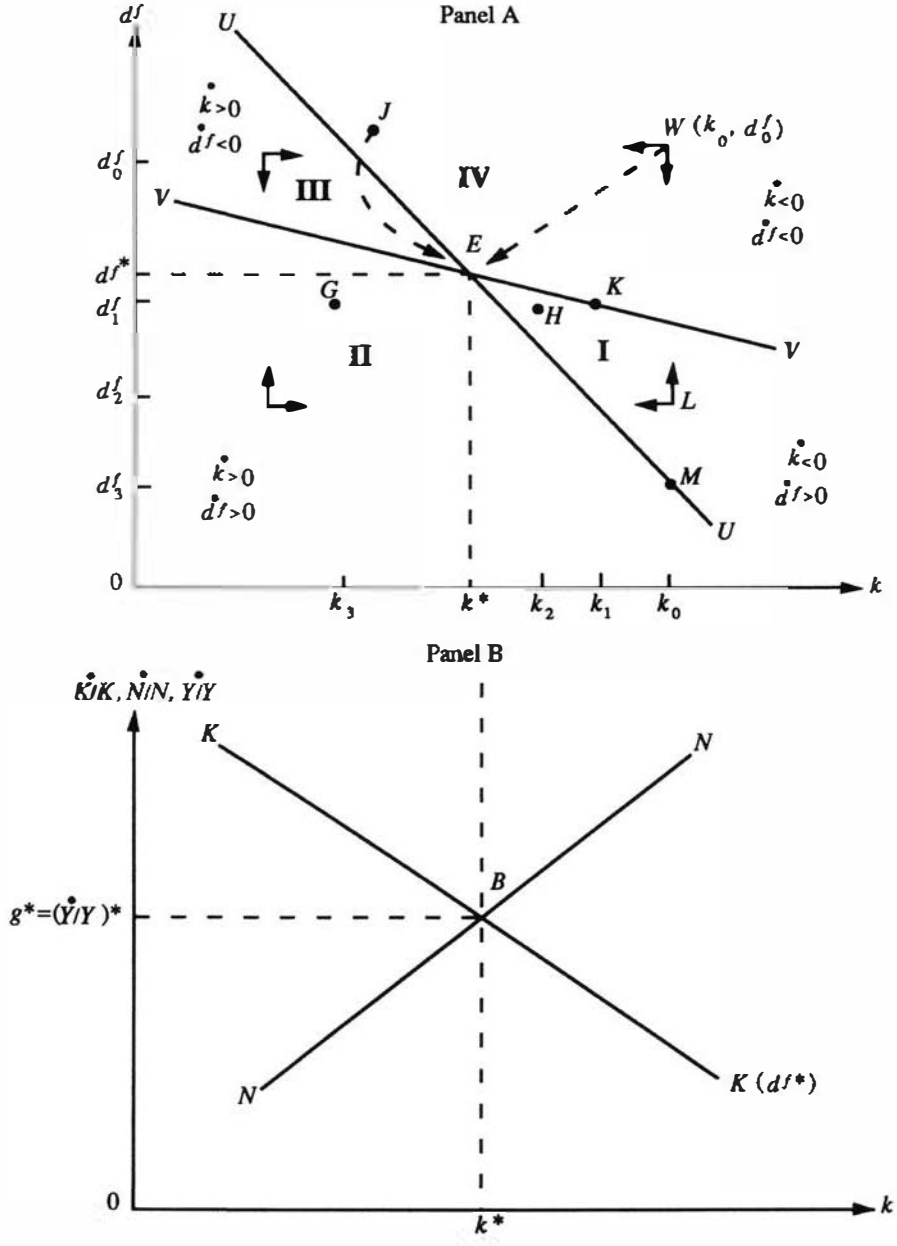
$$\begin{aligned}(dk/dt)/k &= \{(P/eP^*)s_1[f(k)/k] - s_2 red^f\}/(1 - d^f) \\ &\quad + [d^f/(1 - d^f)][(P/eP^*)f'(k) - \delta - r] - h_g s_3 f(k) \\ &\quad - \delta/(1 - d^f) - (n + \lambda) \\ &= U(k, d^f) \qquad (21)\end{aligned}$$

$$\begin{aligned}(dd^f/dt)/d^f &= (P/eP^*)f'(k) - \delta - r \\ &= V(k, d^f), \qquad (22)\end{aligned}$$

[18] For such a model with exogenous technical change and no imported capital goods, see van Wijnbergen (1983). For a simpler model that combines growth, inflation, and the balance of payments, see Khan and Montiel (1989; in this issue of *Staff Papers*). Although these growth models incorporate the inflationary process, they share the well-known property of the standard Solow-Swan model that, as Grossman and Helpman (1988, p. 1) put it, the "(endogenous) growth in per capita income dissipates in the long run. For this reason, the familiar models which incorporate investment only in capital equipment seem ill-suited for analysis of long-run growth."

[19] In this model, exports ($X$) are assumed to equal aggregate domestic savings ($S$). If one allows for only a fraction $b$ of imports $Z$ in investment goods $I$, so that $I = bZ$, the relationship becomes $X = S + [(1 - b)/b]I$. The major conclusions of the paper are unaffected by this modification.

Figure 2. *Long-Run Equilibrium*



where

$$s_1 = [s_c(1 - \tau_c - tr) + (1 - c_g - h_g)(\tau_c + tr)]\Pi_k + [s_n(1 - \tau_n) + (1 - c_g - h_g)\tau_n]\Pi_n + (1 - c_g - h_g)ntx$$

$$s_2 = [(1 - c_g - h_g)\alpha + s_c(1 - \alpha)](1 - \beta)$$

$$s_3 = (\tau_c + tr)\Pi_k + \tau_n\Pi_n + ntx$$

$$r = r^* + \phi[d^f/(X/K)(P/eP^*)].$$

Appendix I also shows that, under certain reasonable assumptions about the size and sign of some parameters, this reduced model possesses an equilibrium solution that is unique and globally stable. The phase diagram representing equations (21)–(22) is illustrated in panel A of Figure 2.

The *UU* curve gives combinations of $k$ and $d^f$ such that the rate of increase in the capital stock (the warranted rate of growth, denoted by $g_w$) is equal to the rate of increase in the effective labor force (the natural rate of growth, denoted by $g_n$). Thus, along this curve the capital-labor ratio remains unchanged (that is, $\dot{k} = 0$). The *VV* curve traces combinations of $k$ and $d^f$ such that the ratio of external debt to capital stock remains unchanged (that is, $\dot{d}^f = 0$). As a result, the proportionate growth of real external debt (denoted by $\tilde{D}^f$) is equal to the warranted rate of growth. Points along the *VV* curve include loci of sustainable external debt ratios.[20]

The *UU* curve is drawn steeper than the *VV* curve because, for a given increase in $k$, a larger decline in the external debt-capital ratio is required to bring the warranted rate in line with the natural rate of growth (that is, for $\dot{k} = 0$) compared with the requirement of a stationary external debt-capital ratio (that is, for $\dot{d}^f = 0$). Intuitively, the reasons are the following. An increase in $k$ reduces both the rate of domestic investment and the rate of foreign borrowing because of diminishing returns of "owned" and "borrowed" capital and because of the rise in the cost of capital induced by a higher risk premium that is, in turn, brought about by a decline in the output-capital ratio.

As the warranted growth rate of capital falls, however, the natural rate of growth rises because of a higher rate of labor augmentation induced by the increase in labor's average productivity. Therefore, if the economy is to remain on the *UU* curve, it is necessary for the warranted rate

[20] Such that the marginal product of capital, net of depreciation, is just equal to the cost of capital.

to increase to the level of the natural rate. For this to occur, the external debt-capital ratio must decline substantially in order to restore and raise the level of disposable income and, hence, domestic savings and to restore and raise the level of foreign borrowing through a reduction in the risk premium and, hence, in the cost of capital. For the ratio of external debt to capital to remain stationary at the new lower level, it is sufficient that the cost of capital be brought down to the lower marginal product of capital associated with a higher capital intensity. This requires a smaller decline in the external debt-capital ratio (the second effect mentioned above). An intersection of these two curves, as at point $E$ in panel A of Figure 2, means that the economy is in the steady state or in long-run equilibrium (that is, $dk/dt = 0$ and $d(d^f)/dt = 0$, with $k = k^*$ and $d^f = d^{f*}$). With a given $d^{f*}$, the warranted rate of growth schedule is positioned as the $KK(d^{f*})$ curve in panel B of Figure 2. This curve intersects the natural rate of growth schedule (the $NN$ curve) at point $B$ ($k^*$, $g^*$). Thus, at $B$, $\tilde{D}^f = g_n = g_w = \tilde{Q} = \tilde{Y} = \tilde{X}$. Real external debt grows at the same rate as effective labor, capital, output, income, and exports. The capital-labor ratio, the interest payments ratio, and the real stock of debt per unit of capital are all constant. The equilibrium values of the capital-labor ratio, the ratio of real external debt to the capital stock, and the growth rate of income are denoted by $k^*$, $d^{f*}$, and $[(dY/dt)/Y] = g^*$, respectively.[21]

Given the conditions imposed on the production function and reasonable economic assumptions about the sizes and signs of some partial derivatives (see Appendix I), a unique intersection point at $E(k^*, d^{f*}) > (0, 0)$ is established. The next question is the stability of this equilibrium. To help understand the stability issue, the disequilibrium regions I, II, III, IV shown in panel A of Figure 2 may be given the following economic interpretation.

At any point below the $VV$ curve (that is, in regions I and II), $d(df)/dt$ takes on a positive value, indicating that the ratio of external debt to capital stock tends to increase over time. To see this, consider point $K$ ($k_1$, $d_1^f$) on the $VV$ curve, so that the ratio of external debt to capital remains unchanged. Next, consider point $H$, located in region I, or point $G$, located in region II. At either point the value of $k$ is lower than at point $K$ ($k_3 < k_2 < k_1$) for the same value of $d^f$ ($= d_1^f$), with the result that the marginal product of capital is higher. At the same time, the ratio of output to capital and thus the ratio of export to capital is higher, reducing the ratio of external debt to exports and, hence, the risk premium. Both the higher marginal product of capital and the lower cost of exter-

[21] See Appendix I for the equations determining the rate of growth of income.

nal borrowing lead to an increase in external borrowing per unit of capital (that is, $\dot{d}^f > 0$). The mechanism works in the opposite direction at any point above the *VV* curve (that is, in regions III and IV).

At any point above the *UU* curve (that is, in regions I and IV), $dk/dt$ takes on a negative value. To verify this, consider point $M(k_0, d_3^f)$ on the *UU* curve. Now take either point *L*, located in region I, or point *W*, located in region IV. At either point *L* or *W*, the value of $d^f$ is higher than at point $M$ ($d_0^f > d_2^f > d_3^f$) for the same value of $k (= k_0)$. The higher ratio of external debt to capital will increase the risk premium, raising the cost of external borrowing. This in turn increases the interest payments on the external debt of the corporate and government sectors, leading to a decline in disposable income and thus in domestic savings. Both the increase in the cost of external borrowing and the decline in domestic savings result in a lower rate of capital formation, thus reducing the capital-labor ratio (that is, $dk/dt < 0$). The opposite is true at any point below the *UU* curve (that is, in regions II and III).

Given the dynamics discussed above, the arrows can be positioned as shown in the phase diagram in panel A of Figure 2. Starting from any point off *E*, the dynamics of the model are such that $k$ and $d^f$ would tend to move to $E(k^*, d^{f*})$. Therefore, the point *E* is globally stable (for a formal proof, see Appendix I).

To have a clearer idea of the dynamics of adjustment, consider the point $W(k_0, d_0^f)$ as the initial position of the economy. At *W*, $k_0 > k^*$ and $d_0^f > d^{f*}$. The external debt-capital ratio and thus the risk premium are higher than their respective equilibrium values. Consequently, the interest burden on debt is excessive, resulting in lower levels of national income and, hence, of domestic savings to finance investments. Moreover, foreign borrowing per unit of capital is discouraged by the high risk premium associated with an unsustainable debt-export ratio.[22] The warranted rate falls short of the natural rate of growth. Therefore, the rates of change in $k$ and in $d^f$ turn negative; both $k$ and $d^f$ decline toward $k^*$ and $d^{f*}$, respectively.

The steady decline in $k$ and $d^f$ is an essential element of the adjustment process, easing the interest burden on debt, releasing some domestic resources for investment, and raising the marginal and average productivity of capital (thus lowering the risk premium). As these adjustment efforts bear fruit, the debt-export ratio (or the ratio of debt to domestic savings) moves downward. In this event, the risk premium will narrow, setting the stage for the resumption of foreign borrowing. The

[22] It is possible that the debt-export ratio is so high that medium- and long-term lending, at least the commercial component, ceases altogether.

process of adjustment continues until the economy reaches equilibrium at $E$, where the debt-export ratio stabilizes at its sustainable equilibrium level, and participation in the international capital market returns to normal. The path $W-E$ illustrates one such adjustment process in which the capital intensity and the ratio of external debt to capital steadily decline toward their equilibrium level. Another possible adjustment path is traced by $J-E$, where the debt-capital ratio falls steadily toward its equilibrium value and capital intensity initially declines and then rises to its steady-state level.

## External Debt Dynamics

The dynamic aspects of external debt in the model are illustrated in Figure 3. From an initial equilibrium point such as $A(k_0^*, d_0^{f*})$, suppose that an exogenous technological development raises the marginal and average product of capital. This shifts both $UU$ and $VV$ curves upward to, say, $U'U'$ and $V'V'$, respectively. The new equilibrium is reached at point $B(k_2^*, d_1^{f*})$, where the steady-state values of both capital intensity and the ratio of external debt to capital are higher.

Relatively liberal external trading and financial systems are crucial for the economy to move from $A$ to $B$. In such a favorable environment, exports per unit of capital rise, and the risk premium and, hence, the cost of capital decline. In response to the higher marginal product of capital and the lower cost of credit, external borrowing increases—that is, $d(d^f)/dt > 0$—and external debt grows. The debt-capital ratio rises from $d_0^{f*}$ to $d_1^{f*}$. The capital-labor ratio goes up, and economic growth is stimulated.

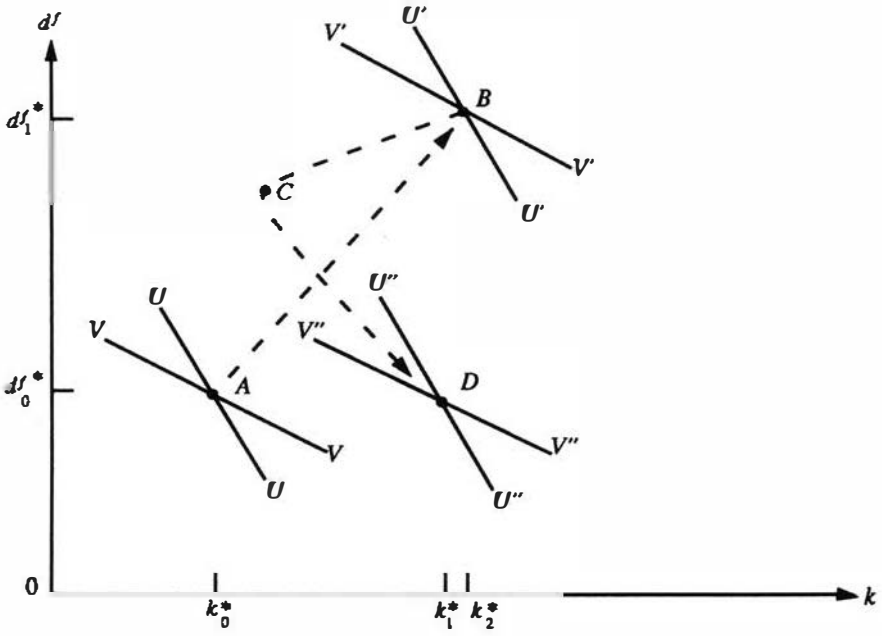
Now, suppose that a subsequent shock to the financial market shifts the $VV$ curve downward from $V'V'$ to $V''V''$.[23] Moreover, the export markets are more difficult to penetrate.[24] Because of these adverse external developments, the $U'U'$ curve also shifts downward to $U''U''$. The new equilibrium is established at point $D(k_1^*, d_0^{f*})$.

The dynamic response of the external debt-capital ratio from $d_1^{f*}$ to $d_0^{f*}$ may be described as follows. At point $B$, both the ratio of external debt to capital and the level of capital intensity are excessive and unsustainable in relation to the new equilibrium position. The high external debt ratio is reflected in a high risk premium and a correspondingly high cost of capital. Furthermore, the marginal product of capital at point $B$

[23]This was the case, for example, after the debt crisis of 1982, with the shock exacerbated by the decline in the terms of trade.

[24]Barriers might be, for instance, rising protectionism in the forms of quotas and tariffs and slow growth in industrial countries.

Figure 3. *Dynamics of External Debt*




is lower than that at point *D*. The lower marginal product of capital and the higher cost of credit discourage external borrowing. The large interest burden on debt reduces the amount of domestic resources available for investment; together with declining foreign capital inflows, the growth of the capital stock falls short of that of labor. Consequently, both the external debt ratio and capital intensity tend to fall.

The decline in both $d^f$ and $k$ is an important part of the macroeconomic adjustment to the new equilibrium at point *D*. As the interest burden eases, domestic resources are released for investment purposes. Furthermore, the rate of decline of $d^f$ slows as the marginal and average products of capital recover (thus narrowing the risk premium) with a fall in $k$. Because the cost of capital still exceeds its marginal product (net of depreciation), $d^f$ continues to fall. Meanwhile, after a point, such as *C*, the capital-labor ratio stops declining and starts rising. The reason is that the increasing share of output (net of debt service)[25] allocated to capital

[25] The higher share would be made possible by decreases in interest payments on external debt arising from the falling stock of debt and its cost.

accumulation and the incipient recovery in foreign borrowing stimulate investments. Capital intensity recovers and settles at a level ($k_1^*$) below the previous level ($k_2^*$).

The decline in capital intensity is an element in the process of rationalizing investments by the corporate and government sectors, with resulting efficiency gains. The steady decline in the ratio of external debt to capital is an integral part of adjustment to a sustainable debt-export or debt-capital ratio at $d_0^{f*}$. Economic growth slows, but this is to be expected as the economy adjusts to a permanent deterioration in the external environment.

## Comparative Dynamics

Some "comparative dynamic" exercises may now be performed to analyze the sensitivity of the dynamic equilibrium point $E(k^*, d^{f*})$ to changes in domestic policies and in the external environment. Table 2 summarizes their effects on the long-run equilibrium values of capital intensity, the ratio of external debt to capital, and per capita real economic growth.

Table 2. *Effects of Structural Parameters on Capital Intensity, Ratio of External Debt to Capital, and Per Capita Output Growth in Steady State*

| Parameter | Capital Intensity ($k^*$) | Ratio of External Debt to Capital ($d^{f*}$) | Per Capita Output Growth ($g^* - n$) |
|---|---|---|---|
| $\tau_c$ [a] | + | + | + |
| $\tau_c$ [b] | − | − | − |
| $\tau_n$ [c] | + | + | + |
| $\tau_n$ [d] | − | − | − |
| $c_g$ | − | − | − |
| $s_n$ | + | + | + |
| $s_c$ | + | + | + |
| $h_g$ | − | + | + |
| $r$ | − | − | − |
| $n$ | − | + | − |
| $\delta$ | − | − | − |
| $\lambda$ | − | + | + |

[a] If $(B/k)(1-c_g-h_g-s_c)-h_g \geq 0$.
[b] If $|(B/k)(1-c_g-h_g-s_c)| \geq 2h_g$.
[c] If $(B/k)(1-c_g-h_g-s_n)-h_g \geq 0$.
[d] If $|(B/k)(1-c_g-h_g-s_n)| \geq 2h_g$, where $B = P/(1-d^f)eP^*$.

*Tax Policies*

The long-run effects of tax policies are taken up first. Revenue measures are captured by, among others, the tax parameters $\tau_c$ (corporate) and $\tau_n$ (personal). Expenditure policies are actions on the parameters $c_g$ (share of consumption expenditures in the budget) and $h_g$ (budgetary share of expenditures on the improvement of human capital). Measures to increase revenue will shift the *UU* curve upward to the right (panel A of Figure 4) as they raise the savings rate and thus the investment rate. The *VV* curve also shifts upward as higher output and exports reduce the risk premium. The two curves intersect at point $G(k_s^*, d_s^{f*})$. The equilibrium level of capital intensity and the debt-capital ratio rise.

This result can be demonstrated by examining the relative magnitude of the shifts in the *KK* and the *NN* curves in panel B of Figure 4. In panel B the warranted rate of growth first shifts upward to the right under the combined impact of higher domestic savings and an increase in the rate of foreign borrowing, then shifts back down somewhat because of a higher level of interest payments associated with a higher stock of real external debt. The natural rate of growth shifts upward to the left, since increased tax revenues can now support a higher rate of labor augmentation. The warranted rate intersects the natural rate of growth at point $H(k_s^*, g_s^*)$—at a higher equilibrium growth rate of output, exports, and income. In panel A, the new *VV* curve will intersect the new *UU* curve at point *G*, which is associated with a higher debt-capital ratio and a higher capital intensity, making the new equilibrium stable.[26]

The positive effects of income tax increases on long-run equilibrium economic growth depend on certain conditions. For example, as shown in Appendix I for the cases of $\tau_c$ and $\tau_n$, these conditions are:

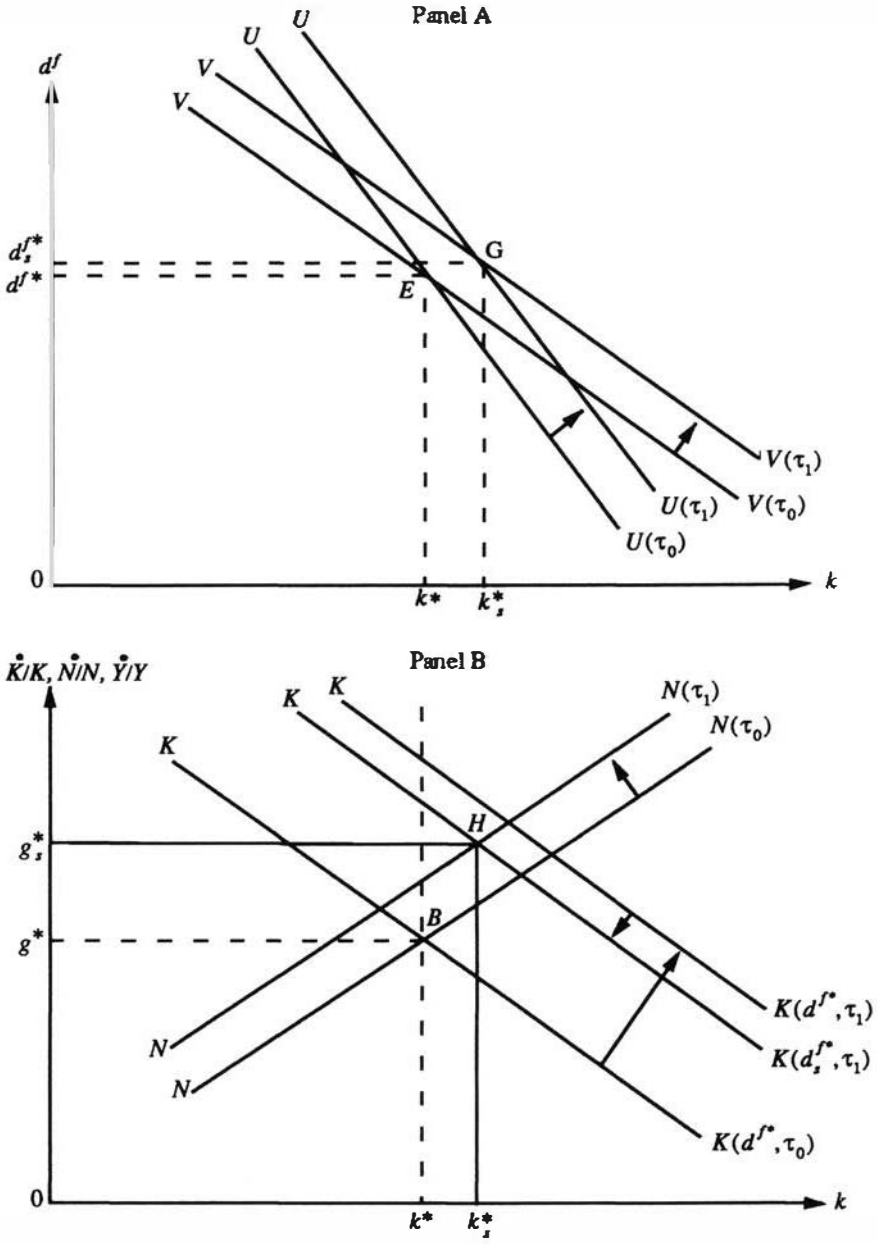
$$(B/k)(1 - c_g - h_g - s_c) - h_g \geq 0, \quad \text{and} \quad (B/k)(1 - c_g - h_g - s_n) - h_g \geq 0,$$

respectively, for $k > 0$, where $B = P/(1 - d^f)eP^*$.

If the first term on the left-hand side of these inequalities is negative, as may be the case for a number of countries, the conditions for the negative growth effects of tax measures are $|(B/k)(1 - c_g - h_g - s_c)| \geq 2h_g$ and $|(B/k)(1 - c_g - h_g - s_n)| \geq 2h_g$. An economic interpretation of these conditions is straightforward. Ignoring the term $(B/k)$, the first set of conditions states that, for income tax increases to promote economic growth, the savings rate of the government must exceed the sum of its rate of

[26]If the new *UU* and *VV* curves intersect at a point associated with a lower debt-capital ratio and a higher capital intensity, the system is unstable because a lower debt-capital ratio will decrease the risk premium and raise disposable income and domestic savings, which in turn will shift the *UU* curve further and further to the right.

Figure 4. *Effects of Income Tax Increases* ($\tau_1 > \tau_0$)




Note: It is assumed that $(B/k)(1 - c_g - h_g - s_i) - h_g \geq 0$ for $i = c, n$.

expenditures on human capital and the savings rate of the private (corporate and household) sector. The second set of conditions states that, for income tax increases to depress economic growth, the dissavings rate of the government must be at least as large as twice its rate of expenditures on human capital plus the private savings rate. Intuitively, these conditions are necessary because increases in income taxes reduce private disposable incomes and, hence, savings of the private sector, and also because government expenditures on physical and human capital both benefit from increases in tax revenues. In certain countries where government current expenditures virtually exhaust total current revenue, these conditions also underscore the importance of *combining* tax reforms with a reduction in the *budgetary share of consumption expenditures* in order to improve the chances of achieving a higher rate of economic growth.

*Consumption Spending Policies*

The effects of an increase in government consumption expenditure are unambiguously negative on equilibrium capital intensity, debt per unit of capital, and the long-run growth of output and income. In panel A of Figure 4, both the $UU$ and $VV$ curves shift downward, resulting in a lower equilibrium level of capital intensity and a lower debt-capital ratio. The reduction in the rate of foreign borrowing is the result of a higher risk premium induced by a lower level of output and exports. In panel B, the $KK$ curve for the warranted rate of growth shifts downward to the left when $c_g$ rises, then recovers somewhat when the equilibrium debt ratio falls, and finally intersects the stationary $NN$ curve at an equilibrium point below and to the left of $B$—that is, at a lower equilibrium growth rate of income corresponding to the lower capital-labor ratio.

*Expenditure Policies for Human Capital*

An increase in the budgetary share of expenditures on human capital shifts the $UU$ curve downward and leaves the $VV$ curve unaffected. The equilibrium capital intensity declines, and the equilibrium debt-capital ratio rises. In panel B of Figure 4, the $NN$ curve shifts upward. The $KK$ curve shifts downward somewhat under the impact of larger interest payments associated with a higher debt-capital ratio. The two curves intersect at a point above and to the left of $B$, with a lower equilibrium capital intensity and a higher equilibrium growth rate of income. The latter is financed by a higher flow of foreign financing of capital formation, owing to an increase in the marginal productivity of capital associated with the lower level of capital intensity, and by a higher level of domestic savings resulting from a higher output-capital ratio.

*Financial Sector Reform*

Successful financial sector reform, of which a flexible interest rate policy and a stable financial climate are integral elements, would be reflected in a higher proportion of household disposable income saved in bank accounts (that is, in a higher $s_n$). The growth in the number of banks and their branches (monetization) also tends to raise $s_n$. The long-run effects on equilibrium capital intensity, the debt-capital ratio, and the growth rate of income are thus positive.

*External Policies and Developments*

External policies and developments are captured by an exogenous shift in the world demand for exports and the cost of borrowing abroad ($r$), which in turn is determined by movements in the foreign interest rate ($r^*$) and the parameters surrounding the risk assessment factor $\phi(\cdot)$. An exogenous increase in the growth rate of export volume is analogous to an increase in the domestic savings rate and thus would raise the equilibrium levels of capital intensity, the external debt-capital ratio, and the rate of economic growth. An increase in the foreign interest rate or in the risk assessment factor will have opposite effects.

*Population Growth*

Finally, an increase in the population growth rate or in the exogenous rate of labor-augmenting technical change reduces the equilibrium capital intensity and raises both the debt-capital ratio and the equilibrium rate of economic growth. The rise in the debt ratio is caused by an improvement in the marginal productivity of capital, which encourages external borrowing. The increase in output growth brought about by an increase in population growth, however, will be less than unity because of the decline in equilibrium capital intensity. Thus, the equilibrium growth rate of per capita output falls.[27]

The above comparative dynamic results assume that the economy faces no restrictions on (at least some of) its exports. But many developing countries do experience a variety of quantitative restrictions on their exports. When restrictions are imposed on *all* exports,[28] the warranted rate of growth schedule is positioned by the given export-capital ratio.

[27]The equilibrium growth rate of per capita output is $g^* - n = h_g s_3 f(_k{}^*) + \lambda$. The effect of an increase in population growth ($n$) on per capita output growth is $\partial(g^* - n)/\partial n = h_g s_3 (\partial f/\partial_k{}^*)(\partial_k{}^*/\partial n) < 0$, since $h_g$, $s_3$, and $\partial_f/\partial_k{}^*$ are all positive and $\partial_k{}^*/\partial n$ is negative.

[28]This is an unlikely situation because restrictions are usually placed only on some types of exports of developing countries (for example, textiles) rather than on all exports.

Therefore, any changes in government consumption or in household or corporate savings rates will have no effect on the economy. An increase in the exogenously given growth rate of exports, however, will lead to a higher equilibrium level of capital intensity, the external debt ratio, and per capita economic growth. The economic effects of changes in the other structural parameters are similar to those obtained above.

## III. Concluding Remarks

The objective of this paper has been the development of an aggregate growth model that is capable of assessing the impact of major macroeconomic policies on the long-term performance of a developing country. The reduced form derived from this model helped to identify some of the key contributing factors in long-term growth performance. These factors included the domestic savings and export performance, the rate of expenditures on human capital, the cost of capital, and the rate of population growth. The analysis of the theoretical model suggests several implications that are relevant to the strategy of economic growth.

- Expenditures on human capital play a critical role in the development process. In an economy facing a secular decline in export earnings, such expenditures would become a crucial element of the growth process because they would increase labor productivity, reduce the capital-labor ratio, and raise the marginal product of capital. The higher marginal product of capital would permit a higher sustainable rate of foreign borrowing, which would increase the warranted rate of growth to a higher natural rate. The development of human capital is also essential when the external debt burden is already excessive. An improvement in the quality of labor would enhance the profit opportunities of the corporate sector and raise domestic savings and exports. This would have the salutary effect of reducing the foreign borrowing requirement to the level dictated by the improvement in the marginal productivity of capital.
- A sustained increase in the rate of aggregate domestic savings is crucial to growth-oriented adjustment efforts. The mobilization of domestic savings over the years would greatly facilitate the achievement of growth potentials in many developing countries. Obviously, there are many ways to raise domestic savings. In countries where government current expenditures virtually exhaust total revenues, it is advisable to combine tax reforms aimed to raise the revenue-income ratio with measures to reduce the budgetary share of consumption expenditures. In other countries, financial deepening through an integration of unofficial money markets may be a key to allowing households to hold their savings in financial assets.

• Where trade restrictions are present, it is essential that they be eliminated, regardless of whether they are imposed by developing countries themselves or by their trading partners. The removal of trade restrictions would certainly help to enhance the effectiveness of domestic policies aimed to increase levels of aggregate domestic savings and exports and to improve the efficiency of resource allocation. How to expand the export sector would, of course, depend on the situation in which each country is placed—for example, in certain countries adjustments may need to be made in the exchange rate and the trading systems; in other countries an improvement in monetary and fiscal incentive schemes may be required. These measures have to be complemented by market-opening policies in industrial countries and in the developing countries themselves.

• The theoretical analysis suggests that flexibility in the real returns of capital and in real wages is necessary for increased efficiency in the use of capital and labor. This means that integration of the unorganized money market into the official financial market should be pursued, and that domestic prices should be allowed to adjust to reflect changes in the prices of imported capital goods and in the cost of capital.

• A general reduction in the world market interest rate or a reduction in the risk premium would naturally reduce the cost of external borrowing and help to ease the burden of external debt. Toward this end, both the international community and the developing countries themselves have active roles to play.

Although the theoretical analysis presented in this paper has contributed to a greater understanding of the growth process in developing countries and has drawn important implications for the design of structural policies at the macroeconomic level, empirical work would be desirable to further the understanding of the issues involved. In addition, some analytical extensions would be useful. First, an endogenous treatment of inflation and inflationary expectations would shed much light on the inflationary problems that many developing countries face and on the implications for an appropriate growth strategy. Although such treatment would complicate the growth model, it would enable one to determine the inflationary effects of alternative domestic and external policies and developments. Second, the role of intermediate imports could be formally introduced in the production function, in the manner of Bardhan and Lewis (1970). This would allow a more explicit consideration of the impact of import restrictions on growth performance as well as on inflation. Extensions of these types are clearly necessary to understand fully the process of economic growth in developing countries and to identify the policy actions that governments of developing countries can take to quicken the pace of that growth.

# APPENDIX I

## Mathematical Derivations

Equations (1)–(20) in the text comprise a complete system in 20 unknowns and time; that is,

$$Q,\ Y,\ K,\ N,\ L,\ T,\ I,\ S_c,\ S_g,\ M,\ D,\ D^{f*},\ D^{fc*},\ D^{fg*},\ D^{fn*},\ q,\ y,\ k,\ d^f,\ r.$$

The relationship $X = S$, where $X$ is real exports and $S$ is real aggregate domestic saving (corporate, household, government) is implicit in the model because the excess of domestic investment over domestic saving is identical to the excess of imports over exports and because, in the model, investment is equal to imports. The price of domestic output and the rental rate of capital adjust to equate real factor prices with the relevant marginal products, which are functions of $k$.

Because of the assumption of linear homogeneity of the production function $F$, that function can be written as

$$q = f(k); \qquad f' > 0,\ f'' < 0, \tag{23}$$

where $F_K = f'$.

Differentiating equation (14) in the text with respect to time yields

$$(dk/dt)/k = (dK/dt)/K - (dN/dt)/N. \tag{24}$$

The equation for $(dK/dt)/K$ is obtained by successive substitution, into text equation (3), of text equations (4)–(10), (14), (17)–(20), and appendix equation (23). The equation for $(dN/dt)/N$ is derived by differentiating text equation (11) and substituting into it text equations (12)–(13), using appendix equation (23).

### Equilibrium

Partially differentiating text equations (21) and (22) with respect to $k$ and $d^f$ and evaluating in the neighborhood of the steady state yields

$$U_k = Bs_1(kf' - f)/k_2 - \{s_2 d^f r_k + Cd^f[f''(P/eP^*)] - r_k\} - e_g s_3 f' < 0, \tag{25}$$

since $r_k > 0$. That is, an increase in $k$ will reduce $X/K = S/K$ and thus raise the risk premium:

$$U_{df} = Cd^f V_{df} - Cs_2(r + d^f r_{df}) - C^2\delta - s_2 r d^f C^2 + BCs_1 f/k < 0, \tag{26}$$

since $r_{df} > 0$—that is, an increase in the debt-capital ratio raises the risk premium—and it is assumed, quite reasonably, that the sum (in absolute value) of the first four terms on the right-hand side of equation (26) exceeds the last term. In economic terms, a rise in the ratio of external debt to capital will reduce the rate of capital accumulation because of diminishing returns to "borrowed" capital:

$$V_k = (P/eP^*)f'' - r_k < 0 \tag{27}$$

$$V_{df} = -r_{df} < 0. \tag{28}$$

In the steady state,

$$dk/dt = U(k,\ d^f)k = 0 \tag{29}$$

and

$$d(d^f)/dt = V(k,\ d^f)d^f = 0. \tag{30}$$

The slope of the $dk/dt = 0$ curve is equal to

$$-U_k/U_{df} < 0, \tag{31}$$

and that of the $d(d^f/dt) = 0$ curve is equal to

$$-V_k/V_{df} < 0. \tag{32}$$

Equations (31) and (32) are obtained by totally differentiating equations (29) and (30) with respect to $k$ and by evaluating the slope $d(d^f)/dk$ in the neighborhood of the steady state.

It is reasonable to assume that the absolute value of the (negative) effects of a rise in capital intensity on the rate of capital accumulation exceeds that of the effects on the rate of foreign borrowing, since the former includes the reduction in domestic savings from a decline in the output-capital ratio. Thus, $|U_k| > |V_k|$. From equations (31) and (32), it remains to be shown that $|V_{df}| > |U_{df}|$ for the absolute value of (31) to be greater than that of (32). It is reasonable to assume that the absolute value of the (negative) effect of a rise in the debt-capital ratio on the rate of external borrowing is at least as great as that of the effect on the rate of investment, since the latter includes as well some positive level of domestic saving, which in part compensates for the negative impact on the rate of investment of a rise in the debt-capital ratio. Given these considerations, the slope of the $dk/dt = 0$ curve is drawn steeper than that of the $d(d^f/dt) = 0$ curve in panel A of Figure 1 of the text. Thus, there is only one intersection between the two curves, which establishes a unique equilibrium point such as $E(k^*, d^{f*})$.

## Stability

Let $A$ be the matrix of partial derivatives defined by equations (25)–(28), with $a_{11} = U_k$, $a_{12} = U_{df}$, $a_{21} = V_k$, and $a_{22} = V_{df}$. A necessary and sufficient condition for global stability is that the eigenvalues of $A$ have negative real parts, and a necessary and sufficient condition for this is

$$tr(A) < 0$$

and

$$det(A) > 0.$$

The trace condition is met, and in view of the assumptions made in the preceding paragraph, the determinant condition is also satisfied.

## Comparative Dynamics

To determine the directional effects of an increase (decrease) in any structural parameter $p$ on the equilibrium capital-labor ratio $k^*$ and on the debt-capital ratio $d^{f*}$, solve equations (29) and (30) for $k_p^*$ and $d_p^{f*}$. Using Cramer's rule,

$$k_p^* = -(a_{22}\,U_p - a_{12}\,V_p)/det(A)$$

and

$$d_p^{f*} = -(a_{11}\,V_p - a_{21}\,U_p)/det(A).$$

Once the signs of $k_p^*$ and $d_p^{f*}$ are determined, the effects on the equilibrium

growth rates of capital, labor, output, and income can be obtained from the capital and labor growth equations:

$$[(dK/dt)/K]_p^* = (\tilde{K}_k)k_p^* + (\tilde{K}_{df})d_p^{f*} + \tilde{K}_p$$

and

$$[(dN/dt)/N]_p^* = (\tilde{N}_k)k_p^* + \tilde{N}_p,$$

where $\tilde{K} = (dK/dt)/K$ and $\tilde{N} = (dN/dt)/N$.

The conditions for increases in income taxes to raise capital intensity and the rate of economic growth are derived as follows:

$$k_{\tau_n}^* = [1/det(A)](-a_{22}U_{\tau_n} - a_{12}V_{\tau_n})$$

$$d_{\tau_n}^{f*} = [1/det(A)](-a_{11}V_{\tau_n} - a_{21}U_{\tau_n}),$$

where

$$U_{\tau_n} = f\Pi_n[(B/k)(1 - c_g - h_g - s_n) - h_g]$$

$$V_{\tau_n} = -r_{\tau_n} > 0.$$

For $k_{\tau_n}^* > 0$, it is necessary that $U_{\tau_n} \geq 0$. If $U_{\tau_n} \geq 0$, then $d_{\tau_n}^{f*} > 0$.

Similarly, for increases in $\tau_c$,

$$k_{\tau_c}^* = [1/det(A)](-a_{22}U_{\tau_c} - a_{12}V_{\tau_c})$$

$$d_{\tau_c}^{f*} = [1/det(A)](-a_{11}U_{\tau_c} - a_{21}U_{\tau_c}),$$

where

$$U_{\tau_c} = f\Pi_k[(B/k)(1 - c_g - h_g - s_c) - h_g]$$

$$V_{\tau_c} = -r_{\tau_c} > 0.$$

## APPENDIX II

### Data Sources and Definitions of Variables

Countries in the country groups used in the study are identified in Table 3.

Data Sources

Statistical sources were as follows:

A International Monetary Fund, data file for *Balance of Payments Statistics* (Washington)
B International Monetary Fund, data file for *Government Financial Statistics* (Washington)
C International Monetary Fund, data file for *International Financial Statistics* (Washington)
D International Monetary Fund, *World Economic Outlook* (Washington)
E United Nations, *Statistical Yearbook* (New York)
F United Nations Educational, Scientific, and Cultural Organization (UNESCO), *Statistical Yearbook* (Paris).

In addition, various country sources and the Fund's country reports were used.

Table 3. *Country Groups*

| Group | Countries in Group |
|---|---|
| | *By region* |
| Africa | Algeria, Côte d'Ivoire, Ghana, Kenya, Liberia, Madagascar, Mauritius, Morocco, Nigeria, Senegal, Tanzania, Togo, Tunisia |
| Asia | Burma, Fiji, India, Indonesia, Rep. of Korea, Malaysia, Pakistan, Philippines, Singapore, Solomon Islands, Sri Lanka, Thailand |
| Europe | Cyprus, Greece, Malta, Portugal, Turkey, Yugoslavia |
| Middle East | Egypt, Israel, Jordan, Kuwait, Saudi Arabia, Syrian Arab Republic |
| Western Hemisphere | Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Peru, Trinidad and Tobago, Uruguay, Venezuela |
| | *By income level*[a] |
| High income | Algeria, Argentina, Barbados, Brazil, Chile, Costa Rica, Cyprus, Fiji, Greece, Israel, Jamaica, Rep. of Korea, Kuwait, Malaysia, Malta, Mexico, Portugal, Saudi Arabia, Singapore, Trinidad and Tobago, Uruguay, Venezuela, Yugoslavia |
| Middle income | Bolivia, Colombia, Ecuador, El Salvador, Ghana, Guatemala, Côte d'Ivoire, Jordan, Mauritius, Nicaragua, Nigeria, Peru, Syrian Arab Republic, Tunisia, Turkey |
| Low income | Burma, Egypt, Honduras, India, Indonesia, Kenya, Liberia, Madagascar, Morocco, Pakistan, Philippines, Senegal, Solomon Islands, Sri Lanka, Tanzania, Thailand, Togo |

[a]High-income group: countries with average per capita nominal GNP of US$1,100 or above; middle-income group: countries with average per capita nominal GNP of more than US$560 but less than US$1,100; low-income group: countries with average per capita nominal GNP of US$560 or less.

Definitions of Variables

Growth rate of real GNP was defined as in sources C and E.

Growth rate of population was used as defined in source C.

For the ratio of domestic savings to GNP, domestic savings were defined as the sum of gross capital formation (from source C) and the external current account balance (from sources A, C, and E).

For the budgetary share in total government revenue (from source B) of expenditure on human capital, such expenditure is defined as the sum of current and capital spending on education (from sources B and F).

The growth rate of the volume of exports is derived from source C.

For the ratio of external debt to exports, figures for external debt were as defined in source D, and export figures were taken from source C.

The nominal interest rate on external debt was as defined in source D.

Export prices were taken from source C.

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# Oil Wealth and Economic Behavior

## The Case of Venezuela, 1965–81

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*A short-run macroeconomic model is estimated for Venezuela to examine the hypothesis that the availability of oil resources may entail a "confidence effect"—on perceived future incomes—that influences the expenditure and portfolio behavior of economic agents. The confidence effect is found to be empirically significant. Model simulations reveal that the impact of oil price changes on the level and variability of money demand, the balance of payments, and inflation are significantly more pronounced when this effect is present, with important implications for the size and structure of the needed policy interventions.* [JEL 121, 132]

THE PURPOSE of this paper is to examine the short-run macroeconomic implications of natural resource availability—as well as its exhaustibility—in the case of Venezuela. Although considerable attention has been paid in the economic literature to the manner in which the economies of oil producers such as Venezuela are influenced by variations in the flow of income generated by oil resources, the models used in the studies have in general ignored two important distinguishing characteristics of oil-based economies. The first relates to the possible "confidence effect" that resource availability might have on the behavior of economic agents. This effect has been highlighted by the studies of the "Dutch disease"—that is, the problem of deindustrialization attributable to a booming export sector (Buiter and Purvis (1983), Cordon and Neary (1982), Eastwood and Venables (1982), Neary and van Wijnbergen (1984), and van Wijnbergen (1984)). It arises from the impact of resource availability on future expected income, which can in turn influ-

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ence saving behavior, the pattern of expenditure, and the composition of asset portfolios. The second important characteristic is the exhaustibility of oil resources. Although the economic literature is replete with studies of the implications of the exhaustibility of petroleum resources for optimal production and price strategies in petroleum-based economies, the short-run macroeconomic models of such economies have in general sidestepped the question of the depletability of the main source of income (Aghevli (1977), Aghevli and Sassanpour (1982), Khan (1976), and Knight and Mathieson (1980)). Although these models do recognize that the exhaustibility of oil has major implications from the point of view of economic management, in general they consider exhaustibility as a long-run concept with little or no consequences in the short run. The validity of such a position is questionable, however, because exhaustibility is likely to influence expectations about future income, thus inducing shifts in perceived wealth that may in turn affect private sector confidence and its behavior in the short run.

The analytical framework of this paper explicitly incorporates these key characteristics of major oil-based developing countries.[1] The analysis suggests that, in the case of Venezuela, the impact of an oil-price shock on the economy becomes considerably more pronounced once these features are taken into account. In particular, such a disturbance would lead to significantly greater variations both in the balance of payments and in domestic prices than is suggested by earlier models that ignore these features of resource-based economies. Consequently, remedial policies adopted in the face of such disturbances would need to be greater in intensity and, sometimes, longer in duration than those suggested by previous studies.

The model is applied to the Venezuelan economy over the period 1965–81. The choice of country was dictated both by data availability and by a desire to preserve the general characteristics of the model as far as possible, thus to make it applicable to other oil-producing developing countries. Venezuela seems especially suitable for this purpose because it is a small and relatively liberal economy where the generality of the model specification could be preserved.

Moreover, during the sample period Venezuela maintained a free exchange system with no restriction on capital flows. Since early 1983, however, the Venezuelan exchange system has undergone major modifications, rendering it highly restrictive. In particular, a multiple exchange system has been introduced, and all private capital transactions

[1] For a detailed discussion of other characteristics of oil-producing developing countries, see Amuzegar (1983).

are now channeled through the free exchange market and are subject to prior authorization. Choice of the period of study was based on these considerations.

The rest of the paper is organized as follows. The specification of the model is presented in Section I, followed in Section II by a discussion of the estimation results and their policy implications. Some simulation exercises are reported in Section III to highlight the impact of exogenous shocks on the economy, and the conclusions of the study are summarized in Section IV.

## I. Model Specification

In the tradition of the "warehouse" models of oil supply, it is assumed that oil is stored in a warehouse so that the costs or technical difficulties associated with its production or exportation are negligible. The usage rate is also assumed not to be constrained by any conservation motive. The analysis thus abstracts from the issues related to optimal pricing and production strategies over time, on which much of the literature on exhaustible resources has focused. This implies that, given an exogenous foreign price of oil, the rate of depletion is always equal to the quantity demanded at the going price. Oil revenues can thus be treated as exogenous (Motamed (1979)).

This assumption is not too restrictive because it is not always possible for a country such as Venezuela, which is a member of the Organization of Petroleum Exporting Countries (OPEC), to vary unilaterally its price or output sufficiently to achieve a targeted income. Moreover, so long as the price elasticity of demand for oil from a particular country is infinitely large, an output restriction is sufficient to render oil revenues exogenous. Although the global elasticity of demand for oil may be low, demand for a specific country's oil exports need not necessarily be low. An approximate measure of this elasticity is given by

$$\epsilon = [\epsilon_\omega + (1 - s)\eta]/s,$$

where

$\epsilon$ = the price elasticity of the world demand for oil from country $i$
$\epsilon_\omega$ = the price elasticity of world demand for oil
$\eta$ = the supply elasticity of other oil producers
$s$ = the share of country $i$ in the world oil market.

Although this is an approximate measure, since it assumes that there is excess capacity in the combined production of competitors, it shows that the price elasticity of demand for oil from country $i$ is larger, the smaller

is its share of the market. For Venezuela, this share has varied between 3 percent and 5 percent. In the limiting case when the supply elasticity of other producers ($\eta$) is zero, the elasticity of demand for Venezuelan oil can be between 20 to 33 times larger than the elasticity of the world demand for oil. Given a large elasticity of demand for Venezuelan oil, the assumption of exogenous oil revenue is not too restrictive.

The role of oil as an intermediate input is left out of the model. As a result, non-oil-producing sectors are not directly influenced by changes in oil prices.[2] Such an omission is not too restrictive if the size of the non-oil (including petrochemical) sector is small in relation to the size of the economy, or if the domestic use of oil is relatively unimportant (as is the case in many oil-exporting developing countries). Moreover, in such countries the domestic production sector is usually insulated from movements in the export price of oil as a matter of policy. The cost of oil input in domestic production is thus not sensitive to developments in the oil price, and the impact on domestic production of higher oil revenues generated through price hikes does not work through the oil input component of domestic production.

The impact of oil resources does, however, enter the model on the demand side. Both the demand for real balances and the private demand for consumption and investment goods are influenced by these resources. In contrast to some recent theoretical models that recognize the separate impact of oil resources on demand but implicitly assume that these revenues accrue directly to the private sector (Eastwood and Venables (1982), Buiter and Purvis (1983), and Neary and van Wijnbergen (1984)), in the present model the influence of these resources in private behavior is indirect because oil revenues are assumed to be received entirely by the government. This indirect influence can be interpreted as the confidence effect of the oil wealth. It arises because the stock of oil may be viewed by the society as accumulated savings or as a source of wealth to be drawn upon in the future. The knowledge of the existence of this source of wealth, from which eventually all the inhabitants of the country can be expected to benefit, affects the public's confidence about prospects for future income, leading to adjustment in their permanent income. This will, in turn, have an influence on savings behavior, expenditure patterns, and the composition of asset portfolios. In other words, the indirect impact of oil wealth on current expenditures and desired

[2] Allowing for oil as an intermediate input may be tantamount to building an automatic Dutch disease process into the model, with the non-oil export sector being adversely affected whenever oil export prices increase. This procedure may, of course, be justified in some countries such as Canada. See Knight and Mathieson (1980).

holdings of real balances works not through a rise in current disposable income, but through expectations about future income.

In the oil-based economies, the large size of export earnings accruing to the government relative to the size of the economy imparts more importance to the operations of the government than is the case in other developing countries. Because the oil sector is typically characterized as a enclave sector, the government's operations serve as the main link between that sector and the rest of the economy. This linkage implies that the loss of oil export proceeds will not automatically lead to a decline in aggregate demand. Since the loss falls entirely on the government, specific adjustment measures will be required to bring demand into line with resource availability. In contrast, where the economy is dependent on the export of a single agricultural crop, reduced crop prices abroad will result in lower incomes for many households as well as for the government, thereby leading to a decline in aggregate demand and reducing the extent of required adjustment in financial policy.[3]

The collection of government receipts from oil exports, all of which are denominated in foreign currency, entails no deflationary impact because it does not represent a withdrawal from the domestic income stream. Similarly, the expenditure of these revenues on imports of goods and services does not immediately increase domestic liquidity and is not inflationary. Moreover, there is an immediate coincidence of oil-financed domestic expenditure with increases in domestic liquidity that may to some extent blur the distinction between monetary and fiscal policies.[4] The rate of growth of the money supply is, therefore, greatly influenced by the government's domestic operations. The domestic budget balance—that is, the difference between the government's domestic revenues and domestic expenditures—becomes a highly useful concept in analyzing the impact of government operations on domestic liquidity.

Unlike much of the earlier work on macroeconomic models undertaken at the Fund, the model in this paper does not follow in a purely monetarist tradition but takes into account structural factors underlying inflationary and growth impulses. The model recognizes the interdependence of commodity and money markets by explicitly allowing for the

[3] A fall in the relative price of the crop induces a shift to other profitable crops, whereas in oil-exporting countries a switch to other exports that could adequately substitute for oil is clearly not feasible in the short run (see Lewis (1984)).

[4] If the country is small, so that its import supply function is inelastic, and if domestic and foreign goods are perfect substitutes and no import restrictions exist, it makes no difference whether the government initially spends oil revenues on domestic or on foreign goods and services. Rather than influencing domestic prices, any excess liquidity created through government operations will initially leak out through imports. See McKenzie and Schadler (1980).

spillover of disequilibrium effects across different markets. The level of absorption and prices are thus influenced by disequilibrium in both money and commodity markets. Moreover, in contrast to earlier models that focus on aggregate private expenditures, an explicit investment function is incorporated to isolate the impact of oil resources on productive potential. The specification of the model in disequilibrium form also helps to provide information on the lag structure of the economy.

The model consists of 9 behavioral equations and 8 identities explaining 17 endogenous variables. The definition of variables is given in Table 1, and the model is reproduced in Table 2. Lowercase letters denote the logarithm of the corresponding uppercase variable deflated by the price index, except $p$, $p^t$, and $p^n$, which denote the logarithm of the corre-

Table 1. *List of Variables*

| Variable | Definition |
|---|---|
| | *Endogenous variables* |
| $CON$ | Actual private consumption expenditures |
| $CON^d$ | Private demand for consumer goods |
| $CP$ | Credit to private sector |
| $DR$ | Government domestic revenues |
| $E$ | Desired private expenditures |
| $G$ | Government expenditure |
| $GDP$ | Gross domestic product |
| $GR$ | Government revenues |
| $IM$ | Imports of goods and services |
| $IM^d$ | Desired imports of goods and services |
| $KF$ | Private investment (capital formation) |
| $M^d$ | Demand for money balances |
| $MS$ | Nominal money stock broadly defined (M2) |
| $NFAB$ | Net foreign assets of the banks |
| $FNACB$ | Net foreign assets of the central bank |
| $PKI$ | Net private capital inflow |
| $P$ | Domestic price level (index) |
| $P^n$ | Price of nontraded goods (index) |
| $X^n$ | Real exports of goods and services other than oil |
| $Y$ | Non-oil GDP |
| $Y^d$ | Demand for non-oil output |

Table 1 (*concluded*).

| Variable | Definition |
|---|---|
| | *Exogenous variables* |
| *BOP* | Residual item in the balance of payments (including, on a net basis, all the above-the-line variables except the trade balance, non-factor services, government capital inflow, and short-term private capital inflows) |
| *DA* | Net domestic assets of the central bank |
| *DOC* | Domestic consumption of oil |
| *F* | Expected oil wealth |
| *GDE* | Government domestic expenditure |
| $i$ | Expected domestic interest rate |
| $i_f$ | Foreign interest rate adjusted for expected exchange rate change |
| *INV* | Inventories calculated from national accounts data |
| *MM* | Money multiplier |
| *OR* | Oil revenues |
| $P^t$ | Prices of traded goods |
| *PIM* | Private imports |
| *UCB* | Change in cash balances of the treasury |
| *YUS* | Nominal U.S. GDP |
| $\pi$ | Price of oil |

sponding price indices $P$, $P^t$, and $P^n$. The symbols $i$ and $i_f$ represent, respectively, domestic and foreign interest rates measured in percentages.

## Demand for Real Balances ($m^d$)

The demand for real balances is assumed to depend on real non-oil income ($y$), the expected oil wealth ($f$), and the domestic ($\iota$) and foreign ($i_f$) interest rate ($s$).[5] The relationship between expected oil wealth and the demand for money represents a confidence or psychic factor, as discussed earlier, but it is also consistent with Friedman's (1959) hypothesis that demand for real balances depends on permanent rather than actual income. The inclusion of both non-oil income and expected oil wealth in

[5] Because oil income accrues to the government, its impact on money demand (and other private demand variables) works indirectly through the government expenditure function. Thus, oil income has not been included as an independent variable in money demand and private expenditure equations.

Table 2. *List of Equations*

| Equation Number | Equation |
|---|---|
| | *Behavioral equations* |
| (1) | $m = a_1 + a_2 y + a_3 f + a_4 i + a_5 i_f + a_6 m_{t-1}$ |
| (2) | $con = b_1 + b_2 y + b_3 f + b_4 EFD_{t-1} + b_5 con_{t-1}$ |
| (3) | $KF/P = u_0 + u_1 (Y/P) + u_2 q + u_3 (F/P) + u_4 (K/P)_{t-1}$ |
| (4) | $\Delta p = c_1 + c_2 \Delta y^d + c_3 \Delta k + c_4 \Delta EFD_{t-1} + \Delta p'$ |
| (5) | $\Delta y = D_1 + D_2 y^d + D_3 EFD + D_4 (p^n - p') + D_5 y_{t-1}$ |
| (8) | $im = k_1 + k_2 (p^n - p') + k_3 e + k_4 g + k_5 im_{t-1}$ |
| (10) | $dr = l_1 + l_2 y$ |
| (11) | $g = \lambda gr + (1 - \lambda) g_{t-1}$ |
| (13) | $PKI = w_0 + w_1 (i - i_f) + w_2 \Delta GDP + w_3 YUS$ |
| | *Identities* |
| (6) | $Y^d = CON^d + KF + G + X^n$ |
| (7) | $e = \log (CON^d/P + KF/P)$ |
| (9) | $GR = OR + DR$ |
| (12) | $X^n = Y - CON - KF - G + IM - \Delta INV + DOC$ |
| (14) | $GDP = Y + OR + DOC$ |
| (15) | $\Delta M = G - DR + X^n - IM + \Delta CP + PKI + BOP$ |
| (16) | $EFD = (M/P)^d - (M/P)_{t-1} - \Delta (DA/P) MM$ |
| (17) | $F = \pi_{t-1} S$ |

the demand for money equation also permits a test of the plausible hypothesis that the elasticity of demand for money with respect to oil should differ substantially from that with respect to non-oil income, reflecting the dominant role of the government in oil-related transactions.

In a relatively open economy such as that of Venezuela, both foreign and domestic interest rates ($i_f$ and $i$, respectively) should be included in the demand for money equation to represent the yield on foreign and domestic assets (Hamburger (1977)). In a completely open economy these assets are perfectly substitutable, so that the movements in their yields are correlated, and there is no need to include both interest rates in the equation. Because the degree of openness is an empirical question, however, the demand function is specified to include both interest rates (the time subscripts $t$ have been suppressed throughout the paper for ease of presentation):

$$m^d = m^d(\underset{+}{y}, \underset{+}{f}, \underset{+}{i}, \underset{-}{i_f}).$$

The actual stock of real balances is assumed to adjust with a lag to the desired stock:

$$\Delta m = \mu(m^d - m_{t-1}); \qquad 0 \leq \mu \geq 1,$$

where $\mu$ is the speed of adjustment and $\Delta$ is the first difference operator:

$$\Delta X = X_t - X_{t-1}.$$

The above relationships result in the following estimating equation:

$$m = a_1 + a_2 y + a_3 f + a_4 i + a_5 i_f + a_6 m_{t-1}, \tag{1}$$

where $a_2, a_3, a_4, a_6 > 0$ and $a_5 < 0$.

## Private Consumption Expenditures ($con$)

The level of aggregate private consumption rises whenever there is an excess private demand for consumer goods:

$$\Delta con = b_0(con^d - con_{t-1}); \qquad 0 \leq b_0 \leq 1,$$

where $con^d$ denotes the desired level of private consumption. It is assumed to vary directly with non-oil real income ($y$) and expected oil wealth ($f$), and inversely with the level of monetary disequilibrium in the previous period:

$$con^d = con^d(\underset{+}{y}, \underset{+}{f}, \underset{-}{EFD_{t-1}}),$$

where $EFD$ denotes the level of disequilibrium in the money market, as defined later in this section (in the subsection "Monetary Disequilibrium"). Eliminating $con^d$ from the above relationships yields the estimating equation:

$$con = b_1 + b_2 y + b_3 f + b_4 EFD_{t-1} + b_5 con_{t-1}, \tag{2}$$

where $b_2 > 0$, $b_3 > 0$, $b_4 < 0$, and $b_5 < 0$.

## Private Investment ($KF$)

The desired level of real private capital stock $(K/P)^d$ is assumed to be a linear function of real non-oil income ($Y/P$), expected real oil wealth ($F/P$), and the opportunity cost of capital ($q$):

$$(K/P)^d = K[(Y/P), q, F/P]; \qquad (+, -)$$

$q$ is measured by the rental wage ratio,

$$q = P(i - \pi)/W,$$

where $W$ represents the nominal wage index and $\pi$ denotes the rate of change in capital goods prices.

An expansion in non-oil income could raise the level of desired capital stock, whereas an increase in the rental wage ratio would lower it by encouraging substitution of labor for capital. However, the impact of an increase in expected oil wealth on desired private capital stock is ambiguous. Because the immediate beneficiary of higher income from oil is the government, the direction of the effect would depend on the expected pattern of government expenditure. That is, the desired private capital stock may rise if government expenditures are viewed as complementary to private investment (as could be the case with government expenditures channeled to infrastructural investment). The desired private capital stock will decline if government expenditures are expected to be of a competing nature, concentrated on projects usually undertaken by the private sector. The sign of the coefficient of $F/P$ is therefore indeterminate a priori.

In each period the actual level of capital stock adjusts partially to the desired level:[6]

$$\Delta(K/P) = u[(K/P)^d - (K/P)_{t-1}]; \qquad 0 \leq u \leq 1.$$

The level of real gross fixed capital formation ($KF/P$) is given by

$$KF/P = \Delta(K/P) + DEP,$$

where $DEP$ denotes depreciation of the capital stock, assumed to be a constant proportion $\Theta$ of the capital stock in the previous period; that is,

$$DEP = \Theta\ (K/P)_{t-1}.$$

The estimating relationship for $KF/P$ is thus given by

$$KF/P = u_0 + u_1(Y/P) + u_2 q + u_3(F/P) + u_4(K/P)_{t-1}, \qquad (3)$$

where $u_1 > 0$, $u_2 < 0$, and $u_4 = \Theta - u$.

[6]Some studies (for example, Sundararajan and Thakur 1980) have postulated an increasing relationship between the speed of adjustment ($u$) and the availability of resources for private capital formation. The variable for availability, measured by the difference between aggregate savings and government investment, was not found to be a significant factor determining private investment in Venezuela.

## Domestic Price Inflation

The domestic price level ($p$) is assumed to be a weighted average of the prices of traded and nontraded goods ($p^t$ and $p^n$, respectively):

$$p = \omega p^n + (1 - \omega)p^t; \qquad 0 \leq \omega \leq 1.$$

Movements in prices of nontraded goods result from variations in money market disequilibrium or from changes in the excess of demand over potential supply in the goods market ($ECD$):[7]

$$\Delta p^n = p^n(\overset{+}{\Delta ECD}, \overset{+}{\Delta EFD}).$$

If potential output is assumed to be proportional with the real capital stock ($k$), one can write

$$ECD = y^d - \alpha k; \qquad \alpha > 0,$$

where $y^d$ represents the level of demand in the goods market. These relationships give the following estimating equation for domestic inflation:

$$\Delta p = c_1 + c_2 \Delta y^d + c_3 \Delta k + c_4 \Delta EFD_{t-1} + \omega \Delta p^t, \tag{4}$$

where $c_2 > 0$, $c_3 = -\alpha c_2 < 0$, and $c_4 < 0$.

## Growth of Non-Oil Output ($y$)

The supply of non-oil output ($y$) responds to excess demand in the commodity market, to the disequilibrium in the money market (with a time lag), and to relative prices:

$$\Delta y = d_1 + d_2(y^d - y) + d_3 EFD_{t-1} + d_4(p^n - p^t); \qquad d_2 > 0, \; d_3 < 0.$$

An improvement in the terms of trade in favor of nontraded goods could be expected to stimulate the supply of non-oil output because nontraded goods make up the bulk of domestic non-oil production. However, the increase in the relative price of nontraded goods may shift the consumption pattern away from such commodities, thus inducing a cutback in production. The sign of the coefficient $d_4$ is therefore indeterminate a priori.

After rearrangement, the estimating equation can be derived as follows:

[7] The possibility that the divergence of relative prices from their long-run equilibrium value could also influence nontraded-goods prices was excluded from the price equation, since empirical tests showed that this divergence was not significant.

$$\Delta y = D_1 + D_2 y^d + D_3 EFD + D_4(p^n - p^t) + D_5 y_{t-1}, \tag{5}$$

where $D_2 > 0$, $D_3 < 0$, and $0 > D_5 = -d_2/(1 + d_2) > -1$.

The demand for domestic non-oil output ($Y^d$) comprises public ($G$) and private demand for goods and services and demand for non-oil exports ($X^n$):

$$Y^d = CON^d + KF + G + X^n. \tag{6}$$

## Imports ($im$)

The level of actual real imports ($im$) rises whenever there is excess demand for imports:

$$\Delta im = k_0(im^d - im_{t-1}); \qquad 0 \leq k_0 \leq 1.$$

The desired level of imports ($im^d$) is assumed to depend on planned private expenditures ($e$), on government real expenditures ($g$), and on the relative prices of traded and nontraded goods:

$$im^d = im(\underset{+}{e}, \underset{+}{g}, \underset{+}{p^n - p^t}).$$

The variables $e$ and $g$ enter the import function separately to account for the difference in the import content of private and government expenditures. The underlying demand for private expenditure is composed of desired consumption and planned investment:

$$e = \log (CON^d/P + KF/P). \tag{7}$$

In the present formulation, the planned and actual levels of investment are assumed to be equivalent. In other words, plans to adjust to the desired capital stocks at a given speed are assumed to be fully realized. The following equation can thus be derived:

$$im = k_1 + k_2(p^n - p^t) + k_3 e + k_4 g + k_5 im_{t-1}, \tag{8}$$

where $k_2 > 0$, $k_3 > 0$, $k_4 > 0$, and $1 \geq k_5 = 1 - k_0 \geq 0$.

## Government Revenues ($GR$) and Expenditure ($G$)

Government revenues ($GR$) consist of oil revenues ($OR$) and non-oil revenues ($DR$):

$$GR = OR + DR. \tag{9}$$

Non-oil revenues are related to non-oil income:

$$dr = l_1 + l_2 y; \qquad l_2 > 0. \tag{10}$$

Given the exogeneity of the price and demand for oil, the governments of oil-producing countries can exercise little discretionary control over the bulk of their revenues, particularly in the short run. As a result they have attempted, to a larger extent than is the case with other countries, to adjust their expenditures in line with revenues. Indeed, studies of the Islamic Republic of Iran and of Indonesia have shown that the level of government expenditure in each period is established in these countries in such a way as to move toward a balanced budget over time (Aghevli and Sassanpour (1982) and Sassanpour (1985)). Adopting such an assumption allows the following relationship to be specified:

$$\Delta g = \lambda[gr - g_{t-1}]; \qquad 0 \leq \lambda \leq 1,$$

which results in the estimating equation

$$g = \lambda gr + (1 - \lambda) g_{t-1}. \tag{11}$$

## Non-Oil Exports ($X^n$)

Non-oil exports are determined as a residual from the income identity:[8]

$$X^n = Y - CON - KF - G + IM - \Delta INV + DOC, \tag{12}$$

where $\Delta INV$ is the change in inventories and $DOC$ is domestic consumption of oil. Non-oil exports are thus affected by developments on both the demand and supply sides of the economy.

## Capital Flows ($PKI$)

Capital flows usually respond to a variety of factors that no single relationship can adequately capture. Nevertheless, in the present model it is assumed that the differential in expected returns on domestic and foreign assets and changes in domestic and foreign incomes bring about changes in desired asset holdings, thus generating capital flows. Because most capital movements are to and from the United States, foreign variables refer to that country:

$$PKI = w_0 + w_1 (i - i_f) + w_2 \Delta GDP + w_3 \Delta YUS, \tag{13}$$

[8] Non-oil exports accounted for no more than 5 percent of total exports in Venezuela during the sample period.

where

$$GDP = Y + OR + DOC \tag{14}$$

and *YUS* denotes nominal U.S. GDP. Note that estimating a net capital flow equation of the type specified assumes that foreign and domestic assets are not perfect substitutes.[9] If assets are perfectly substitutable, this equation should be replaced by an interest arbitrage equation linking $i$ and $i_f$.

## The Money Supply Identity

As noted earlier, the impact of government operations on domestic liquidity can be measured by the government's domestic budget balance; that is, by the difference between domestic revenues and domestic expenditures ($GDE$). In other words, even if the overall budget is in balance or in surplus, the net impact of the government's operations can be expansionary. It is more useful, therefore, to write the money supply identity in terms of the domestic budget balance, as follows:[10]

$$\Delta M = GDE - DR + X^n - PIM + \Delta CP + PKI + BOP,$$

where $PIM$ denotes private imports, $CP$ stands for credit to the private sector, and $BOP$ represents a residual item in the balance of payments. Because complete data are not available for the government's domestic expenditures ($GDE$), the above identity is rearranged in terms of total government expenditure and total imports (Aghevli and Sassanpour (1982)):

$$\Delta M = G - DR + X^n - IM + \Delta CP + PKI + BOP. \tag{15}$$

In equation (15), $BOP$ is exogenous, and all the other variables except $CP$ are determined from the equations specified earlier. Therefore, this relationship now determines the flow of credit to the private sector.

## Monetary Disequilibrium

Two measures of monetary disequilibrium have been used in the literature. The first embodies a stock concept, whereby disequilibrium is

[9] If assets are perfectly substitutable, net capital flows will be indeterminate, and the estimates obtained from this equation cannot be interpreted meaningfully.

[10] It is assumed that government foreign receipts equal oil export receipts plus net foreign borrowing.

measured in terms of the deviation of the actual stock of real balances from demand:[11]

$$ESD = (M/P)^d - (M/P)_{t-1},$$

where $ESD$ is the excess stock demand for real balances.

This concept ignores the role that domestic credit expansion during the period plays in the closing the real balance gap. Another measure, proposed by Blejer (1977) and Sundararajan (1986) among others, focuses on the concept of "flow disequilibrium," which makes appropriate allowances for the authorities' attempt to fill the real balance gap through credit creation. Accordingly, the flow excess demand ($EFD$) is defined as

$$EFD = (M/P)^d - (M/P)_{t-1} - \Delta(DA/P)MM, \tag{16}$$

where $MM$ is the money multiplier and $\Delta DA$ refers to the change in the net domestic asset of the central bank during the period.

The choice of the disequilibrium concept has important implications for the dynamic effect of monetary policy in empirical models dealing with small open economies. In this study, the disequilibrium concept represented in equation (16) is used.

## Expected Income from Oil Extraction

The expected oil wealth ($F$) in each period is defined as

$$F_t = E_t(PV_t) = E_t\left[\sum_{i=t}^{T} \pi_i Q_i/(1+d_i)^{i-t}\right],$$

where

$PV$ = the present value of the streams of income derived from oil over the lifetime of the resource
$d$ = the rate of discount
$Q_i$ = the rate of oil exploitation at time $i$
$\pi_i$ = the price of oil at time $i$
$T$ = the time of depletion of the oil stock
$E_t$ = the expectations operator.

Because $T$ is unknown, this relationship cannot be readily incorporated in the model. For empirical purposes, a simplified version could be derived on the assumption that the expected rate of oil price inflation is

[11] This difference between the two stocks can be viewed as the "flow" demand for real balances; see Sundararajan (1986).

equal to the discount rate. It is well known from the theory of exhaustible resources that the optimal rate of extraction is determined at the point where the marginal productivity of the resource in all its uses is equalized (see Hotelling (1931) and Davarajan and Fisher (1981)). The expected rate of oil price inflation represents the marginal productivity of oil if left underground, whereas the rate of return on financial assets (or the interest rate) represents the marginal productivity of the resource if invested in financial assets. Thus, at the optimal rate of extraction, the rate of oil price inflation is equal to the interest rate.

In contrast, if expected oil price inflation is higher than the rate of interest, then the optimal policy dictates keeping the resource underground; if it is lower, no equilibrium rate of extraction will exist because it would be optimal to exhaust the resource instantaneously.[12] Assuming that the social discount rate is equal to the rate of interest,[13] and denoting the rate of oil price inflation in period $i$ by $r_i$, one can write

$$F_t = E_t\left[\sum_{i=t}^{T} \pi_i\,(1+r_i)^{i-t} Q_i/(1+d_i)^{i-t}\right]$$
$$= E_t(\pi_t \Sigma_i Q_i) = E_t(\pi_t S_t) = S_t E_t(\pi_t),$$

where $S$ is the stock of proven oil reserves in time $t$. Assuming static oil price expectations, $E(\pi_t) = \pi_{t-1}$, the following relationship is obtained:

$$F_t = \pi_{t-1} S_t. \tag{17}$$

This simple relationship represents the confidence or wealth effect of natural resource availability. It also embodies the concept of exhaustibility of oil (since $S_t$ is declining over time), so that this important feature of the oil-producing countries is built into the model, albeit in an admittedly crude fashion.

## The Dynamic Process

To trace the dynamic process embodied in the model, consider the effect of an increase in $F$ brought about through a resource discovery, so

[12]The theory from which these decision rules are derived assumes, among other things, a monopolistic market structure, no binding technological constraints, and full information—none of which may hold in practice. In addition, the decision rules will be more complicated because the rate of return on financial assets may itself be affected by the variations in the price of oil. Given these considerations, the simplifying assumption in the text may be somewhat unrealistic.

[13]This assumption can be justified on the grounds that, in a market economy, the most obvious indicator of time preference is the rate of interest. In other

that oil revenues do not necessarily rise immediately.[14] If one abstracts from the accompanying leads and lags, the immediate confidence effect of higher expected wealth directly increases demand for real balances and private consumption expenditures and also influences private investment. These in turn will generate opposing forces that exert both upward and downward pressures on the level of income and prices (as explained in the next paragraph), so that the final outcome cannot be established a priori and needs to be determined empirically.

Initially, the higher demand for money will widen the real balance gap ($EFD$), since $\mu < 1$. This effect will depress the prices of nontraded goods[15] and, hence, both imports and domestic inflation. The larger monetary disequilibrium will also dampen private demand for consumer goods and depress the growth of non-oil income. The excess of demand for non-oil commodities over potential output will then decline, further depressing nontraded-goods prices and domestic inflation.[16]

Thus, through its impact on demand for real balances alone, an increase in expected real oil wealth would eventually lead to lower domestic inflation and income; it is also likely to lead to an improvement in the current account of the balance of payments because imports decline while exports remain unchanged. The overall balance of payments may also improve if capital outflows—which result, according to equation (13), from a decline in income growth—are not too large.

These results do not, however, constitute the final outcome of an increase in $F$, because the larger $F$ also stimulates private demand for goods and services ($con^d$). Consequently aggregate demand ($y^d$) rises relative to supply, putting upward pressure on the prices of nontraded goods and dampening the demand for real balances. A lower monetary disequilibrium will then result that will help to weaken or offset the feedback effects generated through the initial impact of the larger expected oil wealth on demand for real balances.

The net effect of these forces on the prices of nontraded goods will change relative prices. Given the fixed exchange rate, a decline (in-

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words, the interest rate is supposed to adjust until it simultaneously equates the rate of time preference of all individuals in the society and the rate of return on productive investment.

[14] Oil revenues ($OR$) rise if the extraction rate or the price of oil increases. A resource discovery does not necessarily lead to either of these developments.

[15] More precisely, the larger real balance gap will reduce the rate of change in nontraded-goods prices compared with what that rate would have been in the absence of a change in the real balance gap.

[16] The ensuing feedback effects will be strengthened or weakened depending on whether private investment is stimulated or depressed by a rise in $F$; that is, whether $u_3$ in equation (3) is positive or negative.

crease) in the prices of nontraded goods while the level of traded-goods prices remains unchanged will result in reduced (increased) demand for imports. Any change in relative prices will also have an impact on domestic output, the direction of which is ambiguous a priori (as discussed earlier). The net result will feed into the dynamic system described above, strengthening or weakening some of the feedback effects. The final outcome of the movements in the variables depends on leads and lags (which were ignored in the discussion above) as well as on the relative speeds of adjustment and the strength of impact multipliers. These factors also determine the stability characteristics of the system. The eventual outcome for non-oil income, public and private expenditures, and imports will determine GDP and non-oil exports. The capital account as well as the overall balance of payments outcome will then be established, and the level of credit to the private sector will be determined by the money supply identity.[17]

The distinguishing characteristic of the dynamic process embodied in this model can best be seen with respect to the impact of an increase in oil production (rather than in oil wealth). In contrast to the earlier work on oil-producing countries, where an increase in oil production usually leads to a rise in prices and non-oil output, in the present model the impact of an increase in oil production on prices and on non-oil output is ambiguous. The expansion of oil output results in lower availability of the resource (that is, in a smaller $S$), and thereby in smaller expected oil wealth $F$. This outcome will tend to depress domestic output and prices, provided that the impact of the oil wealth effect on private expenditures is stronger than its impact on demand for money, as discussed above.[18] In contrast, the expansion in oil revenues arising from the larger output will raise government expenditures, which may serve to reverse this trend. The overall impact is therefore not clear a priori.

[17] Although the starting point of the above discussion is the effect of a change in $F$, the subsequent argument could be applied to changes in any other variable of the model. Clearly, however, the sequence of events as well as the final outcome will vary according to the nature of the original change. The feedback effects of movements in money supply and capital flows fall on credit to the private sector. Although the exchange rate variable does not enter the model explicitly, the impact of changes in this variable can be analyzed in a similar way. Because a change in the exchange rate affects oil revenues and prices of traded goods instantaneously, its impact on endogenous variables is equivalent to the combined effect of changes in these variables.

[18] This effect is absent from the previous empirical works on oil-exporting countries.

## II. Estimation Results

The definition of variables and the complete model are presented, respectively, in Tables 1 and 2 above. The behavioral relationships of the model were estimated by a two-stage least-squares method using annual data for the period 1965–81.[19] To ensure that cross-equation restrictions on the parameters of the money demand equation were satisfied, the variable $(M/P)^d$ was replaced by the antilog of

$$(1/\mu)[\hat{m} - (1 - \mu)m_{t-1}]$$

in all estimating equations, where $\hat{m}$ is the predicted value of $m$ obtained from the estimated demand for money equation.[20] Similarly, the unobservable variable $con^d$ is formulated from the estimated private consumption equation using the relationship

$$con^d = (\hat{con} - b_5 \hat{con}_{t-1})/(1 - b_5),$$

where $b_5$ is the estimated coefficient of $con_{t-1}$. This variable was then used to calculate demand for domestic non-oil output ($y^d$) and for private expenditures ($e$). A dummy variable ($D$) was introduced in the capital flow equation to account for unexplained variations in capital flows in 1980/81.

The estimation results are presented in Table 3. On the basis of the usual statistical criteria, the model performs well. The explanatory power of the model's equations is quite reasonable, and all coefficients have the expected signs. Moreover, of the 39 estimated coefficients, all but 8 are significant at more than the 90 percent confidence level, and half are significant at the 99 percent confidence level.[21]

[19] Data sources are given in the Appendix. The consumer price index $P$ has been used as the deflator except in the case of imports, for which an index of traded goods prices—calculated from partner country data—has been used. A systems estimation method, such as full information maximum likelihood (FIML), would have been preferable for reducing the simultaneous equation bias and to ensure that the a priori restrictions on parameters were satisfied. Such method, however, could result in large specification errors, especially for small samples.

[20] The coefficient of $m_{t-1}$ in equation (1) in Table 3 is equal to $1 - \mu$.

[21] These results should be interpreted with caution because, for small samples, the properties of the probability distribution of coefficients estimated by the two-stage least-squares method are not well known. Goldfeld (1966) believes that this procedure tends to produce conservative $t$-statistics.

Table 3. *Estimated Model*

| Item | Estimated Equation |
|---|---|
| Demand for real balances (equation (1))[a] | $m = 8.362 + 1.228y + 0.154f - 0.011i_f + 0.327m_{t-1}$<br>$(-4.712)\ (4.457)\ \ (2.894)(-1.701)\ \ (2.021)$<br>$\bar{R}^2 = 0.992 \qquad H = 0.335 \qquad \text{SEE} = 0.045$ |
| Real private consumption (equation (2)) | $con = -0.632 + 0.229y + 0.063f - 0.000001EFD_{t-1} + 0.680con_{t-1}$<br>$(-2.754)\ (4.866)\ \ (2.900)(-0.592)\qquad\qquad (9.329)$<br>$\bar{R}^2 = 0.997 \qquad H = -1.183 \qquad \text{SEE} = 0.019$ |
| Real private investment equation (3)) | $KF/P = -16459.4 + 1.071(Y/P) - 0.01(F/P) - 0.159(K/P)_{t-1} - 1125.76q$<br>$(-2.101)(4.248)\qquad (-2.493)\qquad (-1.349)\qquad\qquad (-2.666)$<br>$\bar{R}^2 = 0.924 \qquad \text{DW} = 1.449 \qquad \text{SEE} = 1586.0$ |
| Domestic inflation (equation (4)) | $\Delta p = 0.115 + 0.265\Delta y^d - 0.410\Delta k - 0.000001\Delta EFD + 0.034\Delta p^f$<br>$(5.403)\ (3.385)\ \ (-7.243)\ \ (-0.967)\qquad\qquad (0.803)$<br>$\bar{R}^2 = 0.966 \qquad \text{DW} = 2.140^b \qquad \text{SEE} = 0.019$ |
| Growth of non-oil income (equation (5)) | $\Delta y = +1.545 + 0.466y^d + 0.017(p^n - p^f) - 0.000001EFD_{t-1} - 0.622y_{t-1}$<br>$(-2.052)\ (5.078)\ \ (0.882)\qquad\ (-0.141)\qquad\qquad (-4.279)$<br>$\bar{R}^2 = 0.795 \qquad \text{DW} = 2.342 \qquad \text{SEE} = 0.02$ |

| | |
|---|---|
| Imports (equation (8)) | $im = -5.585 + 0.316e + 0.835g + 0.878(p^n - p^t) + 0.418im_{t-1}$<br>$(-8.639)\ (1.510)\ \ (6.102)\ \ (13.895)\ \ \ \ (3.882)$<br>$\bar{R}^2 = 0.993 \quad H = -0.562 \quad \text{SEE} = 0.047$ |
| Government domestic revenues (equation (10)) | $dr = -8.608 + 1.605y$<br>$(-8.007)\ \ (16.980)$<br>$\bar{R}^2 = 0.954 \quad \text{DW} = 1.930^b \quad \text{SEE} = 0.069$ |
| Government expenditure (equation (11)) | $g = 0.304gr + 0.698g_{t-1}$<br>$(4.499)\ \ (10.099)$<br>$\bar{R}^2 = 0.976 \quad H = 0.158 \quad \text{SEE} = 0.068$ |
| Private capital flows (equation (13)) | $PKI = -7121.360 + 1738.04(i - i_f) + 0.157\Delta GDP + 0.009\Delta YUS - 27070.8D$<br>$(-2.223)\ \ (3.073)\ \ \ (2.333)\ \ \ (2.500)\ \ \ (-10.733)$<br>$\bar{R}^2 = 0.919 \quad \text{DW} = 2.073^b \quad \text{SEE} = 2920$ |

Note: Figures in parentheses are $t$-ratios; $\bar{R}^2$ is the adjusted coefficient of determination; DW is the Durbin-Watson statistic; $H$ is the Durbin $H$-statistic; and SEE is the standard error of the estimate.

[a] The domestic interest rate was deleted from this equation because it did not prove to be significant and its inclusion did not improve the standard error of the equation. Moreover, since bolívares have been stable in relation to the U.S. dollar for almost all of the estimation period, the expected exchange rate change has been assumed to be zero. The foreign interest rate was proxied by the three-month U.S. Treasury bill rate. Various formulations of actual and expected inflation were also included in this equation to reflect the opportunity cost of holding money instead of real assets but were dropped because their estimated coefficient was found invariably to carry the wrong sign, to be statistically insignificant, or to lead to unstable simulations. This does not necessarily imply, of course, that this opportunity cost of holding money is irrelevant to the money demand function in Venezuela, only that the mechanism for its measurement is more complicated.

[b] Corrected for autocorrelation by the Cochrane-Orcutt transformation.

## The Confidence Effect of Oil Wealth

The estimation results clearly indicate the existence of an oil wealth effect on the behavior of the economic agents, an aspect that has been neglected in previous analyses of the economies of major oil producers. The variable $f$ (or $F$) is highly significant in all the equations where it appears: those for the demand for money, private consumption, and private investment. As expected, both money demand and private consumption respond positively to changes in expected oil wealth. A 1 percent increase in the expected oil wealth, everything else remaining equal, eventually raises both the real demand for money and private consumption by 0.2 percent. Because demand for money is stimulated by resource availability, expansionary monetary policy would be less inflationary in the presence of the oil wealth effect than in its absence.

Expected oil wealth tends to have an adverse impact on private investment (since the parameter $u_3$ is negative). As discussed earlier, this may reflect the competing nature of private and government investment expenditures as perceived by private entrepreneurs. The availability of petroleum resources reduces the private sector's propensity to save and its demand for investment. As a result, the growth prospects of the economy would depend, to a larger extent than in other countries, on the activities of the government. This finding highlights the importance of the composition of government expenditure for the growth prospects of oil-based economies. Whether oil wealth will act as a stimulant or a barrier to economic growth in the long run depends on the government's ability to take a leading role in expanding the productive capacity of the economy through appropriate expenditure policies and through appropriate incentive schemes for the private sector to help mitigate the adverse influence of oil wealth on private investment.

## Monetary Disequilibrium

The results indicate that monetary disequilibrium is not a significant variable in the determination of private expenditures. The implication of this result is that, given the financial structure of the economy, monetary disequilibrium probably affects the interest rate, the exchange rate (relative prices), or capital flows and that it influences expenditures, mainly indirectly, through prices; direct effects are insignificant. Thus, the role of credit policy would also be to influence the interest rate, the exchange rate, and capital flows, and, through them, expenditures.

## Demand for Money

The estimated results of the money demand equation indicate that the main determinants of money demand in Venezuela are non-oil income and expected oil wealth. Contrary to expectations, the influence of the foreign interest rate on Venezuela's open economy is not highly significant ($t$-probability of the estimated coefficient is 0.89), and the long-run interest elasticity of money demand is not very large; a 1 percent increase in the foreign interest rates, everything else remaining unchanged, reduces the demand for real balances by 0.02 percent. As can be expected in an open economy, equation (1) reveals the rapid adjustment of the actual to the desired level of the real money stocks ($\mu_1 = 0.67$): 90 percent of all the adjustments occur in the first 24 months following a disturbance.[22]

## Private Expenditures

The results show that real private consumption is also determined primarily by the income and wealth variables ($y$ and $f$, respectively). The influence of monetary disequilibrium on private consumption decisions seems to be negligible.[23] The actual level of real private consumption exhibits substantial sluggishness in adjusting to the desired level; only 50 percent of the adjustment occurs in the first two periods after a disturbance.

In addition to expected oil wealth and non-oil income, as shown by the results the relative price of capital is also an important determinant of private investment demand. Because the interest rate enters the calculation of the relative price variable, it could be argued that private investment is sensitive to changes in the interest rate, so that the growth rate of the economy is also affected by movements in the rate of interest. The estimated coefficient of lagged capital stock does not turn out to be significant, pointing to the possibility that the positive effect arising from replacement investment is offset by the low speed of adjustment of actual investment to the desired level.

[22] Adjustment over $T$ periods is calculated as $\sum_{t=0}^{T} \mu_1(1 - \mu_1)^t$.

[23] A variable that does not appear to be significant in a particular equation could, however, be significant in the context of the model as a whole, and its omission could result in appreciable changes in other coefficients of the model.

## Non-Oil Income

The estimated equation for the growth of non-oil income indicates that domestic output responds strongly to the disequilibrium in the home-goods market but is not significantly affected by monetary disequilibrium or the terms of trade.[24] The results indicate, however, that an improvement in the relative prices of nontraded goods could stimulate the supply of domestic non-oil output despite a shift in demand from domestic to imported commodities.

## Inflation

The rate of inflation is determined primarily by the level of disequilibrium in the commodity market, which is measured by the excess of demand over potential output (Table 3). The disequilibrium variable enters the equation through its components $y^d$ and $k$, and its impact on the inflation rate cannot be easily quantified. As indicated by relevant elasticities, however, the rate of inflation is more responsive to supply rather than demand factors; a 1 percent increase in the growth of potential output, everything else remaining equal, reduces the rate of inflation by 0.41 percent, whereas the same increase in the growth of demand raised the inflation rate by 0.27 percent.

## Imports

The estimation result of the import equation indicates that government expenditure and relative prices are the main determinants of import demand. The elasticity of imports with respect to government expenditure is almost four times larger than that with respect to private expenditure, reflecting mainly the large import content of government outlays. The relative price elasticity of imports is estimated at 1.5, indicating that a 1 percent devaluation would reduce imports by 1.5 percent. However, the adjustment of actual imports to the desired level is very slow; the mean lag of adjustment (calculated as $(1 - k_5)/k_5$) is shown to be 17 months.

[24] The coefficients of $y^d$ and $y_{t-1}$ (the variables that constitute the components of excess demand in the goods market) are significant at the 1 percent level in equation (4). The results for this equation, as well as for those for domestic inflation, are quite reasonable in view of the fact that these equations are estimated in the first-difference form; even if original errors are independent, negative correlation could be introduced in first-difference equations, rendering both the standard error of the coefficients and the $\bar{R}^2$ biased.

## Government Expenditure and Revenues

The estimated equation for government expenditure indicates that the government's budgetary policy has been formulated as if to aim at a balanced budget over the long term.[25] It also shows that government expenditures are adjusted slowly in response to changes in revenues; no more than 30 percent of any difference between government revenues and expenditures can be corrected in any one period. Government domestic revenues are shown to be strongly responsive to non-oil income, which alone explains 95 percent of their variations. Inclusion of oil revenues as a separate explanatory variable in this equation did not improve explanatory power, and the variable did not turn out to be significant. To the extent that oil receipts have any indirect impact on domestic revenues, this effect is therefore likely to be captured by the non-oil income variable.

## Capital Flows

The estimated equation for capital flows indicates that private short-term capital flows respond strongly to interest rate differentials between Venezuela and the United States and to GDP growth in both Venezuela and the United States. If the interest rate differential widens by 1 percentage point in favor of domestic rates, short-term capital flows would grow by Bs 1,738 million. The growth of domestic output results in larger movements in capital flows than does growth of U.S. GDP.[26] A structural change in the behavior of capital flows seems to have occurred in 1980, as indicated by the strong statistical significance of the dummy variable.[27]

The above discussion has focused on the direct impact of changes in explanatory variables on the dependent variables. It has ignored the feedback effects from the rest of the model implied by a simultaneous system. Because the model is nonlinear in variables, it cannot be solved

[25]The estimated coefficients of $gr$ and $g_{r-1}$ add up to unity.

[26]These results are in contrast to those obtained by Khan (1974), in which GDP growth in either country was not found to be a significant factor affecting capital movements in Venezuela.

[27]Given the wide fluctuations in these flows, the extent of the variations explained by the capital flow equation (92 percent) is quite impressive. The results of this equation are superior to those obtained by Khan (1974), both in terms of the explanatory power of the equation and the significance of the variables. This superiority could be attributable in part to Khan's use of the change in U.S. interest rates as an explanatory variable instead of interest rate differentials, as in the present study.

Table 4. *Correlation Between Actual and Simulated Values, 1966–81*

| Variable | Correlation |
|---|---|
| *y* | 0.985 |
| *con* | 0.999 |
| *P* | 0.996 |
| *m* | 0.992 |
| *KF/P* | 0.929 |
| *g* | 0.989 |
| *dr* | 0.959 |
| *im* | 0.990 |
| *PKI* | 0.909 |

to obtain the impact and dynamic multiplier effects of the exogenous variables on the endogenous variables. The model is therefore simulated to examine the effects of exogenous shocks and changes in policy variables.

## III. Simulation Results

To test its reliability in tracking the endogenous variables, the model was simulated over the sample period using the estimated coefficients, the actual values of the exogenous variables, and the lagged values generated by the model.[28] Simulation results (presented in Figure 12 in the Appendix) indicate that the model tracks the time path of the endogenous variables quite well. In almost all cases, the turning points are well captured by the simulated results. As shown in Table 4, correlation of the actual and simulated series of endogenous variables is quite high. The smallest correlation coefficient is obtained for the capital flow equation. Even in this case, however, the correlation is close to 0.9—quite impressive given the volatility of such flows.

To quantify the impact of the wealth effect and of a change in oil prices, the following experiments were conducted. First, oil prices were assumed to increase by 25 percent in 1970 and to return to their historical level in the following year. This assumption implies that both oil revenues ($OR$) and expected oil wealth ($F$) increase by 25 percent in 1970 and 1971, respectively. In the rest of this section this experiment is referred to as the full oil price shock. In the two succeeding experiments,

[28]This procedure is called dynamic simulation. It provides a more rigorous test of model stability than static simulation because in static simulation actual values of the lagged endogenous variables are used, whereas in dynamic simulation errors can accumulate over time.

the impact of this type of disturbance was broken down into two separate components, the income effect and the confidence effect. First, oil revenues were allowed to increase by 25 percent in 1970, with the expected oil wealth remaining unchanged (referred to as the partial oil price shock). Although this is an unlikely possibility in practice,[29] it serves to demonstrate the impact of an oil price hike on the economy as captured by earlier models of oil-producing countries that concentrate on the income effect and exclude the expected wealth effect of such shocks. The final experiment attempts to record the latter effect, represented by the influence of a temporary increase in $F$ that is not accompanied by a change in oil revenues (called the resource discovery shock).[30]

The results of these experiments are reported in Figures 1–11, which record the difference between the values of endogenous variables after the shock and those before the shock, which were obtained from a control simulation. These differences are expressed in percentages, except in the case of inflation ($INF$), relative prices ($P^n/P^t$), capital flows ($PKI$), and the balance of payments ($\Delta R$), for which the absolute difference between the values obtained from shock simulations and from the control simulation has been presented.

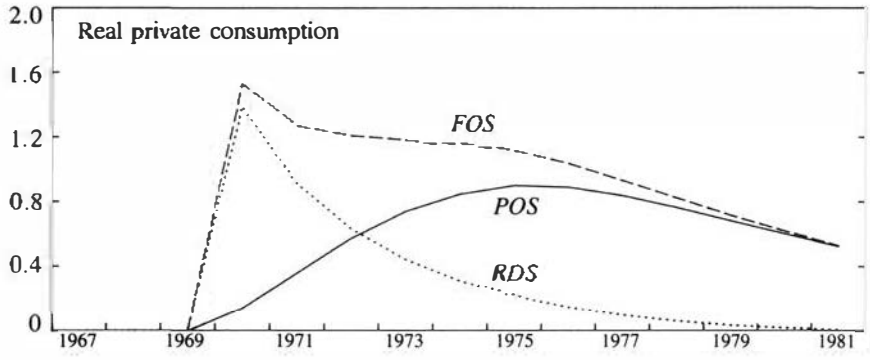
The results of the first two experiments clearly show that ignoring the wealth effect can have serious adverse implications for the design of economic policy in the face of disturbances. Consider the impact of various shocks on real private consumption expenditures. A temporary increase of 25 percent in the price of oil at an unchanged level of wealth effect (or partial oil price shock) would increase real private consumption by about 0.9 percent above the level consumption would have attained in the absence of the disturbance. This occurs within five periods following the shock (Figure 1). Thereafter the impact dissipates slowly, reflecting the sluggishness of the adjustment, but consumption remains slightly above the control level even ten years after the original shock.

The impact of a full oil price shock—that is, a price shock when its associated wealth effect is not neutralized—is much more substantial. Real private expenditures rise by more than 1.5 percent within two years and remain at a higher level than that resulting from a partial oil price shock. The steeper increase is attributable to the impact of the wealth

[29] A price hike always affects expected oil wealth, even if the price hike is accompanied by an equivalent expansion in oil output. In the latter case, expected oil wealth decreases in the period when output grows but remains unchanged in the subsequent periods ($F = \pi_{t-1} S_t$).

[30] Again, this is an unlikely scenario because it implies a temporary increase in $S$. It is examined here in an attempt to isolate the impact of oil wealth on the economy.

Figure 1. *Impact of Exogenous Disturbances: Real Private Consumption*
(In percentage deviation from control simulation)

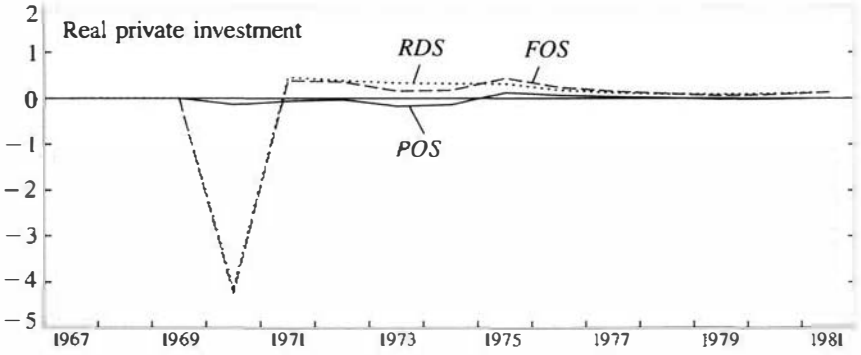



Note: Here and in Figures 2–11, *POS* indicates partial oil price shock, *FOS* indicates full oil price shock, and *RDS* indicates resource discovery shock.

effect on private consumption. This finding is confirmed by results of the third experiment, in which the shock consists of a resource discovery, so that only the oil wealth is increased (by 25 percent). This experiment also shows that the impact of a temporary increase in expected wealth, although substantial, tends to wear off rapidly and, unlike the impact of an increase in oil revenues, dissipates completely about ten years after the original shock.

The significance of the oil wealth effect is more pronounced in the case of its impact on private capital formation (Figure 2). Whereas changes in real private investment resulting from the partial oil price shock are almost imperceptible, those brought about by the full price shock are substantial. The wealth effect associated with the full price shock results in an immediate decline of about 4 percent in private real investment. This is corrected in the next period, however, because the growth of non-oil income—itself stimulated by the increase in expected oil wealth—compensates for the adverse impact of higher expected wealth on investment. For the rest of the simulation period, the level of real private capital formation remains above the level it would have attained in the absence of the shock. The effects of two types of price shocks on non-oil income tend to converge as the influence of higher expected oil wealth dissipates, leading eventually to the same proportionate expansion in non-oil output (Figure 3).

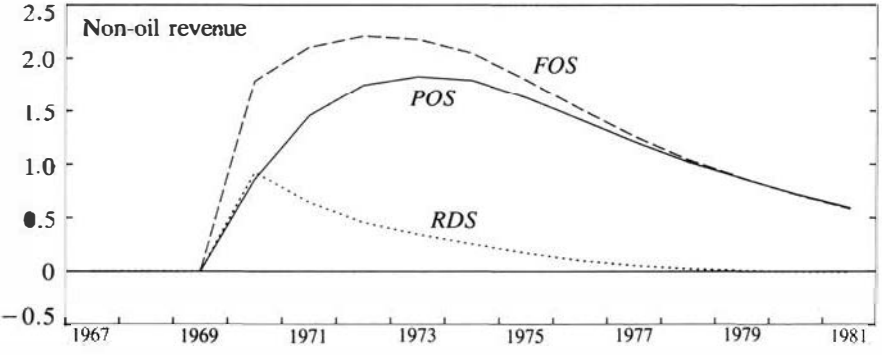
Figure 2. *Impact of Exogenous Disturbances: Real Private Investment*
(In percentage deviation from control simulation)




Note: See note to Figure 1.

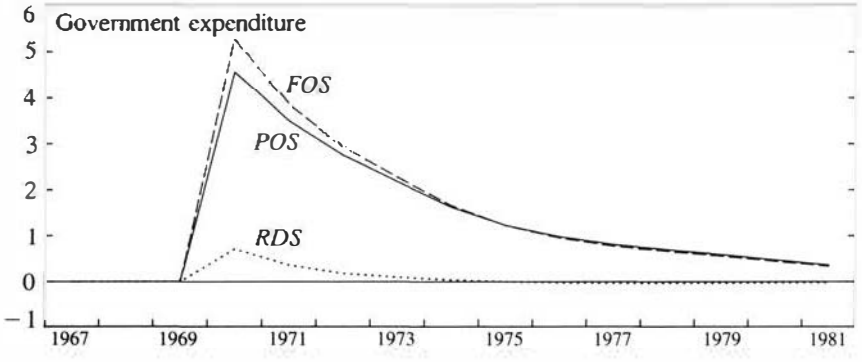
The confidence effect of the oil wealth influences primarily the behavior of the private sector. As a result, government expenditure responds in an almost identical manner irrespective of the nature of the oil price disturbance and is only slightly affected by the resource discovery shock (Figure 4). Both types of oil price shocks lead to a sharp expansion of

Figure 3. *Impact of Exogenous Disturbances: Non-Oil Revenues*
(In percentage deviation from control simulation)



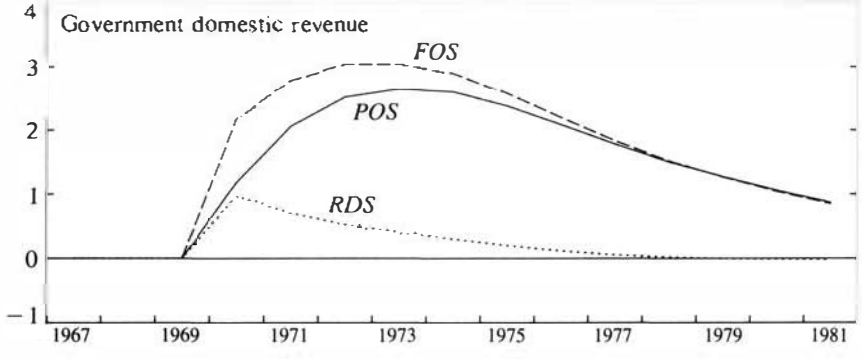

Note: See note to Figure 1.

Figure 4. *Impact of Exogenous Disturbances: Government Expenditure*
(In percentage deviation from control simulation)




Note: See note to Figure 1.

Figure 5. *Impact of Exogenous Disturbances: Government Revenues*
(In percentage deviation from control simulation)



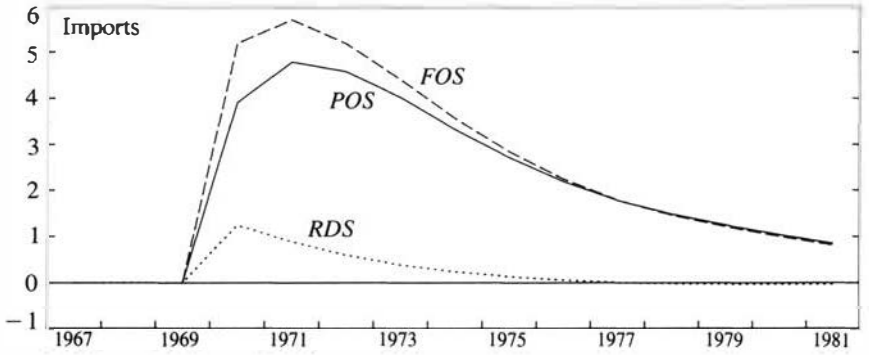

Note: See note to Figure 1.

about 5 percent in expenditure in the first period, followed thereafter by a slow adjustment toward the historical level. However, reflecting their responsiveness to non-oil income, government domestic revenues are affected differently by the two types of price shocks. Government revenues rise more substantially if the oil wealth effect is present than if it is not (Figure 5).

Reflecting the dominant influence of government expenditure on imports, a pattern similar to that of the former emerges for imports in the aftermath of exogenous disturbances (Figure 6). The time path of imports is also affected, however, by the impact of disturbances on relative prices. Because of the associated wealth effect, the full oil price shock causes a larger improvement in relative prices, in favor of nontraded goods, than does the partial oil price shock (Figure 7). This outcome reinforces the indirect influence of the wealth (or confidence) effect on imports, so that the initial difference between the effects of full and partial oil price shocks on imports is larger than the difference observed in the impact of these shocks on government expenditure. The time paths of imports resulting from the two types of shocks converge later, in line with the diminishing influence of the temporary increase in the wealth effect.

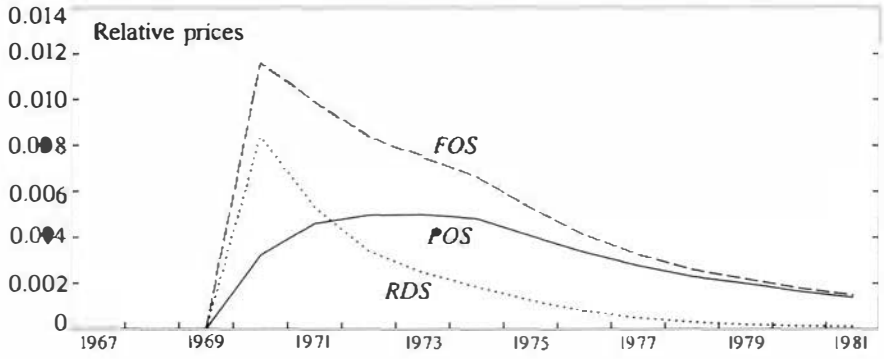
The oil price shocks have a sharp but ephemeral impact on capital

Figure 6. *Impact of Exogenous Disturbances: Imports*
(In percentage deviation from control simulation)



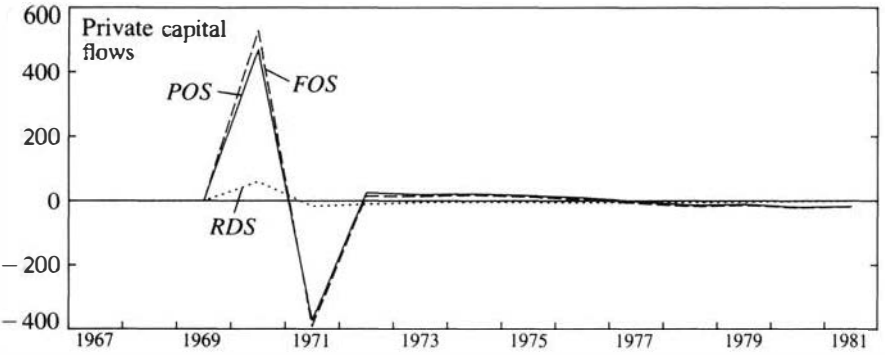

Note: See note to Figure 1.

Figure 7. *Impact of Exogenous Disturbances: Relative Prices*
(In percentage deviation from control simulation)




Note: See note to Figure 1.

Figure 8. *Impact of Exogenous Disturbances: Private Capital Flows*
(Deviation from control simulation; in millions of bolívares)




Note: See note to Figure 1.

flows (Figure 8).[31] In the first period net inflows grow by almost Bs 530 million over the historical level in response to the full oil price shock, of which Bs 470 million is due to the income effect and the rest to the confidence effect (indicated by the partial price shock and the resource discovery shock, respectively). Thus, although the wealth effect has an appreciable impact on private capital flows, its impact is overshadowed by the influence of the growth in oil revenues (and hence in domestic GDP) on such flows.[32] In the second period, net inflows decline as GDP growth slows down, and the impact of the shocks fades rapidly in the subsequent periods as GDP growth is restored to its historical level.[33]

These results imply that the failure to take the wealth effect of oil price hikes into account could lead to a substantial underestimation of their adverse effect on the balance of payments in the medium term. This conclusion is confirmed by the results obtained for the balance of payments under various external disturbances (Figure 9). In the first period, both types of price shocks result in an improvement in the balance of payments as oil exports increase, but the impact of the full oil price shock is more pronounced, owing mainly to the influence of the wealth effect on capital flows. This improvement is followed by a sharp deterioration in the balance of payments, reflecting the combined effects of the growth of imports, increase in capital outflows, and reduction in export revenues (from the level achieved immediately after the shock). Again, the wealth effect has a substantial impact that causes a deterioration in the balance of payments that is sharper under the full price shock than under the partial shock. Moreover, although under the partial shock the balance of payments improves during several succeeding periods, this is not the case under the full price shock. The demand effect of the temporary increase in expected oil wealth wears off slowly, thus helping to raise the level of absorption and resulting in a larger deterioration in the balance of payments.

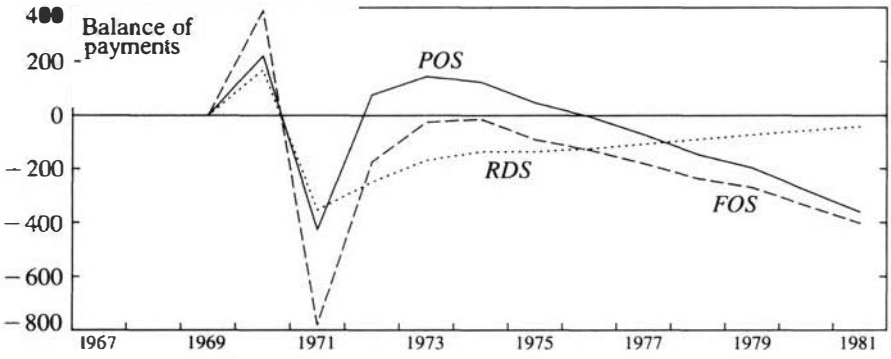
The time paths of inflation (*INF*) in response to different types of oil price shocks are markedly distinct (Figure 10). Initially the rate of inflation rises in relation to the historical level as a result of either type of

[31] The charts for capital flows (Figure 8) and the balance of payments (Figure 9) record the time path of the absolute (rather than percentage) difference between the shock simulations and the base run. This is necessary because these variables can be positive or negative during the sample period.

[32] GDP growth is an argument in the capital flows equation.

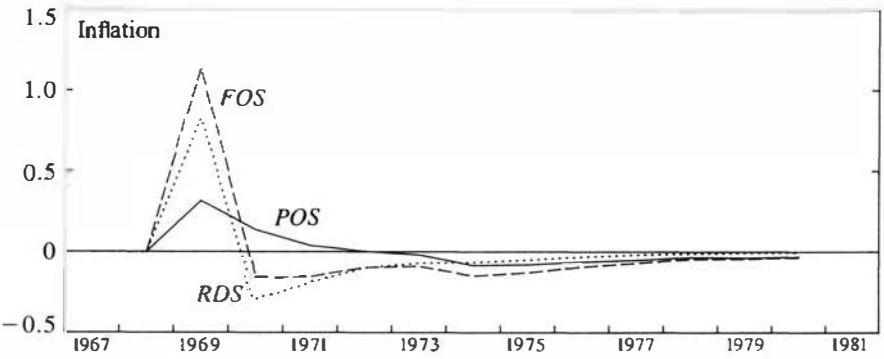
[33] Because oil is the dominant component of GDP in Venezuela, GDP grows rapidly in the first period as oil revenues increase. The second period witnesses a decline in GDP (compared with the historical trend) as oil revenues are restored to their original level. Thereafter, GDP growth reflects only the increase in non-oil output because oil income remains unchanged.

Figure 9. *Impact of Exogenous Disturbances: Balance of Payments*
(Deviation from control simulation; in millions of bolívares)




Note: See note to Figure 1.

Figure 10. *Impact of Exogenous Disturbances: Inflation*
(In percentage-point deviation from control simulation)



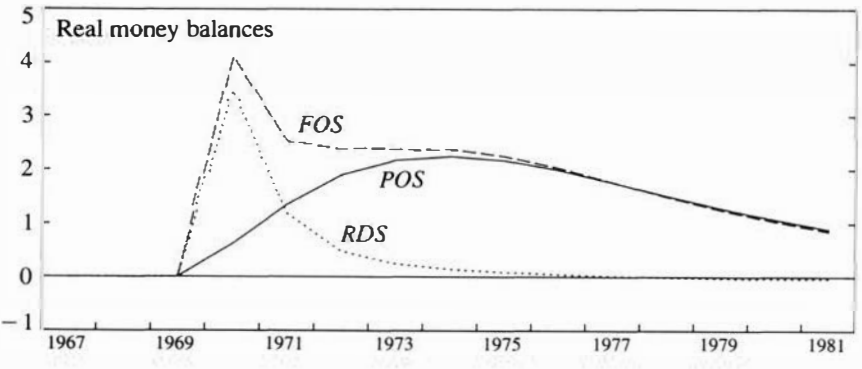

Note: See note to Figure 1.

price shock, reflecting the dominance of demand effects associated with higher oil revenues. The increase is considerably steeper in the case of the full oil price shock, however, owing to the impact on private expenditure of the wealth effect associated with this type of disturbance. In the next period the supply effect of higher oil revenues becomes dominant, resulting in a decline in the inflation rate. Again the decline is steeper—and the inflation rate actually falls below the historical level—in the case of the full price shock as the wealth effect leads to a greater monetary disequilibrium, which, in turn, exerts a further dampening impact on domestic inflation. Eventually, as the impact of the higher expected oil wealth wears off, both types of shocks produce a similar trend in domestic prices, with the inflation rate remaining below the historical level.

The discussion so far has indicated that the presence of an oil wealth or confidence effect exacerbates the impact of oil price shocks on the economy of Venezuela. In particular, because of the wealth effect these disturbances entail, they are likely to affect the balance of payments more substantially and bring about wider fluctuations in domestic prices than previously thought. Although the impact of oil price shocks on domestic price inflation would be eventually dampened by the wealth effect, an oil price hike could generate stronger inflationary pressures in the initial stages. Therefore, in periods of rising oil prices, achieving balance of payments equilibrium or price stability would pose more significant policy challenges than previously recognized.

Although an analysis of the nature and adequacy of different policy responses that may be called for in the face of oil price shocks is beyond the scope of this paper, monetary policy implications are evident from the simulation results. The demand for real balances, and hence the level of monetary disequilibrium, shifts significantly as a result of the various shocks (Figure 11). Failure to account for the wealth or confidence effect of oil price shocks, however, leads to a serious underestimation of the shift in demand for real money balances; whereas the full oil price shock leads to an increase of more than 4 percent in the demand for money in the first period after the shock, the partial oil price shock causes an increase of no more than 1 percent. The magnitude of the shift in monetary disequilibrium, and that of the task confronting monetary policymakers, is thus substantially larger when the wealth effect of resource availability is taken into account. In addition to its implication for the magnitude of policy response, the wealth effect has significant implications for the timing of monetary policy. The results show, for instance, that failure to take the wealth effect into account may result in a gradualist policy in the face of shocks, with the magnitude of intervention

Figure 11. *Impact of Exogenous Disturbances: Real Money Balances*
(In percentage deviation from control simulation)




Note: See note to Figure 1.

increasing slowly and reaching its peak five to six years after the original shock. If the wealth effect is recognized, in contrast, the appropriate policy response would consist of a massive initial intervention which diminishes in intensity in subsequent periods.

## IV. Conclusions

This paper has examined the implications of the availability and exhaustibility of oil resources for the economy of Venezuela in the framework of a model that incorporated the concept of exhaustibility and specified the main channels through which the availability of the resource (and the flow of income generated by it) affects economic variables. The estimation and simulation results confirmed that the availability of the resource entails a confidence effect that influences the behavior of the private sector. It was also confirmed that this effect is transmitted through demand for real balances and private expenditures (consumption and investment).

The empirical results indicated that, through its impact on money demand, the confidence effect associated with the availability of oil eventually dampens the inflationary consequences of expansionary policy. The confidence effect, however, adversely influences private saving and investment, and it imparts more significance to the pattern of govern-

ment expenditure—as opposed to its level—in the oil-producing countries compared with other developing countries. This implies that the growth prospects of the economy would depend on the ability of the government, which is the recipient of oil revenues, to embark on adequately productive projects that compensate for the adverse effect of expected oil wealth on the willingness of the private sector to undertake investment and that prepare the country for the eventual depletion of oil resources. A further implication is that private investment would need to be encouraged through incentive schemes that compensate for the adverse influence of oil wealth.

The speed of adjustment in money demand was found to be rapid, whereas that in the real sector tended to be sluggish, implying that changes in monetary disequilibrium are transmitted to the rest of the economy more quickly than are movements in the level of disequilibrium in the goods market. The authorities may thus have more time in containing the impact of real shocks to the economy than they will have in containing the consequences of financial disturbances.

The simulation results also showed that the impact of an increase in oil prices on the economy can be substantially more pronounced in the presence of an oil wealth effect than in its absence. In particular, failure to take the confidence effect of resource availability into account could lead to serious underestimation of the adverse influence of an oil price hike on balance of payments and inflation. Moreover, it was shown that, eventually, the wealth effect tends to dampen the inflationary impact of rising oil prices, but it continues to exacerbate the adverse impact of such developments on the balance of payments. Thus, a major policy challenge facing the authorities during periods of rising oil prices would be that of devising a response that reconciles the dual objectives of balance of payments equilibrium and price stability. Moreover, in designing their policies in the face of disturbances, the authorities would have to keep in mind not only the nature of the shock but also the extent of the wealth effect associated with the country's petroleum resources.

Although the nature and effectiveness of various policy responses that could be initiated to achieve balance of payments equilibrium and price stability in the aftermath of exogenous shocks were not discussed, the simulation results indicated that, at least in the case of monetary policy, the magnitude of the required response is substantially larger if the wealth effect is taken into account. It was also shown that the timing of intervention could be critical to the success of any monetary policy initiative. To devise an appropriate policy response, the authorities would need to know the time paths of the target variables that are likely to emerge both as a consequence of exogenous disturbance and in re-

sponse to a policy intervention. Experiments similar to those conducted in this paper could serve to shed some light on these outcomes.

Although the model performed well in terms of the usual statistical criteria, the policy implications mentioned above need to be interpreted cautiously, primarily because of the small size of the sample and the large number of exogenous variables. In addition, the model needs to be modified slightly to account for the changes in the exchange system of Venezuela that have occurred since early 1983, so that its relevance and robustness could be tested against the developments in the Venezuelan economy during the post-sample period. For example, the model could be rendered more appropriate for policymaking purposes by endogenizing such important variables as the behavior of banks, represented by the excess reserves ratio, and the behavior of the private sector, such as the cash deposit ratio. The model could also be extended to incorporate more explicitly other policy variables, such as the exchange rate.

## APPENDIX

### Data Sources and Simulation Results

All the data used in the study, except for those mentioned below, have been obtained from the International Monetary Fund's *International Financial Statistics* (Washington, various issues).

The index of traded goods price ($p'$) was calculated as the weighted average of trading partners' export prices, adjusted for the exchange rate. The countries and weights used were the following: United States (0.33), Netherlands Antilles (0.14), Canada (0.08), Japan (0.06), Italy (0.06), Brazil (0.04), Federal Republic of Germany (0.03), other (0.26).

The level of oil production ($OP$) and the stock of oil reserves ($S$) in 1982 were obtained from various issues of the *Petroleum Economist* (London). The stock of oil for other periods was obtained as

$$S_t = S_{1982} + \sum_{i=t+1}^{1982} OP_i; \qquad t = 1963\text{–}81.$$

Domestic oil consumption ($DOC$) was obtained from various Fund reports on Venezuela.

The following variables were derived residually:

non-oil GDP, $Y$:

$$Y = GDP - \text{oil exports} - \text{domestic consumption of oil } (DOC);$$

private expenditures, $E$:

$$E = Y - GE - X^n + IM - DINV;$$

private capital inflows (net), $PKI$:

$$PKI = \Delta M - GE + DR - X^n + IM - \Delta CP;$$

domestic government revenues, $DR$:

$$DR = GR - OR.$$

The dummy variable ($D$) was set equal to unity for 1980 and 1981 and equal to zero otherwise. Domestic and foreign interest rates were measured by the rate offered on one-year deposits in Venezuela and by the three-month U.S. Treasury bill rate, respectively.

Simulation results, discussed in Section III of the text, are presented graphically in Figure 12, panels A–J.

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Figure 12. *Dynamic Simulations*
(In millions of bolívares unless noted otherwise)

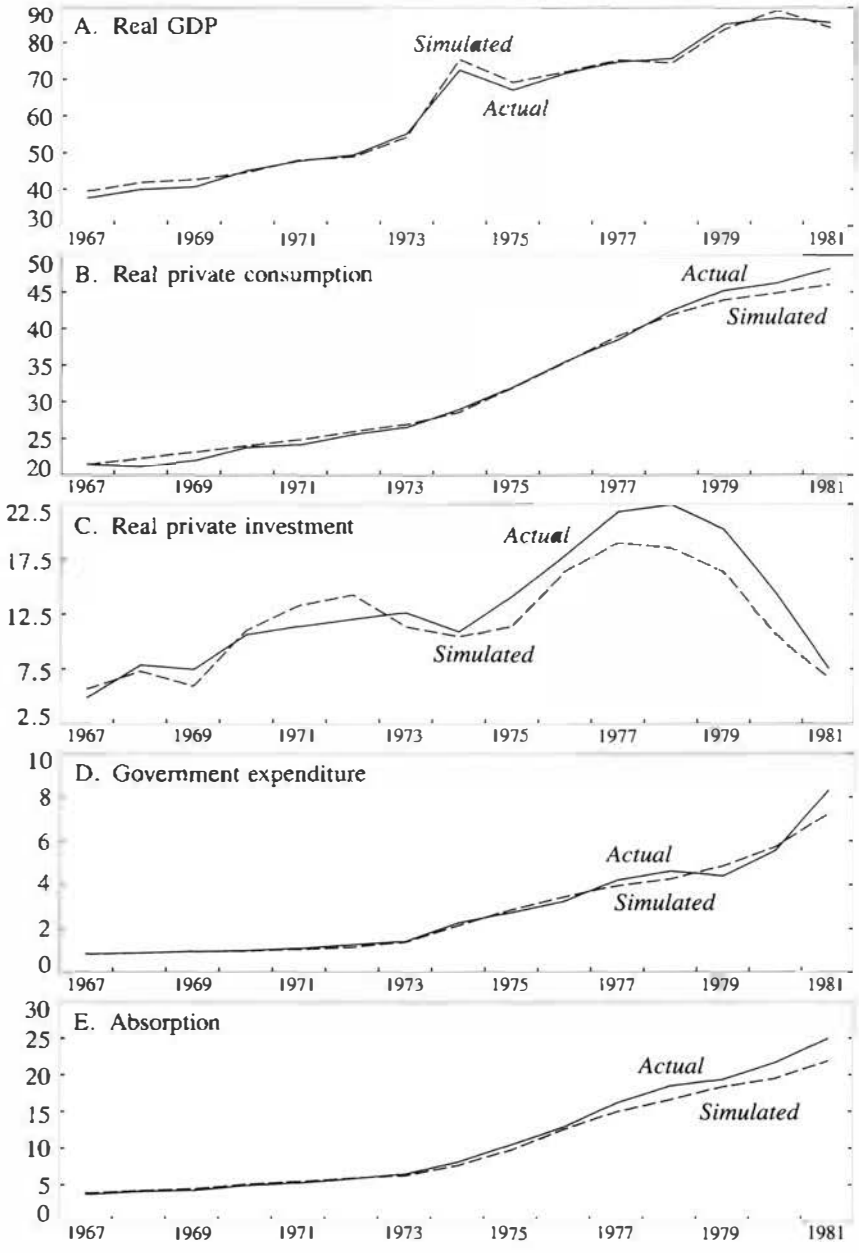
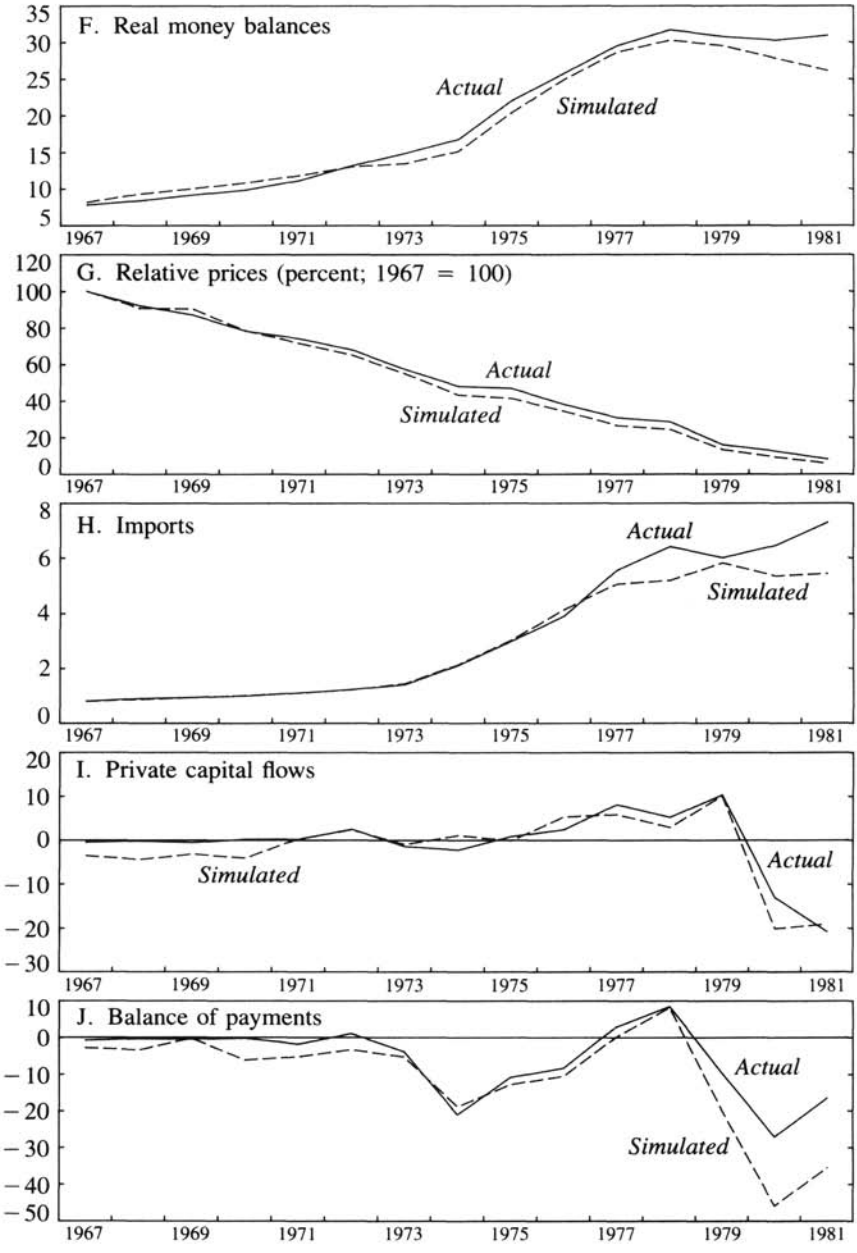


Figure 12. (*concluded*).



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# The Currency Composition of Foreign Exchange Reserves

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*Determinants of the currency composition of foreign exchange reserves are examined for both industrial and developing countries. Empirical results indicate that the currency composition of reserves during the period 1976–85 has been influenced by each country's exchange rate arrangements, trade flows with reserve-currency countries, and the currency in which its debt service payments are denominated. The evidence suggests that managing the currency composition of a country's net foreign asset position is done more cheaply by altering the currency of denomination of assets and liabilities that are not held as reserve assets.* [JEL 431, 432]

ALTHOUGH CONCERNS about official foreign exchange management practices were a key element in the discussions of the Fund's Substitution Account during the 1970s, the emergence of the view that foreign exchange market intervention had little effect on exchange rates subsequently limited the attention focused on this topic. The sharp swings in exchange rates among currencies of the major industrial countries in the 1980s, however, have led to proposals for achieving greater exchange rate stability through the use of coordinated intervention, target zones, or a return to fixed parities. Reserve management practices

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Table 1. *Share of National Currencies in Total Identified Official Holdings of Foreign Exchange, 1976–86*

(In percent)

| Currency | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All countries | | | | | | | | | | | |
| U.S. dollar | 78.8 | 79.2 | 76.1 | 73.2 | 68.6 | 71.5 | 70.5 | 71.2 | 69.4 | 64.2 | 66.2 |
| Pound sterling | 2.2 | 2.1 | 1.8 | 2.0 | 2.9 | 2.2 | 2.5 | 2.6 | 3.0 | 3.1 | 2.8 |
| Deutsche mark | 8.2 | 8.4 | 11.0 | 12.1 | 15.0 | 13.0 | 12.5 | 11.7 | 12.5 | 15.2 | 15.0 |
| French franc | 2.0 | 1.3 | 1.1 | 1.3 | 1.7 | 1.5 | 1.4 | 1.1 | 1.1 | 1.3 | 1.2 |
| Yen | 2.5 | 2.7 | 3.4 | 3.6 | 4.4 | 4.3 | 4.8 | 4.9 | 5.7 | 7.8 | 7.6 |
| Unspecified[a] | 6.2 | 6.1 | 6.5 | 7.6 | 7.4 | 7.5 | 8.2 | 8.4 | 8.4 | 8.4 | 7.2 |
| Industrial countries | | | | | | | | | | | |
| U.S. dollar | 87.0 | 89.0 | 86.2 | 83.5 | 77.6 | 78.7 | 77.1 | 77.4 | 73.6 | 65.4 | 68.8 |
| Pound sterling | 1.8 | 1.7 | 0.7 | 0.8 | 0.8 | 0.7 | 0.8 | 0.9 | 1.6 | 2.1 | 1.6 |
| Deutsche mark | 4.4 | 4.6 | 7.9 | 9.5 | 14.4 | 13.0 | 12.5 | 13.1 | 15.2 | 19.8 | 17.8 |
| French franc | 0.5 | 0.3 | 0.4 | 0.6 | 0.5 | 0.5 | 0.4 | 0.3 | 0.4 | 0.5 | 0.6 |
| Yen | 1.9 | 1.8 | 2.3 | 2.6 | 3.5 | 3.8 | 4.5 | 5.2 | 6.3 | 8.8 | 8.1 |
| Unspecified[a] | 4.3 | 2.6 | 2.5 | 3.0 | 3.2 | 3.2 | 4.7 | 3.2 | 2.9 | 3.4 | 3.1 |
| Developing countries | | | | | | | | | | | |
| U.S. dollar | 71.9 | 69.5 | 62.7 | 62.9 | 59.8 | 64.1 | 63.8 | 64.8 | 64.9 | 62.8 | 62.3 |
| Pound sterling | 2.4 | 2.6 | 3.2 | 3.2 | 5.0 | 3.6 | 4.3 | 4.5 | 4.4 | 4.4 | 4.6 |
| Deutsche mark | 11.5 | 12.3 | 15.2 | 14.8 | 15.5 | 12.9 | 12.6 | 10.3 | 9.7 | 9.9 | 10.7 |
| French franc | 3.3 | 2.3 | 2.1 | 2.1 | 2.9 | 2.5 | 2.5 | 1.9 | 1.7 | 2.2 | 2.2 |
| Yen | 3.0 | 3.6 | 4.8 | 4.6 | 5.3 | 4.9 | 5.1 | 4.7 | 5.0 | 6.7 | 6.8 |
| Unspecified[a] | 7.9 | 9.6 | 12.0 | 12.3 | 11.5 | 12.0 | 11.7 | 13.9 | 14.2 | 14.1 | 13.5 |

Sources: International Monetary Fund, various publications, the *Annual Report*, and staff estimates.

Note: Starting with 1979, the SDR value of European currency units (ECUs) issued against U.S. dollars is added to the SDR value of U.S. dollars, but the SDR value of ECUs issued against gold is excluded from the total distributed here.

[a] This residual is equal to the difference between total identified reserves and the sum of the reserves held in the five currencies listed in the table.

could play an important role in determining the stability of any such arrangements.

This study examines one key aspect of reserve management practices—the factors influencing the currency composition of foreign exchange reserves in both industrial and developing countries for the period 1976–85. In contrast to most earlier analyses that relied on currency composition data for country groups (for example, the industrial countries), our empirical analysis uses individual country data in combined cross-country, time-series regressions. Use of such data avoids the difficulties involved in distinguishing between the changes in the currency composition of a group's foreign exchange reserves because of shifts in the portfolio preferences of the authorities in individual countries from those associated with changes in the distribution of reserves across countries within the group. The results suggest that, although risk and return considerations play some role in determining countries' net foreign asset (liability) positions in different currencies, countries' gross holdings of reserve assets were more strongly influenced by transaction costs.

## I. Trends in the Currency Composition of Foreign Exchange Reserves

Between the end of 1976 and the end of 1986, there was an ongoing diversification of the currency composition of foreign exchange reserves (Table 1).[1]

### Aggregate Data

For all countries combined, the proportion of reserve assets denominated in U.S. dollars has declined from nearly 80 percent at the end of 1976 to 66 percent at the end of 1986, and this shift has been matched by a rise in the proportions held as deutsche mark (from 8 percent to 15 percent) and yen (from 3 percent to nearly 8 percent).[2] However, these

[1] In Table 1, European Currency Units (ECUs) that have been issued by the European Monetary Cooperation Fund to the central banks of the members of the European Monetary System in exchange for the deposits of 20 percent of gold holdings and 20 percent of members' U.S. dollar holdings have not been treated separately. Instead, the value of ECUs issued against U.S. dollars has been added to dollar holdings, and the value associated with gold holdings has been excluded. The discussions of Table I.2 of Appendix I of the Fund's *Annual Report* (1987) provide more detailed information on these adjustments.

[2] The unspecified currencies consist principally of holdings of Netherlands guilders and Swiss francs.

changes in the aggregate currency composition of foreign exchange reserves have encompassed somewhat contrasting behavior on the part of industrial and developing countries. For the industrial countries, the erratic but significant decline in the share of reserves denominated in U.S. dollars—from 87 percent at the end of 1976 to 69 percent at the end of 1986—was accompanied by sharp increases in the shares of the deutsche mark (from 4 percent to 18 percent) and the yen (from 2 percent to 8 percent). For the developing countries, the pattern of currency diversification has been much more uneven. After an initial sharp decline in the dollar's share between the end of 1976 and the end of 1980 (by 12 percentage points), this share was relatively stable between the end of 1981 and the end of 1986. In contrast, although the share of reserves denominated in yen more than doubled over the period between 1976 and 1986, the share of developing country reserves denominated in deutsche mark reached a peak of nearly 16 percent at the end of 1980 before declining to about 11 percent at the end of 1986.

## Previous Studies

Previous analyses of the behavior of the currency composition of foreign exchange reserves have argued that the proportion of foreign exchange reserves denominated in a particular currency should be related either to the currency composition of the authorities' exchange market activities (transaction approach) or to the risks and returns associated with holding reserve assets denominated in different currencies (the mean-variance approach). The transaction approach postulates that the desired currency composition of reserve assets is independent of the optimal distribution of net wealth across currencies. Instead, the holdings of reserve assets denominated in a particular currency would be related to transaction costs associated with the government's purchases and sales of foreign exchange. The alternative mean-variance approach suggests that a rational government would not put all of its wealth in the one currency that has the highest expected yield, because of the possibility of highly variable outcome for its wealth depending on future exchange rates changes. Moreover, countries producing or consuming different goods and services would optimally hold different portfolios of financial assets.[3]

[3] A theoretical and empirical literature has developed relating international asset demand to principles of expected utility maximization. Theoretical papers include Kouri (1977), Kouri and Macedo (1978), Frankel (1979), Krugman (1981), and Dornbusch (1982). Empirical work includes Roll and Solnik (1977), Kouri and Macedo (1978), Macedo (1980), Dornbusch (1982), Healy (1981), and

Heller and Knight (1978) provided evidence in support of the view that transaction needs played a major role in determining the currency composition of reserves. This study explained variations in the proportions of a country's foreign exchange reserves held as assets denominated in the U.S. dollar, pound sterling, deutsche mark, French franc, and other reserve currencies as a function of the country's exchange rate arrangements, which influenced both the foreign currencies bought and sold to defend such arrangements and the share of its trade with a particular reserve-currency country.[4] Their results indicated that countries increased the proportion of their foreign exchange reserves held as a given reserve currency if they pegged their exchange rate to that currency or if the reserve center was an important trading partner.

In the late 1970s and early 1980s, several studies applied optimal portfolio theory to the selection of official reserve portfolios. For example, Ben-Bassat (1980, 1984) argued that a country's optimal reserve-portfolio composition depends on three factors: (1) a country's motivations for holding reserves, (2) the risk and return on the various reserve currencies, and (3) a country's interest in maintaining international currency stability. Establishing the optimal reserve portfolio would first involve identifying the combinations of reserve positions that are on the efficiency frontier (that is, those positions which yield the highest rate of return for a given level of risk as measured by the variance of yields) and then allowing the authorities to select their preferred risk-return combination. Using data from the 1970s, Ben-Bassat (1984) compared actual and optimal reserve portfolios for both developing and industrial countries in 1976 and 1980. For the developing countries, actual and optimal portfolios in 1976 were regarded as similar. Moreover, this group reduced the U.S. dollar share in its actual portfolio between 1976 and 1980, which further reduced the gap between the actual and optimal reserve portfolios. The gap between the actual and optimal reserve portfolios for the industrial countries, however, increased between 1976 and 1980. In addition, the proportion of reserves denominated in the U.S. dollar held by industrial countries that were not part of the Snake arrangements (members of the European System of Narrower Exchange Rate Margins) increased, although the calculated optimal portfolio implied that this proportion should decline.[5]

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von Furstenberg (1981). Asset demand functions derivable from expected utility maximization have been used to estimate the effects of changes in the relative supplies of assets on exchange rates and rates of return. See Branson, Halttunen, and Masson (1977); Frankel (1982); and Dooley and Isard (1983).

[4]That is, the sum of a country's exports plus imports to a particular reserve country divided by the sum of its total exports plus imports.

[5]Macedo, Goldstein, and Meerschwan (1984) examined the optimal diversi-

In evaluating the use of the mean-variance and transaction approaches to explain the currency composition of reserves of developing countries, Dooley (1986) stressed that there were a number of difficulties associated with applying the mean-variance optimal portfolio approach.[6] First, the mean-variance approach typically deals with allocation of wealth to net holdings of particular assets, whereas foreign exchange data refer to gross holdings of particular assets. Second, for the optimal portfolio approach to be useful it must encompass decisions regarding all of the financial positions, whereas reserve holdings constitute only a small subset of potential assets or liabilities. This means that both the yields on a variety of assets and liabilities other than reserve assets and the covariances of these yields with the returns on reserve assets would typically have to be included as determinants of optimal reserve positions. In addition, since reserve decisions are made by central banks that use their reserve instruments for transactions, it may be more efficient for the typical government to alter its net foreign currency position by changing the currency composition of its assets and liabilities that are held as reserves. As a result, the currency composition and level of foreign exchange reserves would most likely reflect the authorities' transaction needs in the foreign exchange market. Finally, mean-variance portfolio considerations would be relevant for a single country, whereas data on the currency composition of foreign exchange reserves considered in most studies have referred to country groups rather than to individual countries. Dooley's empirical analysis supported the view that reserve assets are held for transaction reasons, and the currency composition of such assets was determined by the consideration that they could be easily liquidated and used to make payments.

Recently, Horii (1986) examined reserve-currency diversification during the 1970s and 1980s. Although he noted that the currency composition of reserves should be studied on an individual country basis, Horii

fied portfolio for an agent (not necessarily a central bank) operating in international financial markets. On the basis of data from April 1973 to March 1981, they calculated the optimal portfolio for investors holding gold and short-term financial assets denominated in eight major currencies. The minimum-variance portfolio was found to include long positions in four currencies (98 percent in deutsche mark) and gold, and short (net negative) positions in four currencies (including the U.S. dollar). The net negative positions were interpreted as borrowing in the particular currency.

[6]Many earlier studies had concluded that the dollar-denominated proportion of the foreign exchange reserves of developing countries had varied over a narrow range and that observed changes mainly reflected exchange rate changes. Dooley (1986) noted, however, that net currency positions had changed sharply as the share of net liabilities denominated in the U.S. dollar rose from 25 percent to 60 percent of developing countries' total net external liabilities between 1974 and 1979. See also Dooley (1982).

focused on country group data because individual country data were unavailable. After allowing for factors that altered the distribution of reserves across countries, he argued that, for all countries during the 1970s and 1980s, there was no large-scale diversification out of reserve assets denominated in the U.S. dollar. There was, however, some evidence of a movement out of reserves denominated in pounds sterling in 1972–76, a small shift from dollar- to deutsche-mark-denominated instruments in 1976–79 (mainly because of passive exchange rate changes), and a slight diversification out of dollar-denominated instruments in 1980–84. These results led Horii to conclude that the currency composition of reserve holdings could not be explained in terms of a transaction demand determined by trade flows alone, since capital flows have become increasingly important. Moreover, the stability of the currency composition of reserves during a period of significant changes in exchange rate arrangements did not support the view that such arrangements were important determinants of the currency composition, as suggested by Heller and Knight (1978). Finally, Horii calculated the reserve portfolios that should have existed under efficient portfolio theory for 1979 (using data from 1974 to 1979) and 1984 (using data from 1979 to 1984). In general, optimal holdings for reserves denominated in U.S. dollars were well below actual holdings in both years. In contrast, actual holdings of reserves denominated in deutsche mark, French francs, and pounds sterling were well below their calculated optimal levels.

## II. Analysis of Currency Composition of Foreign Exchange Reserves on the Basis of Country Data

Our analysis focuses on developing and testing an empirical model that integrates the mean-variance and transaction approaches to specifying the determinants of the currency composition of foreign exchange reserves. It is argued that, although a country's net foreign currency position in influenced in important ways by risk and return considerations, its gross holdings of foreign exchange reserves will be motivated principally by transaction concerns. In measuring these transactions needs, however, it is important to consider the scale of both trade and capital flows that the authorities are likely to encounter in the foreign exchange market. The model is a direct complement to those models of the demand for reserves that relate holdings of reserves to the scale of a country's imports, its degree of openness, and the variability of the country's balance of payments.[7] Whereas such models seek to explain

[7]Lizondo and Mathieson (1987) have provided a comparison of empirical estimates of alternative specifications of these models.

the overall holdings of reserves and take the currency composition of these reserves as exogenous, this study attempts to identify the determinants of the currency composition while taking overall holdings of foreign exchange reserves as exogenous.

The empirical analysis is based on a cross-country, time-series analysis of the International Monetary Fund's data on the currency composition of foreign exchange reserves for *individual* industrial and developing countries during the period 1976–85. As already noted, these data allow us to avoid one of the principal shortcomings of most previous studies of the currency composition of foreign exchange reserves, which have used data on the portfolio holdings of country groups rather than those for individual countries. In particular, the use of data for country groups makes it impossible to distinguish between changes in the currency preferences of individual countries and shifts in the distribution of reserves across countries that are members of the group.[8]

The empirical results suggest that both developed and developing countries take into account the currency composition of their foreign exchange market transactions, as well as the nature of their exchange rate arrangements, when selecting the currency denomination of their foreign exchange reserves. Moreover, for developing countries, the currency composition of debt service flows has been as important as trade flows in determining the proportions of foreign exchange reserves held in each of the major reserve currencies.

## Basic Model

In this section we consider a simple model that incorporates the role of the transaction costs into the traditional mean-variance approach to the determination of a country's optimal portfolio of external assets and liabilities. It is argued that, although the mean-variance approach provides a description of the authorities' *net* foreign asset (or liability) positions in each potential currency of denomination, the structure of transaction costs as well as the scale of a country's anticipated foreign exchange market transactions are the principal determinants of each country's *gross* asset positions, including its holdings of foreign exchange reserves.

In the standard optimal international portfolio model (see Roll (1977), Macedo (1980), and Horii (1986)), the optimal proportion of currency $i$

[8]Dellas and Yoo (1988) also used data from a single country (the Republic of Korea).

in a country's net foreign asset portfolio is determined by the expected real returns on holding positions in different currencies as well as by the covariances between the yields. If $x_i$ represents the proportion of currency $i$ in the authorities' portfolio and $X$ is the vector of the $x_i$, then the mean ($m$) and variance ($\sigma^2$) of the return on the net foreign asset position will be given by

$$m = X'R \tag{1}$$

$$\sigma^2 = X'VX, \tag{2}$$

where $R$ is the vector of expected real returns on maintaining a position in the various currencies and $V$ is the covariance matrix of expected real yields.[9]

Under the assumption that the authorities' utility is positively related to the expected return on their portfolio and negatively related to portfolio risk (for example, if $U = m - (b/2)\sigma^2$), the optimal vector of portfolio positions ($X^*$) will be given by (see Horii (1986)):

$$X^* = V^{-1}e/e'V^{-1}e + (1/b)V^{-1}[R - (R'V^{-1}e/e'V^{-1}e)e], \tag{3}$$

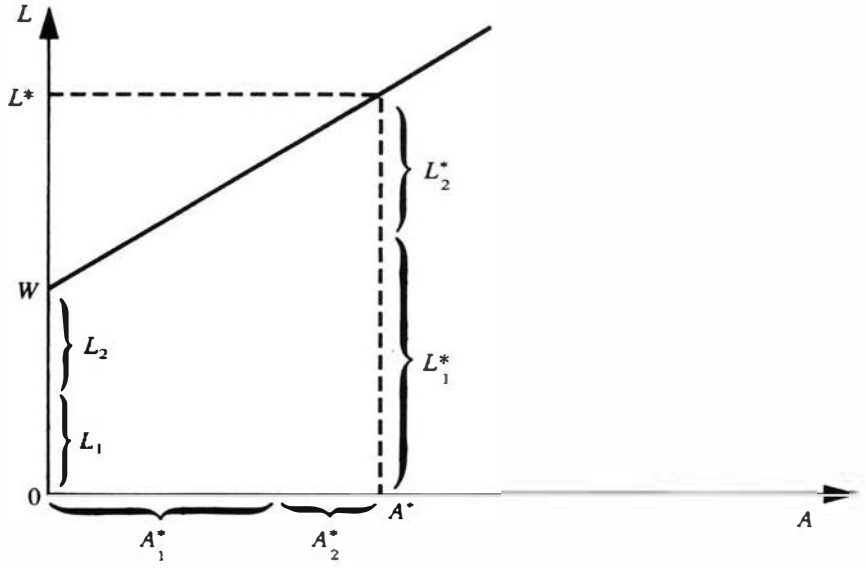
where $e$ is the unit vector and $b$ is the degree of relative risk aversion.

To illustrate the relationship between net and gross asset positions implied by the solution to equation (3), it is convenient to focus on the situation in which there are only two currencies: U.S. dollars (currency 1) and deutsche mark (currency 2). Let $A_i$ represent the holdings of assets in currency $i$, $L_i$ be the issuance of liabilities in currency $i$, and $N_i$ equal the net asset position in currency $i$ ($= A_i - L_i$). Moreover, let the country be a net debtor, where $W$ ($< 0$) represents the overall size of its net debt position (taken as exogenous).[10] Assume that the solution to equation (3) indicates that the optimal net portfolio implies that half of the country's debtor position should be denominated in dollars and half in deutsche mark ($N_1 = N_2$). A country with $A^*$ in gross assets can still maintain its desired net debt position in each currency ($N_1 = N_2$) by altering the currency denomination of its liabilities ($L^*$). Suppose, for example, that to minimize transaction costs the authorities chose to hold most of their gross assets in dollars, so that $A_1^* > A_2^*$ (Figure 1). To maintain their desired *net* positions in each currency, the country would

[9]The expected real yield on a position in currency $i$ ($r_i$) is defined to equal the nominal yield adjusted for the anticipated changes in the exchange rate and the inflation rate for domestic prices.

[10]Let total foreign assets be given by $A$ ($= A_1 + A_2$ if the exchange is initial equal to unity) and total foreign liabilities be given by $L$ ($= L_1 + L_2$). Thus, $W = A_1 + A_2 - L_1 - L_2$.

Figure 1. *Gross and Net Foreign Asset and Liability Positions*




have to issue dollar and deutsche mark gross liabilities such that $L_1^* - A_1^* = L_2^* - A_2^*$. This implies that the theory of optimal *net* foreign exchange positions places no obvious theoretical restrictions on the currency denomination of a country's *gross* reserve position.[11]

In this two-currency model, the roles of transaction costs and risk-return considerations in determining a country's net and gross asset positions can be described more formally as follows. As noted earlier, let $A_i$ be gross holdings of reserve assets denominated in currency $i$, and let $L_i$ be the gross external liabilities issued in that currency. The country can hold reserve assets in currency $i$ that yield a random real world interest rate that has a mean of $r_i$ and a variance of $\sigma_{r_i}^2$. Alternatively, the country can borrow in currency $i$ and must pay $r_i + d_i$, where $d_i$ is a positive constant that reflects the spread between the lending and borrowing rates. The net interest earned on a given net asset position is $r_i(A_i - L_i) - d_i L_i$.

[11] If the desired position cannot be met by manipulation of gross assets and liabilities, the same results could be attained by using forward exchange contracts.

The expected return on the country's foreign asset and liability positions will be given by

$$\begin{aligned} m &= r_1 A_1 + r_2 A_2 - (r_1 + d_1)L_1 - (r_2 + d_2)L_2 \\ &= (r_1 + d_1)N_1 + (r_2 + d_2)N_2 - d_1 A_1 - d_2 A_2, \end{aligned} \tag{4}$$

where $N_i = A_i - L_i$. The variance of this return will therefore equal

$$\sigma^2 = N_1^2 \sigma_{r_1}^2 + N_2^2 \sigma_{r_2}^2 + 2N_1 N_2 \sigma_{r_1 r_2}, \tag{5}$$

where

$\sigma_{r_i}^2$ = the variance of yield $r_i$
$\sigma_{r_i r_j}$ = the covariance of yields $r_i$ and $r_j$.

In addition to earning net interest income, the authorities also incur transaction costs associated with their exchange market transactions.[12] To simplify, assume that the amount of transactions the country undertakes in each currency in each time period can be described by three possible states of nature (Figure 2):

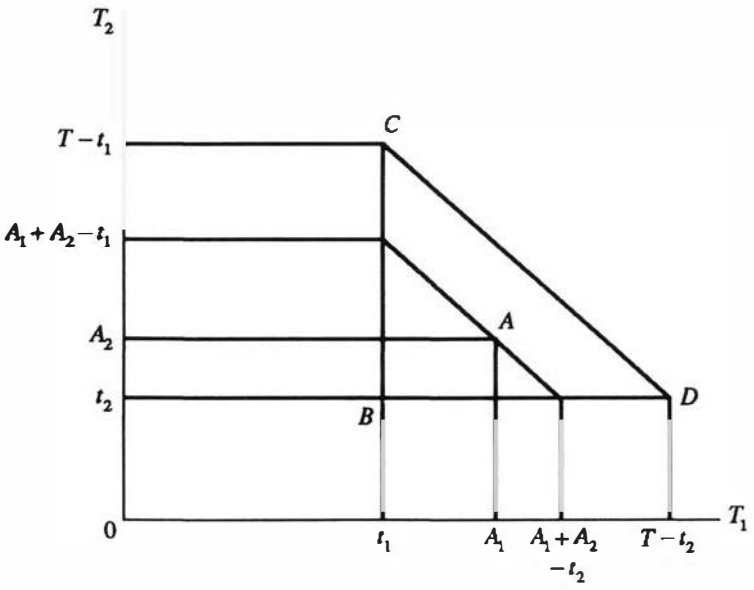
$(t_1, t_2)$ occurs with probability $\pi_1$ (point $B$ in Figure 2)
$(t_1, T - t_1)$ occurs with probability $\pi_2$ (point $C$ in Figure 2)
$(T - t_2, t_2)$ occurs with probability $\pi_3$ (point $D$ in Figure 2),

with $T > t_1 + t_2$ and $\pi_1 + \pi_2 + \pi_3 = 1$.

Given this transaction structure, the country faces transaction costs that are influenced by two factors. First, there is the cost of converting one currency into another. If the authorities hold sufficient reserves denominated in a given currency ($A_i$) to meet the exchange market transactions in that currency, then it is assumed that the authorities do not incur any transaction cost. For example, assume that the authorities' holdings of reserves are represented by point $A$ in Figure 2, with $A_1$ of currency 1 and $A_2$ of currency 2. If actual transactions $t_1$ and $t_2$ (point $B$ in Figure 2), the country would not incur any transaction costs because its reserve holdings in each currency would be sufficient to meet all transactions in the respective currencies. When the transactions are such that the authorities exhaust their holdings of reserves denominated in one currency, however, the authorities must convert the holdings of reserves denominated in the other currencies into the first currency, and this results in transaction costs. In Figure 2, for example, if actual transactions were represented by either point $C$ or $D$, the authorities would

[12] These transactions could include exchange market intervention designed to sustain an exchange rate policy or official purchases of foreign goods and services.

Figure 2. *Reserve Holdings and Transaction Structure*




incur the costs of converting reserves from one currency to another currency because the amount of reserves in one of the currencies will be lower than the level of transactions in that currency.

The second type of cost is associated with the possibility that the authorities may exhaust their reserve holdings. As Figure 2 is drawn, points $C$ and $D$ represent situations in which the country's total reserves are inadequate. Such an outcome could force the authorities to engage in emergency borrowing, which is assumed to be relatively costly.

The costs of converting currencies or of engaging in emergency borrowing to offset reserve shortages are taken as being represented by quadratic functions of the amounts involved. In terms of Figure 2, if the outcome of transactions is $B$, there is no transaction cost because the level of reserves held in each currency is higher than the level of transactions in the respective currency, $A_1 > t_1$ and $A_2 > t_2$. If the outcome is $C$, holdings of currency 1 are higher than transactions in that currency, $A_1 > t_1$, but holdings of currency 2 are lower than transactions in that currency, $A_2 < T - t_1$. In addition, total holdings of reserves $A_1 + A_2$ are lower than total transactions $T$. Therefore, there is a cost associated with the conversion of the excess of currency 1 into currency 2, $A_1 - t_1$, and

a cost associated with the overall shortage of reserves, $T - A_1 - A_2$. The same type of reasoning applies to outcome $D$. As a result, the expected conversion and reserve-shortage costs for holdings of reserves $A_1$ and $A_2$ are given by[13]

$$E(tc) = \pi_2 c(A_1 - t_1)^2 + \pi_3 c(A_2 - t_2)^2 + (\pi_2 + \pi_3)p(T - A_1 - A_2)^2, \tag{6}$$

where $c$ and $p$ are parameters associated with the conversion of reserves from one currency to another and with reserve shortages, respectively.

In determining their holdings of foreign assets and issuance of foreign liabilities, the authorities are assumed to maximize a utility function that is a positive function of the expected return ($m$) on their net foreign asset portfolio (net of expected transaction and emergency borrowing costs) and is negatively related to the variance ($\sigma^2$) of the yield on that portfolio. In particular, the authorities select $A_1$, $A_2$, $L_1$, and $L_2$ subject to the constraint imposed by the size of their overall net foreign asset position, $W = A_1 + A_2 - L_1 - L_2 = N_1 + N_2$ (where $W$ can be either positive or negative). Thus,

$$U = m - b\sigma^2 - E(tc), \tag{7}$$

where

$$\begin{aligned} m &= (r_1 + d_1)N_1 + (r_2 + d_2)(W - N_1) - d_1A_1 - d_2A_2 \\ &= (r_2 + d_2)W + (r_1 + d_1 - r_2 - d_2)N_1 - d_1A_1 - d_2A_2 \\ \sigma^2 &= N_1^2\sigma_{r_1}^2 + (W - N_1)^2\sigma_{r_2}^2 + 2N_1(W - N_1)\sigma_{r_1r_2}, \end{aligned}$$

and where $E(tc)$ is as defined in equation (6).

As shown in Appendix II, the first-order conditions yield

$$N_1 = \frac{(r_1 + d_1 - r_2 - d_2)}{2bD} + W\frac{(\sigma_{r_2}^2 - \sigma_{r_1r_2})}{D} \tag{8}$$

$$N_2 = \frac{(r_2 + d_2 - r_1 - d_1)}{2bD} + W\frac{(\sigma_{r_1}^2 - \sigma_{r_1r_2})}{D}, \tag{9}$$

where $D = \sigma_{r_1}^2 + \sigma_{r_2}^2 - 2\sigma_{r_1r_2}$, and $A_1$ and $A_2$ are given by

$$A_1 = \frac{\pi_3 A + \pi_2 t_1 - \pi_3 t_2}{(\pi_2 + \pi_3)} + \frac{d_2 - d_1}{2c(\pi_2 + \pi_3)} \tag{10}$$

[13]This formula strictly applies only for points within the triangle $BCD$ in Figure 2. However, it can be shown that, with appropriate restrictions on the parameters of the model, only those points are relevant. Analyzing points outside the triangle $BCD$ would lengthen the discussion without adding new insights.

$$A_2 = \frac{\pi_2 A + \pi_3 t_2 - \pi_2 t_1}{(\pi_2 + \pi_3)} + \frac{d_1 - d_2}{2c(\pi_2 + \pi_3)} \tag{11}$$

$$A = \frac{2p(\pi_2 + \pi_3)^2 T + 2c\pi_2\pi_3(t_1 + t_2) - (\pi_3 d_1 + \pi_2 d_2)}{2p(\pi_2 + \pi_3)^2 + 2\pi_2\pi_3 c}. \tag{12}$$

Equations (8) and (9) imply that the country's *net* foreign asset positions in each currency are determined by the expected yields (or borrowing costs), the variances and covariances of these yields, and the degree of relative risk aversion; these positions, however, are independent of the structure of transaction costs or the likely volume of exchange market transactions. In contrast, equations (10)–(13) imply that *gross* holdings of reserve assets will be influenced by transaction costs associated with currency conversion and reserve shortages, and by the minimum and maximum levels of potential exchange market transactions. As a result, the currency composition of foreign exchange reserves will also reflect these transaction considerations.

## Empirical Model

The hypothesis that transaction needs are the principal determinants of the currency composition of foreign exchange reserves can be examined in terms of the behavior of the proportion of reserves denominated in each of the major reserve currencies. In particular, equations (10) and (11) imply that the currency composition of reserves (as represented by $A_i/A$) would be sensitive to the scale of transactions in a given currency relative to total transactions (as well as other variables). But the scale of exchange market transactions undertaken by the authorities would also be influenced by the nature of the exchange rate arrangements they select. For example, maintaining a fixed exchange rate might require a higher level of exchange market intervention in a particular currency than maintaining a floating exchange rate. This relationship between the currency composition of reserves, the relative scale of exchange market transactions in different currencies, and exchange rate arrangements can be represented empirically by

$$\frac{A_{i,k,t}}{\bar{A}_{i,t}} = \beta_0 + \sum_{\substack{v=1 \\ v \neq i}}^{5} \beta_{1,v}(TR_{i,v,t}/TT_{i,t}) + \sum_{\substack{v=1 \\ v \neq i}}^{5} \beta_{2,v}(D_{i,v,t}/TT_{i,t})$$

$$+ \sum_{s=1}^{5} \beta_{3,s} E_{i,s,t} + \mu_{i,t}, \tag{13}$$

where

$t = 1, \ldots, T$ (number of periods)
$i = 1, \ldots, n$ (number of countries)
$k = 1, \ldots, 5$ (number of reserve-currency countries)
$s = 1, \ldots, 5$ (number of exchange rate arrangements)
$A_{i,k,t}$ = reserves of country $i$ held as assets denominated in the currency of reserve country $k$ at time $t$ (converted to U.S. dollars at the end of the period)
$D_{i,v,t}$ = debt service payments of country $i$ denominated in the currency of reserve currency country $v$ at time $t$
$E_{i,s,t}$ = exchange rate arrangement of type $s$ adopted by country $i$ at time $t$
$\bar{A}_i,t$ = total end-of-period foreign exchange reserves for country $i$ at time $t$ (measured in U.S. dollars)
$TT_{i,t}$ = sum of exports, imports, and (in the case of developing countries) debt-servicing payments
$TR_{i,v,t}$ = trade flows (exports plus imports between country $i$ and reserve currency country $v$) at time $t$.

In this formulation, the proportion of a country's reserves held in assets denominated in a particular currency is assumed to be influenced by the currency composition of both its trade flows and debt-servicing payments as well as by the nature of its exchange rate arrangements. Trade transactions denominated in a particular reserve currency are represented by the sum of imports and exports between country $i$ and reserve-currency country $v$. The reserve-currency countries in this study are taken to be France, the Federal Republic of Germany, Japan, the United Kingdom, and the United States. Because the currency composition of a country's import and export contracts need not correspond to the country pattern of its trade flows (for example, contracts for oil imports from a Middle East oil producer could be denominated in U.S. dollars), this measure can be taken as only an approximation to the true proportion of trade flows denominated in a particular currency. Despite these shortcomings, earlier studies (for example, by Heller and Knight (1978)) of the currency composition of foreign exchange reserves have found that this measure of the distribution of trade flows is a useful explanatory variable. However, the signs of the $\beta_{i,v}$ are subject to some ambiguity. Although an increase in trade flows to a given reserve currency $v$ would be likely to lead to increased holding of reserves denominated in that reserve currency ($\beta_{i,v} > 0$), the signs of the other $\beta_{i,v}$ ($i \neq v$)

could be either negative or positive. For example, larger imports from reserve-currency country A could imply the need for larger holdings of reserve country B's currency if some of these imports were priced in terms of B's currency.

Because data on financial flows are not available for most countries, the scale of financial flows was proxied by the level of interest payments associated with the country's external debt denominated in the different currencies. External debt was measured in terms of a country's public and publicly guaranteed debt as reported in the World Bank's *World Debt Tables* (various issues). Because these data are reported by currency of denomination, the interest payments in the different currencies were approximated by multiplying the stock of debt denominated in each currency by the six-month Eurocurrency deposit rate for that currency. Obviously, this measure captures only one component of financial flows; but, for many of the developing countries in the sample, interest payments on external debts account for a significant portion of total financial flows.

The effects of a country's exchange rate arrangements on the currency composition of its foreign exchange reserves were represented by a series of dummy variables corresponding to the type of arrangements used by a country during each year under consideration. The arrangements were classified into categories similar to those used in the Fund's *Annual Report on Exchange Rate Arrangements and Trade Restrictions* (various issues). The categories include pegging to the U.S. dollar, pegging to the French franc, pegging to a composite or other currency, membership in a cooperative arrangement, and maintenance of a flexible exchange rate.[14] Although the placement of countries within this spectrum of arrangements is to some degree arbitrary, these categories do reflect the employment of greater or lesser degrees of exchange rate flexibility. In the regressions, a country's exchange rate arrangement is represented by a series of zero-one dummy variables, one for each type of arrangement. Because there is a general intercept term in each regression (the $\beta_0$) and the set of exchange rate arrangements is exhaustive, one of the exchange rate dummies was excluded in each regression to avoid creating a linear dependency. The $\beta_0$ in each regression therefore reflect the effects of both the excluded exchange rate arrangement and other factors not represented by trade and capital flows.

Because earlier analyses found that the behavior of the currency composition of reserves of the industrial and developing countries differed,

[14] This last category includes independent floaters, those countries with managed floating, and those countries with other flexible arrangements.

the present study examines separate regressions for these groups. Moreover, although the World Bank reporting system for debt contains extensive information on the currency composition of the external debt of the developing countries, no such comparable reporting system exists for industrial countries. Some industrial countries do not appear to have any external debt denominated in foreign currencies (for example, the Federal Republic of Germany and Japan), but many others (for example, certain Scandinavian countries) have significant amounts of such debt. The absence of comprehensive information on the currency composition of external debt for the industrial countries means, however, that the interest payments variable has been excluded from the industrial country regressions.

This specification was estimated using data on the currency composition of foreign exchange reserves supplied to the International Monetary Fund on a regular basis by a large number of central monetary institutions. A series of five cross-section time-series regressions for each of the groups of industrial and developing countries were estimated. In these regressions, the dependent variables were the proportion of foreign exchange reserves held as instruments denominated in U.S. dollars, pounds sterling, deutsche mark, French francs, and yen. The explanatory variables were the exchange rate regime, the five variables representing trade with the reserve centers (as a proportion of total trade plus interest payments), and, in the case of developing countries, five variables reflecting the interest payments on external debt (as a proportion of total trade plus interest payments). Data from a total of 19 industrial countries and 39 developing countries were included.[15] The data consist of annual observations for each country's variables for the period 1976–85. Note that in this formulation the marginal effects of exchange rate arrangements, trade flows, and interest payments are assumed to be uniform across countries (that is, there are no country-specific parameters).[16]

## Estimation Methods

Estimation of equation (13) using ordinary least-squares techniques would in general be inappropriate, since the dependent variable can only

[15] Other countries were excluded because of incomplete information on reserve holdings, trade flows, or external debt.

[16] It might be useful to allow for country-specific parameters, but these would provide information about individual holdings that would violate the confidentiality of the data file.

take values in the interval (0, 1). To illustrate the nature of the problems involved, let the standard regression model be represented by

$$y_i = \beta' x_i + u_i, \tag{14}$$

where $\beta$ is a $k \times 1$ vector of unknown parameters; $x_i$ is a $k \times 1$ vector of known independent variables, and the $u_i$ are residuals independently and normally distributed with a mean of zero and a common variance of $\sigma^2$. Because the $u_i$ are assumed to be distributed normally, this model implies that $y_i$ may take any positive or negative value, which is inconsistent with the particular dependent variable in the problem.

More appropriate for the purposes here is the censored-regression model, also known as the tobit model.[17] In this particular case, the tobit model can be represented by

$$y_i = \beta' x_i + u_i \tag{15}$$

if the right-hand side is greater than zero but less than unity,

$$y_i = 0 \tag{16}$$

if the right-hand side is less than or equal to zero, and

$$y_i = 1 \tag{17}$$

if the right-hand side is greater than or equal to unity, and where the $\beta$ and $u_i$ are defined as above. This model implies that the authorities decide on the share of a particular currency in their foreign exchange reserves according to the linear function in equation (15), but they hold a share of either zero or unity when that linear function indicates a negative share or a share higher than unity, respectively.

Estimation of a censored-regression model by ordinary least squares results in biased and inconsistent estimators. Maximum likelihood estimators, on the other hand, are consistent and asymptotically normal (see Amemiya (1973)). Among the various procedures available to obtain maximum likelihood estimates, we used an iteration method suggested by Fair (1977).[18] Although the problem examined in this paper is strictly described by the two-limit censored-regression model in equations (15)–(17), we estimated a one-limit model because there were virtually no observations on the upper limit,[19] and observations on both limits are

[17]Tobin (1958) was the first to discuss the estimation of the parameters of the truncated normal distribution in the regression context and to relate that technique to the literature on probit analysis.

[18]For a description of other procedures, see Maddala (1983).

[19]There were some countries that held only French francs or U.S. dollars during some time periods.

needed to estimate a two-limit model.[20] Therefore, the estimated model was

$$y_i = \beta' x_i + u_i \tag{18}$$

if the right-hand side is greater than zero, and

$$y_i = 0 \tag{19}$$

otherwise.

As indicated by Dhrymes (1986), it is convenient to have goodness of fit statistics for observations with $y_i > 0$ that are separate from those for observations with $y_i = 0$. For the set of observations with $y_i > 0$, we have therefore used the square of the simple correlation coefficient between the predicted and actual values of the dependent variable ($R^2_{T1}$).[21] For the set of observations with $y_i = 0$, we calculated the proportion of observations correctly predicted to be zero by the model ($R^2_{T2}$) and the mean error ($\bar{E}_T$) for the observations for which the model incorrectly predicted $y_i > 0$.[22] To give an idea of the overall goodness of fit, we also calculated the square of the simple correlation coefficient between predicted and actual values of the dependent variable for the complete sample ($R^2_{T3}$).[23]

One difficulty with the tobit maximum likelihood estimator is that it is sensitive to violations of the assumptions that its error terms have a normal distribution and are homoscedastic. The presence of either nonnormality (see Goldberger (1983)) or heteroscedasticity (see Hurd (1979)) can result in inconsistent tobit estimates. However, Powell (1986) has recently developed estimators that are robust for a wide set of nonnormal or heteroscedastic disturbance distributions. As noted by Newey (1987), Powell's symmetrically censored least-squares (SCLS) estimator not only provides estimates of the regression parameters that are robust to failure in the normality assumption but also make feasible Hausman (1978) tests for the presence of heteroscedasticity or nonnormality on the basis of differences between the tobit estimates and the SCLS estimators.

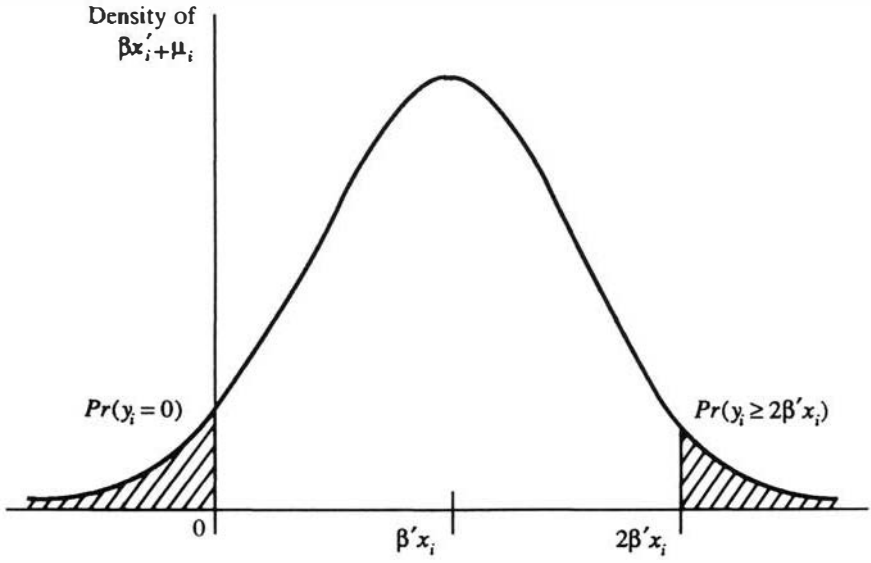
[20] For a discussion of the estimation of two-limit models, see Rosett and Nelson (1975).

[21] There are three types of predictions of $y_i$ given $x_i$. One is the unconditional prediction of $y_i$. Another is the prediction of $y_i$ given the information that $y_i > 0$. The third type of prediction requires a slight reinterpretation of the model. In this reinterpretation, $y_i^* = \beta' x_i + u_i$, where $y_i^*$ is a latent variable; then $y_i = y_i^*$ if $y_i^* > 0$, and $y_i = 0$ otherwise. The third type of prediction is the prediction of the latent variable $y_i^*$. Each one of these predictions is usef l for a particular purpose. For a disussion, see Maddala (1983). For the statistic suggested by Dhrymes (1986), we used the conditional prediction of $y_i$.

[22] In this case, the prediction of the latent variable is the appropriate one.

[23] The unconditional prediction of $y_i$ must be used in this case.

Figure 3. *Symmetrically Censored Least Squares*




Source: Powell (1986, p. 1439)

If the normality or homoscedasticity assumptions are violated, then the use of the SCLS estimator involves symmetrically censoring the dependent variable so that symmetry of its distribution about the regression ($\beta' x_i$) is restored, and least-squares techniques will yield consistent estimators. The nature of the SCLS procedures can be illustrated by Figure 3.[24] As given in equations (18) and (19), $y_i = \max \{0, \beta' x_i + u_i\}$ $(i = 1, \ldots, T)$. In a censored sample, for data points with $u_i < -\beta' x_i$, the value of $y_i$ is taken to be zero. In contrast to the sided (lower-bound) censoring of the tobit model, however, the SCLS procedures set $y_i$ equal to $2\beta' x_i$ when $u_i > \beta' x_i$. Then the observations would have terms in the interval $(0, 2\beta' x_i)$. Because this approach assumes that the original errors were distributed symmetrically, the residuals of the "symmetrically censored" regressions will also be symmetrically distributed about zero, and the dependent variable will take on values between zero and $2\beta' x$ and will be symmetrically distributed about $\beta' x$ (Figure 3). For such a symmetric sample, Powell (1986) derived a series of "normal" equations

[24] Taken from Powell (1986, p. 1439).

that allowed for the estimation of the SCLS parameter ($\beta_s$) as well as their standard errors (see Appendix III for the normal equations).[25]

In addition, Newey (1987) has shown that one can use the tobit and SCLS estimates (and their variance-covariance matrices) to derive a Hausman test statistic ($h$) which tests to see if the normality and homoscedasticity assumptions of the tobit analysis are violated. If $\hat{\beta}_t$ and $\hat{\beta}_s$ are the vectors of tobit and SCLS estimated parameters, then $h = T(\hat{\beta}_s - \hat{\beta}_t)' [V(\hat{\beta}_s - \hat{\beta}_t)]^{-1} (\hat{\beta}_s - \hat{\beta}_t)$, where $T$ is the number of observations, $V(\hat{\beta}_s - \hat{\beta}_t)$ are estimates of the asymptotic covariance matrix for $T(\hat{\beta}_s - \hat{\beta}_t)$, and $h$ will be distributed as $\chi^2$ with $k$ (number of exogenous variables) degrees of freedom. (See Appendix III for the estimate of $V(\hat{\beta}_s - \hat{\beta}_t)$.) In the empirical analysis that follows the SCLS and tobit estimates are examined to see if the normality and homoscedasticity assumptions have been violated.

## Empirical Results

The empirical results indicate that transaction variables and exchange rate arrangements have played important roles in determining the currency composition of foreign exchange reserves throughout the period 1976–85. The estimation results for both the developing and industrial countries for the period 1976–85 are reported in Tables 2–11, which appear together, for ease of comparison, following the appendices.

### *Developing Countries*

The estimation results support the view that, for developing countries, the proportions of foreign exchange reserves held as U.S. dollars, French francs, and yen were most strongly influenced by exchange rate arrangements, especially when the country was pegged to a particular currency. For example, developing countries whose exchange rates were pegged to the U.S. dollar held significantly larger proportions of their foreign exchange reserves as dollars. In addition, countries pegged to the French franc tended to hold a much lower proportion of dollars and higher proportion of French francs. In contrast, countries pegged to other currencies or to composite indicators tended to hold significantly

[25] As with all limited dependent variable estimators, the presence of serial correlation in the error terms would result in inefficient estimates. In cross-sectional estimation, such serial correlation is not typically a problem, but the present data combine both time-series and cross-country data, so that there could be a potential problem. Unfortunately, no appropriate test statistic with a known distribution has been developed to identify the extent of any serial correlation in combined cross-section and time-series analysis.

higher proportions of reserves denominated in the yen, which were offset by lower holdings of U.S. dollars and French francs.

These results also imply that an increase in the proportion of trade between a given developing country and a particular reserve-currency country (relative to the developing country's total external payments) resulted in a significantly higher share of the country's foreign exchange reserves being held in the currency of that reserve-currency country. In contrast, the cross effects of trade flows (for example, the influence of increased trade with France on the country's holdings of U.S. dollars) showed a more mixed pattern, with some significant and positive coefficients (implying that the currencies were complements) and some negative and significant coefficients (implying that the currencies tended to be substitutes).

The proportions of interest payments on the external debt denominated in particular reserve currencies (relative to total external payments) were also a key variable in the developing country regressions. In all cases, the proportions of foreign exchange reserves denominated in a given reserve currency (except for the yen) were positively and significantly related to the proportion of interest payments denominated in that currency. Moreover, eight of the cross-effect parameters were significantly negative. These parameter estimates imply that a rise in the share of a country's external debt denominated in a given currency (for example, the deutsche mark) resulted not only in a higher share of foreign exchange reserves held in that currency, but also in a reduction in the shares of reserves held in other reserve currencies included in the study (for example, the U.S. dollar).[26]

The correlation measures for both the ordinary least-squares and tobit estimators suggest that the explanatory power of these equations varies considerably for the different currencies.[27] Although the regressions explained 99 percent of the observed variation in the share of foreign exchange reserves held as French francs, only 55 percent of the variation in the U.S. dollar share could be explained. The explanatory power de-

[26]Holdings of certain unspecified currencies were excluded from the study.

[27]As noted earlier, four measures of goodness of fit are supplied for each of the tobit regressions. The $R^2_{T1}$ measures the square of the simple correlation coefficient between the predicted and actual values of the dependent variable for those observations in which the actual values were positive; $R^2_{T2}$ measures the proportion of the zero observations correctly predicted by the model; $\bar{E}_T$ is the mean error for the observations that were predicted to be positive but whose actual value was zero; and $R^2_{T3}$ is the square of the simple correlation coefficient between actual and predicted values of the dependent variable for the complete sample.

clined to about 50 percent, 40 percent, and 30 percent for the pound sterling, the deutsche mark, and the yen, respectively.

*Industrial Countries*

For the industrial countries, the absence of complete information about the currency composition of their external debt means that the regression analysis could consider only the role of trade flows and exchange rate arrangements. First, the explanatory power of the regressions for the industrial countries varied considerably. Although over 70 percent of the variability in the French franc share was accounted for by its regression (measured in terms of $R^2_{73}$), the proportions of variability explained for the pound sterling (51 percent), U.S. dollar (41 percent), deutsche mark (35 percent), and yen (35 percent) were lower.

In addition, these regressions suggest that, for the industrial countries, exchange rate arrangements most strongly affected the proportions of reserves held as U.S. dollars, French francs, and deutsche mark. For example, the adoption of a flexible exchange rate was accompanied by a significantly higher proportion of reserves held as U.S. dollar instruments, which was partially offset by a significantly lower share for the deutsche mark. This may reflect the option that countries with flexible exchange rates have of always intervening in U.S. dollars rather than in other currencies (as could occur under certain pegging arrangements). Similarly, participation in a cooperative agreement (for example, the European Monetary System or some of its earlier variants) resulted in a significantly higher proportion of foreign exchange reserves being held as U.S. dollars, which was offset by significantly lower proportions for the French franc and the deutsche mark. The results for the dummy variable for cooperative agreements are consistent with those obtained by Heller and Knight (1978). As they noted, these results reflect the fact that at times the countries that have been members of such arrangements as the European Monetary System (or European System of Narrower Exchange Rate Margins) have committed themselves to intervene in the U.S. dollar and to limit their holdings of other members' currencies. As a result, a higher proportion of foreign exchange reserves was held as U.S. dollars.

In general, a higher level of trade between an industrial country and a particular reserve-currency country led the country to hold a significantly (except in the case of trade with the United States) higher proportion of its reserves in that reserve currency. The effects of an increase in trade with one reserve-currency country on holdings of other reserve

currencies were more mixed, with eight negative and significant cross-effect coefficients and four positive and significant coefficients.

*A Comparison of the Ordinary Least-Squares, Tobit, and Symmetrically Censored Least-Squares Estimates*

Tables 2–11 also allow for a comparison of the estimation results for ordinary least squares based solely on the observations for which the proportions of reserves held in a given currency are nonzero, the tobit estimator, and the SCLS estimator. First, as noted earlier, the tobit estimates were derived under the assumptions that the error terms in the regression were normally distributed and homoscedastic. The test of the residuals from the tobit estimates indicates, however, that in general they were not normally distributed and homoscedastic. Thus, both the ordinary least-squares and tobit estimates were inconsistent. It is only in the case of the U.S. dollar that the hypothesis of normality and homoscedasticity could not be rejected. In part this reflects the fact that virtually all countries held some dollar-denominated reserve assets during each period. In this case, the ordinary least-squares regression on the U.S. dollar share were identical with the tobit estimates. Moreover, the point estimates of the SCLS estimator were also similar to those of the ordinary least-squares and tobit estimators, although the standard errors were smaller because of the censoring technique.

A second difference between the estimators is that the SCLS estimates often implied larger effects for trade flows and debt service payments. To the extent that the ordinary least-squares or tobit estimators are biased and inefficient, then the SCLS estimates suggest that earlier studies based on ordinary least-squares results have tended to understate the influence of trade and capital flows on the currency composition of foreign exchange reserves.

Finally, the SCLS estimates also often suggested larger effects of exchange rate arrangements on the currency composition of foreign exchange reserves.[28] These exchange rate effects were most noticeable

[28]The number of observations censored (excluded) from each regression varied significantly from currency to currency and across country groups. For the developing countries, for example, an average of 164 observations (out of 340 observations) were censored in the five currency regressions, whereas an average of 85 observations (out of 180) were censored in the industrial country regressions.

for the developing countries that pegged to a composite indicator or to some currency other than the U.S. dollar or French franc, and for industrial countries in the case where a flexible exchange rate was maintained.

## III. Conclusions

This study has considered the determinants of the currency composition of foreign exchange reserves for both industrial and developing countries. On the basis of data on the currency composition of the foreign exchange reserves of individual countries, our empirical results indicate that for countries in these groups the currency composition has been influenced by each country's exchange rate arrangements, its trade flows with reserve-currency countries, and the currency of denomination of its debt service payments. During the period 1976–85, a developing country tended to hold a greater proportion of its foreign exchange reserves in assets denominated in a particular reserve currency if its exchange rate was pegged to that currency, if a large share of its exports and imports was with the country issuing the reserve currency, and if a higher proportion of the interest payments on its external debt was denominated in this reserve currency. The currency composition of foreign exchange reserves for industrial countries was also influenced by exchange rate arrangements, although the effects were strongest for those countries that participated in cooperative agreements (for example, the European Monetary System), which tended to hold relatively higher shares of U.S. dollars. In addition, the shares of an industrial country's exports and imports to the reserve-currency countries had significant influences on the proportion of reserves held in different currencies.

The evidence is consistent with the view that managing the currency composition of a country's *net* foreign asset position is done more cheaply by altering the currency denomination of assets and liabilities that are not held as reserve assets. Although transaction costs in currency markets are low, it appears that they are high enough for central banks to find it optimal to avoid holding reserve assets in one reserve currency that must be converted into another reserve currency before it can be used to make payment. This, in turn, suggests that inferences about the stability of preferences for net currency positions on the part of governments cannot be drawn from an analysis of reserve holdings in isolation from the rest of the government's financial portfolio.

## APPENDIX I

### Data Sources

Data on foreign exchange reserves were obtained from the International Monetary Fund's survey of the currency composition of members' foreign exchange reserves. To maintain the confidentiality of the data file, all regressions were run "blind," without any country specific parameters.

Exchange rate arrangements were classified according to the system used in the Fund's *Annual Report on Exchange Arrangements and Exchange Restrictions* (Washington, various issues). The classifications prevailing at the end of 1985 were extended back through the period beginning in 1976.

Data on exports and imports were taken from the Fund's *Direction of Trade Statistics* data file.

For external debt, the currency denomination of public and publicly guaranteed debt was taken from the World Bank's *World Debt Tables* (Washington, various issues).

Eurodollar six-month deposit rates were taken from the Fund's *International Financial Statistics* (Washington, various issues).

## APPENDIX II

### First-Order Conditions for Optimal Net and Gross Foreign Asset Portfolio

Selecting $N_1$, $N_2$, $A_1$, and $A_2$ so as to maximize equation (7) of the text yields

$$\frac{\partial U}{\partial N_1} = r_1 + d_1 - r_2 - d_2 - 2bN_1\sigma_{r_1}^2 + 2b(W - N_1)\sigma_{r_2}^2 - 2b(W - N_1)\sigma_{r_1r_2} + 2bN_1\sigma_{r_1r_2} = 0 \tag{20}$$

$$N_2 = W - N_1 \tag{21}$$

$$\frac{\partial U}{\partial A_1} = -d_1 - 2\pi_2 c(A_1 - t_1) + 2(\pi_2 + \pi_3)p(T - A_1 - A_2) = 0 \tag{22}$$

$$\frac{\partial U}{\partial A_2} = -d_2 - 2\pi_3 c(A_1 - A_2) + 2(\pi_2 + \pi_3)p(T - A_2 - A_2) = 0. \tag{23}$$

Equations (20) and (21) imply equations (8) and (9) in the text. Equations (22) and (23) imply that

$$A_1 - t_1 = \frac{\pi_3}{\pi_2}(A_2 - t_2) + \frac{d_2 + d_1}{2\pi_2 c}, \tag{24}$$

or, using $A = A_1 + A_2$, that

$$A_1 = \frac{\pi_3 A + \pi_2 t_1 - \pi_3 t_2}{(\pi_2 + \pi_3)} + \frac{d_2 - d_1}{2c(\pi_2 + \pi_3)} \tag{25}$$

$$A_2 = \frac{\pi_2 A + \pi_3 t_2 - \pi_2 t_1}{(\pi_2 + \pi_3)} + \frac{d_1 - d_2}{2c(\pi_2 + \pi_3)}. \tag{26}$$

Thus, for a given total level of reserves, the holdings of a particular currency depend on the expected amount of transactions in that currency in comparison with the expected amount of transactions in other currencies, on the cost of converting from one currency to another, and on the differential net costs of borrowing reserves in the different currencies. Note that, from the assumed distribution of transactions,

$$E(T_1) = (\pi_1 + \pi_2)t_1 + \pi_3(T - t_2) \tag{27}$$

$$E(T_2) = (\pi_1 + \pi_3)t_2 + \pi_2(T - t_1), \tag{28}$$

so that $E(T_1)$ increases with $t_1$ and declines with $t_2$, whereas the opposite occurs with $E(T_2)$.

Replacing equations (25) and (26) in either equation (22) or equation (23), it is possible to solve for the total level of reserves $A$. Thus,

$$A = \frac{2p(\pi_2 + \pi_3)^2 T + 2c\pi_2\pi_3(t_1 + t_2) - (\pi_3 d_1 + \pi_2 d_2)}{2p(\pi_2 + \pi_3)^2 + 2\pi_2\pi_3 c}. \tag{29}$$

## APPENDIX III

### Calculation of Symmetrically Censored Least-Squares Estimates

As shown in Powell (1986), the SCLS estimates must satisfy

$$\hat{\beta}_s = \left[\sum_{t=1}^{T} 1(\hat{\beta}_s' x_t > 0) \cdot x_t x_t'\right]^{-1} \sum_{t=1}^{T} 1(\hat{\beta}_s' x_t > 0) \cdot \min\{y_t, 2\hat{\beta}_s' x_t\} x_t, \tag{30}$$

where $x_t$ is the vector of independent variables at $t$:

$$1(A) = 1$$

if $A$ is true, and

$$1(A) = 0$$

otherwise.

The procedures starts with the tobit estimates of the $\beta$ and uses them to calculate the right-hand side of equation (30). This implies an initial vector of $\hat{\beta}_s^0$. The right-hand side of equation (30) was then recalculated using this value of $\beta_s^0$. The iterations were continued until the largest difference between any element in the old and new values of $\hat{\beta}_s$ was less than $10^{-6}$. Between 12 and 60 iterations were required to calculate the $\hat{\beta}_s$ for the different currencies.

The variance-covariance matrix for the SCLS estimates was calculated as

$$V(\hat{\beta}_s) = \frac{1}{T} \hat{C}_T^{-1} \hat{D}_T \hat{C}_T^{-1}, \tag{31}$$

where $T$ is the sample size:

$$\hat{C}_T = \frac{1}{T} \sum_{t=1}^{T} 1(0 < y_t < 2\hat{\beta}_s' x_t) x_t x_t'$$

$$\hat{D}_T = \frac{1}{T}\sum_{t=1}^{T} 1(\hat{\beta}_s' x_t > 0)\ \min(\hat{u}_t^2,\ (\hat{\beta}_s' x_t)^2) x_t x_t'$$

$$\hat{u}_t = y_t - \hat{\beta}_s' x_t.$$

The test statistic ($h$) for the test of normality and homoscedasticity of the error terms was calculated (see Newey (1987)) as

$$h = T(\hat{\beta}_s - \hat{\beta}_t)'[V(\hat{\beta}_s - \hat{\beta}_t)]^{-1}(\hat{\beta}_s - \hat{\beta}_t), \tag{32}$$

where $\hat{\beta}_s$ are the SCLS estimates and $\hat{\beta}_t$ are the tobit estimates. The $V(\hat{\beta}_s - \hat{\beta}_t)$ matrix was calculated following the procedures described in Newey (1987, pp. 129–30, equation (3.6)).

Table 2. *Determinants of Central Bank Holdings of Reserve Currencies: Developing Countries, 1976–85*

(Portion of foreign exchange reserves denominated in U.S. dollars)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 47.78 | 47.78 | 49.00 |
| | (9.53) | (9.53) | (8.83) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | 7.69 | 7.69 | 7.53 |
| | (3.53) | (3.53) | (3.39) |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | −7.06 | −7.06 | −7.46 |
| | (2.39) | (2.39) | (2.46) |
| Cooperative agreement | — | — | — |
| Flexible exchange rate | — | — | — |
| Proportion of trade with each country relative to external payments to all countries[a] | | | |
| United States | 0.58 | 0.58 | 0.57 |
| | (5.89) | (5.89) | (5.27) |
| France | 0.07 | 0.07 | 0.07 |
| | (0.23) | (0.23) | (0.24) |
| Fed. Rep. of Germany | −0.48 | −0.48 | −0.58 |
| | (1.69) | (1.69) | (1.93) |
| United Kingdom | −0.29 | −0.29 | −0.32 |
| | (1.36) | (1.36) | (1.49) |
| Japan | 0.14 | 0.14 | 0.13 |
| | (0.85) | (0.85) | (0.84) |

Table 2 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | 2.28 | 2.28 | 2.20 |
| | (6.29) | (6.29) | (6.70) |
| French franc | 16.34 | 16.34 | 16.73 |
| | (3.14) | (3.14) | (3.83) |
| Deutsche mark | −21.82 | −21.82 | −21.86 |
| | (4.36) | (4.36) | (3.97) |
| Pound sterling | 0.98 | 0.98 | 1.08 |
| | (0.82) | (0.82) | (0.43) |
| Yen | −3.10 | −3.10 | −3.37 |
| | (0.82) | (0.82) | (0.85) |
| $R^2$ | 0.55 | | |
| $\bar{R}^2$ | 0.53 | | |
| $R^2_{T1}$ | | 0.55 | |
| $R^2_{T2}$ | | — | |
| $\bar{E}_t$ | | — | |
| $R^2_{T3}$ | | 0.55 | |
| $h$[b] | | | 0.24 |
| Sample size | 340 | 340 | 340 |

Note: Developing countries whose currencies are pegged to the French franc are excluded; figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] External payments is defined to equal the sum of exports and imports plus debt service payments.

[b] One percent of the time, a $\chi^2$ with 13 degrees of freedom will exceed the value of 27.7.

Table 3. *Determinants of Central Bank Holdings of Reserve Currencies: Developing Countries, 1976–85*

(Portion of foreign exchange reserves denominated in French francs)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 3.67 | 0.63 | −0.83 |
| | (2.68) | (0.51) | (0.63) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | −1.37 | −1.48 | −3.76 |
| | (2.01) | (2.47) | (3.20) |
| Pegged to French franc | 84.34 | 82.75 | 83.90 |
| | (47.7) | (46.81) | (34.56) |
| Pegged to composite or other currency | −2.36 | −2.21 | −8.76 |
| | (2.90) | (2.90) | (4.92) |
| Cooperative agreement | — | — | — |
| Flexible exchange rate | — | — | — |
| Proportion of trade with each country relative to external payments to all countries[a] | | | |
| United States | −0.03 | −0.01 | −0.12 |
| | (1.17) | (0.21) | (2.24) |
| France | 0.18 | 0.25 | 0.23 |
| | (4.52) | (6.39) | (4.22) |
| Fed. Rep. of Germany | −0.02 | 0.17 | 0.24 |
| | (0.23) | (2.39) | (2.51) |
| United Kingdom | 0.05 | −0.03 | 0.28 |
| | (0.82) | (0.54) | (2.71) |
| Japan | −0.09 | −0.10 | 0.17 |
| | (2.05) | (2.19) | (1.88) |

Table 3 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | −0.19 | −0.37 | 0.03 |
| | (1.73) | (3.81) | (0.14) |
| French franc | 1.36 | 1.79 | 1.51 |
| | (4.17) | (5.45) | (3.62) |
| Deutsche mark | 1.27 | 1.79 | 1.07 |
| | (1.35) | (1.92) | (0.90) |
| Pound sterling | −0.84 | 0.27 | −1.17 |
| | (1.29) | (0.42) | (0.59) |
| Yen | 1.20 | 0.84 | −8.16 |
| | (1.12) | (0.81) | (1.67) |
| $R^2$ | 0.99 | | |
| $\bar{R}^2$ | 0.99 | | |
| $R^2_{T1}$ | | 0.99 | |
| $R^2_{T2}$ | | 0.88 | |
| $\bar{E}_t$ | | 1.35 | |
| $R^2_{T3}$ | | 0.99 | |
| $h$[b] | | | 89.95 |
| Number of observations | 258 | 390 | 390 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] External payments is defined to equal the sum of exports and imports plus debt service payments.

[b] One percent of the time, a $\chi^2$ with 14 degrees of freedom will exceed 29.1.

Table 4. *Determinants of Central Bank Holdings of Reserve Currencies: Developing Countries, 1976–85*

(Portion of foreign exchange reserves denominated in pounds sterling)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | −1.64 | −2.64 | −93.14 |
| | (0.71) | (1.17) | (9.44) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | −1.44 | −2.12 | 17.61 |
| | (1.40) | (2.12) | (2.78) |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | −1.50 | −1.94 | 8.64 |
| | (1.10) | (1.46) | (0.83) |
| Cooperative agreement | — | — | — |
| Flexible exchange rate | — | — | — |
| Proportion of trade with each country relative to external payments to all countries[a] | | | |
| United States | 0.04 | 0.01 | −1.03 |
| | (0.89) | (0.16) | (1.47) |
| France | 0.28 | 0.34 | −1.71 |
| | (2.05) | (2.51) | (0.24) |
| Fed. Rep. of Germany | 0.02 | 0.04 | 0.22 |
| | (0.13) | (0.32) | (0.17) |
| United Kingdom | 0.56 | 0.62 | 2.52 |
| | (5.88) | (6.57) | (3.27) |
| Japan | 0.02 | 0.04 | 2.32 |
| | (0.23) | (0.55) | (3.11) |

Table 4 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | 0.17 | 0.09 | 4.16 |
| | (0.99) | (0.53) | (2.32) |
| French franc | −4.56 | −6.01 | 41.74 |
| | (1.80) | (2.53) | (3.65) |
| Deutsche mark | −0.50 | 1.26 | −51.94 |
| | (0.22) | (0.57) | (6.49) |
| Pound sterling | 9.69 | 9.79 | 43.13 |
| | (8.86) | (9.03) | (10.76) |
| Yen | 1.77 | 2.48 | −23.29 |
| | (1.04) | (1.49) | (2.83) |
| $R^2$ | 0.52 | | |
| $\bar{R}^2$ | 0.50 | | |
| $R^2_{T1}$ | | 0.52 | |
| $R^2_{T2}$ | | 0.71 | |
| $\bar{E}_t$ | | 1.74 | |
| $R^2_{T3}$ | | 0.55 | |
| $h$[b] | | | 738.91 |
| Number of observations | 288 | 340 | 340 |

Note: Developing countries whose currencies are pegged to the French franc are excluded; figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] External payments is defined to equal the sum of exports and imports plus debt service payments.

[b] One percent of the time, a $\chi^2$ with 13 degrees of freedom will exceed the value of 27.7.

Table 5. *Determinants of Central Bank Holdings of Reserve Currencies: Developing Countries, 1976–85*

(Portion of foreign exchange reserves denominated in deutsche mark)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 34.14 | 36.36 | 47.49 |
| | (9.87) | (10.53) | (10.47) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | 1.06 | 0.42 | 2.30 |
| | (0.68) | (0.27) | (1.22) |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | 1.59 | 0.33 | −0.18 |
| | (0.78) | (0.16) | (0.10) |
| Cooperative agreement | — | — | — |
| Flexible exchange rate | — | — | — |
| Proportion of trade with each country relative to external payments to all countries[a] | | | |
| United States | −0.53 | −0.69 | −1.14 |
| | (7.06) | (9.79) | (9.54) |
| France | −0.38 | −0.32 | −1.93 |
| | (1.87) | (1.54) | (6.41) |
| Fed. Rep. of Germany | 0.52 | 0.41 | 0.46 |
| | (2.66) | (2.14) | (1.92) |
| United Kingdom | −0.50 | −0.43 | −0.46 |
| | (3.39) | (2.91) | (3.30) |
| Japan | −0.21 | −0.19 | −0.16 |
| | (1.82) | (1.63) | (1.36) |

Table 5 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | −1.74 | −1.85 | −2.60 |
| | (6.63) | (7.07) | (6.85) |
| French franc | −5.94 | −6.68 | −0.24 |
| | (1.69) | (1.86) | (0.08) |
| Deutsche mark | 9.38 | 10.51 | 14.77 |
| | (2.73) | (3.04) | (3.04) |
| Pound sterling | −3.75 | −4.42 | −13.72 |
| | (2.22) | (2.58) | (6.84) |
| Yen | −1.48 | 0.16 | −2.47 |
| | (0.57) | (10.06) | (0.77) |
| $R^2$ | 0.40 | | |
| $\bar{R}^2$ | 0.38 | | |
| $R^2_{T1}$ | | 0.42 | |
| $R^2_{T2}$ | | 0.68 | |
| $\bar{E}_i$ | | 5.91 | |
| $R^2_{T3}$ | | 0.47 | |
| $h$[b] | | | 209.81 |
| Number of observations | 312 | 340 | 340 |

Note: Developing countries whose currencies are pegged to the French franc are excluded; figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] External payments are defined to equal the sum of exports and imports plus debt service payments.

[b] One percent of the time, a $\chi^2$ with 13 degrees of freedom will exceed the value of 27.7.

Table 6. *Determinants of Central Bank Holdings of Reserve Currencies: Developing Countries, 1976–85*

(Portion of foreign exchange reserves denominated in yen)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 7.07 | 8.15 | 6.95 |
| | (3.20) | (3.81) | (1.96) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | −2.00 | −3.29 | −12.45 |
| | (2.04) | (3.47) | (7.60) |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | 4.64 | 5.05 | 11.51 |
| | (3.77) | (4.03) | (5.28) |
| Cooperative agreement | — | — | — |
| Flexible exchange rate | — | — | — |
| Proportion of trade with each country relative to external payments to all countries[a] | | | |
| United States | −0.04 | −0.08 | −0.10 |
| | (0.87) | (1.77) | (1.13) |
| France | −0.12 | −0.28 | −2.61 |
| | (0.68) | (2.06) | (2.21) |
| Fed. Rep. of Germany | −0.03 | −0.14 | 0.40 |
| | (0.24) | (1.15) | (2.07) |
| United Kingdom | −0.07 | −0.08 | −0.24 |
| | (0.79) | (0.84) | (1.91) |
| Japan | 0.24 | 0.27 | 0.22 |
| | (3.36) | (3.96) | (1.67) |

Table 6 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | −0.38 | −0.36 | −0.71 |
| | (2.40) | (2.29) | (0.87) |
| French franc | −4.04 | −3.34 | 4.48 |
| | (1.41) | (1.41) | (0.76) |
| Deutsche mark | 4.15 | −0.76 | 5.98 |
| | (1.54) | (0.34) | (1.12) |
| Pound sterling | −2.70 | −2.55 | −8.62 |
| | (2.69) | (2.42) | (3.89) |
| Yen | 3.54 | 3.29 | 6.63 |
| | (2.34) | (2.08) | (1.53) |
| $R^2$ | 0.32 | | |
| $\bar{R}^2$ | 0.29 | | |
| $R^2_{T1}$ | | 0.32 | |
| $R^2_{T2}$ | | 0.42 | |
| $\bar{E}_t$ | | 2.16 | |
| $R^2_{T3}$ | | 0.39 | |
| $h$[b] | | | 535.44 |
| Number of observations | 273 | 340 | 340 |

Note: Developing countries whose currencies are pegged to the French franc are excluded; figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] External payments is defined to equal the sum of exports and imports plus debt service payments.

[b] One percent of the time, a $\chi^2$ with 13 degrees of freedom will exceed the value of 27.7.

Table 7. *Determinants of Central Bank Holdings of Reserve Currencies: Industrial Countries, 1976–85*

(Portion of foreign exchange reserves denominated in U.S. dollars)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 80.63<br>(13.19) | 80.63<br>(13.19) | 80.63<br>(14.58) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | — | — | — |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | — | — | — |
| Cooperative agreement | 14.30<br>(3.50) | 14.30<br>(3.50) | 14.30<br>(3.18) |
| Flexible exchange rate | 12.54<br>(2.55) | 12.54<br>(2.55) | 12.54<br>(2.64) |
| Proportion of trade with each country relative to total trade with all countries[a] | | | |
| United States | 0.16<br>(1.31) | 0.16<br>(1.31) | 0.16<br>(2.35) |
| France | 0.41<br>(1.37) | 0.41<br>(1.37) | 0.41<br>(1.68) |
| Fed. Rep. of Germany | −0.64<br>(3.24) | −0.64<br>(3.24) | −0.64<br>(3.57) |
| United Kingdom | −0.81<br>(4.98) | −0.81<br>(4.98) | −0.81<br>(4.62) |
| Japan | −1.62<br>(5.53) | −1.62<br>(5.53) | −1.62<br>(6.47) |

Table 7 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | — | — | — |
| French franc | — | — | — |
| Deutsche mark | — | — | — |
| Pound sterling | — | — | — |
| Yen | — | — | — |
| $R^2$ | 0.41 | | |
| $\overline{R}^2$ | 0.38 | | |
| $R^2_{T1}$ | | 0.41 | |
| $R^2_{T2}$ | | — | |
| $\overline{E}_t$ | | — | |
| $R^2_{T3}$ | | 0.41 | |
| $h$[b] | | | 0.00 |
| Number of observations | 180 | 180 | 180 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] Total trade is measured as the sum of exports and imports.

[b] One percent of the time, a $\chi^2$ with 8 degrees of freedom will exceed the value of 20.1.

Table 8. *Determinants of Central Bank Holdings of Reserve Currencies: Industrial Countries, 1976–85*

(Portion of foreign exchange reserves denominated in French francs)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | −2.39 | −1.28 | 3.85 |
| | (5.34) | (2.24) | (1.09) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | — | — | — |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | — | — | — |
| Cooperative agreement | −1.61 | −1.92 | −15.02 |
| | (4.07) | (4.00) | (2.55) |
| Flexible exchange rate | −0.06 | 0.17 | −5.93 |
| | (0.13) | (0.36) | (3.03) |
| Proportion of trade with each country relative to trade with all countries[a] | | | |
| United States | 0.05 | 0.01 | 0.05 |
| | (2.74) | (1.20) | (0.16) |
| France | 0.25 | 0.32 | 0.93 |
| | (8.26) | (9.13) | (2.56) |
| Fed. Rep. of Germany | 0.03 | −0.09 | −0.57 |
| | (1.45) | (3.83) | (2.11) |
| United Kingdom | 0.05 | 0.06 | −0.09 |
| | (5.07) | (4.35) | (2.04) |
| Japan | 0.17 | −0.17 | −0.17 |
| | (1.30) | (2.51) | (0.24) |

Table 8 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | — | — | — |
| French franc | — | — | — |
| Deutsche mark | — | — | — |
| Pound sterling | — | — | — |
| Yen | — | — | — |
| $R^2$ | 0.74 | | |
| $\overline{R}^2$ | 0.72 | | |
| $R^2_{T1}$ | | 0.75 | |
| $R^2_{T2}$ | | 0.84 | |
| $\overline{E}_t$ | | 0.51 | |
| $R^2_{T3}$ | | 0.72 | |
| $h$[b] | | | 130,924.91 |
| Number of observations | 81 | 180 | 180 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a]Total trade is measured as the sum of exports and imports.

[b]One percent of the time, a $\chi^2$ with 8 degrees of freedom will exceed the value of 20.1.

Table 9. *Determinants of Central Bank Holdings of Reserve Currencies: Industrial Countries, 1976–85*

(Portion of foreign exchange reserves denominated in pounds sterling)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 0.97 | 0.91 | −10.72 |
| | (0.77) | (0.69) | (1.10) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | — | — | — |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | — | — | — |
| Cooperative agreement | −1.30 | −1.42 | 1.03 |
| | (1.58) | (1.65) | (0.54) |
| Flexible exchange rate | −0.85 | −2.02 | −23.09 |
| | (0.78) | (1.87) | (4.40) |
| Proportion of trade with each country relative to trade with all countries[a] | | | |
| United States | −0.02 | −0.00[b] | 0.37 |
| | (0.80) | (0.02) | (2.50) |
| France | −0.01 | −0.03 | −0.08 |
| | (0.21) | (0.48) | (0.10) |
| Fed. Rep. of Germany | −0.08 | −0.10 | −0.58 |
| | (2.03) | (2.34) | (0.94) |
| United Kingdom | 0.30 | 0.28 | 0.52 |
| | (8.92) | (8.41) | (10.78) |
| Japan | 0.24 | 0.28 | 1.25 |
| | (3.95) | (4.39) | (4.00) |

Table 9 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | — | — | — |
| French franc | — | — | — |
| Deutsche mark | — | — | — |
| Pound sterling | — | — | — |
| Yen | — | — | — |
| $R^2$ | 0.51 | | |
| $\bar{R}^2$ | 0.48 | | |
| $R^2_{T1}$ | | 0.52 | |
| $R^2_{T2}$ | | 0.86 | |
| $\bar{E}_i$ | | 5.97 | |
| $R^2_{T3}$ | | 0.51 | |
| $h$[c] | | | 489.82 |
| Number of observations | 152 | 180 | 180 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a]Total trade is measured as the sum of exports and imports.

[b]Less than 0.01.

[c]One percent of the time, a $\chi^2$ with 8 degrees of freedom will exceed the value of 20.1.

Table 10. *Determinants of Central Bank Holdings of Reserve Currencies: Industrial Countries, 1976–85*

(Portion of foreign exchange reserves denominated in deutsche mark)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 12.54 | 7.10 | −7.05 |
| | (2.92) | (1.88) | (1.20) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | — | — | — |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | — | — | — |
| Cooperative agreement | −10.41 | −10.80 | −7.21 |
| | (4.24) | (4.47) | (2.76) |
| Flexible exchange rate | −9.45 | −7.07 | −19.31 |
| | (3.05) | (2.40) | (5.80) |
| Proportion of trade with each country relative to trade with all countries[a] | | | |
| United States | −0.04 | 0.01 | 0.27 |
| | (0.52) | (0.01) | (3.44) |
| France | −0.20 | −0.36 | −2.51 |
| | (1.03) | (1.98) | (4.24) |
| Fed. Rep. of Germany | 0.53 | 0.77 | 1.47 |
| | (3.46) | (6.18) | (6.32) |
| United Kingdom | 0.22 | 0.33 | 0.69 |
| | (2.90) | (3.32) | (5.13) |
| Japan | 0.47 | 0.51 | 1.33 |
| | (2.63) | (2.87) | (6.66) |

Table 10 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | — | — | — |
| French franc | — | — | — |
| Deutsche mark | — | — | — |
| Pound sterling | — | — | — |
| Yen | — | — | — |
| $R^2$ | 0.30 | | |
| $\bar{R}^2$ | 0.27 | | |
| $R^2_{T1}$ | | 0.32 | |
| $R^2_{T2}$ | | 1.00 | |
| $\bar{E}_t$ | | 0.00 | |
| $R^2_{T3}$ | | 0.35 | |
| $h$[b] | | | 81.21 |
| Number of observations | 170 | 180 | 180 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] Total trade is measured as the sum of exports and imports.

[b] One percent of the time, a $\chi^2$ with 8 degrees of freedom will exceed the value of 20.1.

Table 11. *Determinants of Central Bank Holdings of Reserve Currencies: Industrial Countries, 1976–85*

(Portion of foreign exchange reserves denominated in yen)

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Constant | 5.94<br>(2.20) | 5.00<br>(1.95) | 11.59<br>(2.70) |
| Exchange rate regime | | | |
| Pegged to U.S. dollar | — | — | — |
| Pegged to French franc | — | — | — |
| Pegged to composite or other currency | — | — | — |
| Cooperative agreement | 0.56<br>(0.34) | −1.27<br>(0.76) | −4.90<br>(2.55) |
| Flexible exchange rate | −1.09<br>(0.55) | −1.64<br>(0.81) | −3.85<br>(2.39) |
| Proportion of trade with each country relative to trade with all countries[a] | | | |
| United States | −0.03<br>(0.38) | −0.20<br>(3.17) | −0.23<br>(0.64) |
| France | −0.33<br>(2.42) | −0.24<br>(1.91) | −0.31<br>(2.07) |
| Fed. Rep. of Germany | 0.06<br>(0.73) | 0.06<br>(0.70) | −0.04<br>(0.46) |
| United Kingdom | 0.03<br>(0.49) | 0.02<br>(0.23) | −0.28<br>(3.33) |
| Japan | 0.67<br>(5.01) | 0.90<br>(7.51) | 0.79<br>(3.31) |

Table 11 (*concluded*).

| Independent Variable | Ordinary Least Squares | Tobit | Symmetrically Censored Least Squares |
|---|---|---|---|
| Proportion of interest payments on external debt in given currency relative to external payments to all countries | | | |
| U.S. dollar | — | — | — |
| French franc | — | — | — |
| Deutsche mark | — | — | — |
| Pound sterling | — | — | — |
| Yen | — | — | — |
| $R^2$ | 0.33 | | |
| $\bar{R}^2$ | 0.29 | | |
| $R^2_{T1}$ | | 0.28 | |
| $R^2_{T2}$ | | 0.42 | |
| $\bar{E}_i$ | | 3.08 | |
| $R^2_{T3}$ | | 0.35 | |
| $h$ [b] | | | 142.61 |
| Number of observations | 137 | 180 | 180 |

Note: Figures in parentheses are $t$-ratios. Other symbols are defined in the text.

[a] Total trade is measured as the sum of exports and imports.

[b] One percent of the time, a $\chi^2$ with 8 degrees of freedom will exceed the value of 20.1.

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# Economic Structure, the Exchange Rate, and Adjustment in the Federal Republic of Germany

## A General Equilibrium Approach

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*The effects of an appreciation of the deutsche mark are traced with the help of a computable general equilibrium model under alternative structural policy scenarios. In the first scenario, characterized by severe structural rigidities, the contractionary effects of exchange rate appreciation dominate the expansionary effects, so that gross domestic product and employment fall and the external surplus declines only slightly. In the alternative case of free movement of goods, services, and factors, the expansionary effects of the appreciation become more prominent as supply and demand respond much more readily to the relative price changes.* [JEL 431]

WHEN EFFORTS to redress the international economic imbalances among major industrial countries began in 1985, the emphasis was on macroeconomic policies and exchange rate changes. With the room for maneuver in these policy areas diminishing and the adjustment being far from complete, however, the focus has recently shifted to structural policies. With regard to the Federal Republic of Germany in particular, the view has gained strength that trade liberalization as well as deregulation of goods, services, and labor markets would make an important contribution to the external adjustment of this economy by increasing its responsiveness to the exchange rate changes that have already taken place.

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The present paper seeks to examine this hypothesis by investigating the effects of structural rigidities and protectionist practices on the adjustment process in Germany. The analysis is conducted in the form of an illustrative quantitative exercise in which the effects of an exogenous appreciation of the deutsche mark are examined under different structural policies. The results of this investigation indicate that structural policy action, supported by macroeconomic policies consistent with the nominal targets of the German authorities' medium-term economic strategy, would indeed facilitate external adjustment in an environment of higher growth, lower unemployment, and lower inflation. In the following section, several protectionist practices and rigidities that could be obstacles to adjustment are identified. Section II outlines an analytical framework for a quantitative analysis of the effects of these policies and rigidities on the German economy, and Section III presents the results of the illustrative exercise. Section IV discusses possible costs of adjustment to more liberal policies, and some concluding observations are made in Section V.

## I. Impediments to Adjustment

In an open economy that is free from restrictions on international trade and the domestic flow of resources and in which foreign currency prices of traded goods are largely determined on world markets, an appreciation of the exchange rate lowers the domestic-currency price of traded goods and, everything else being equal, also the general price level. The decline in prices elicits higher real consumption (the real balance effect), leading to higher domestic demand and to an increase in imports. At the same time, the supply of exports and import substitutes declines in response to lower domestic-currency prices of these goods. As a result, the volume of exports falls relative to that of imports. Higher domestic demand militates against a fall in the price of nontraded goods (the supply of which is limited by the production potential of the economy), even though there might be downward pressure on input costs; thus the increase in the relative price of these goods that was elicited by the decline in the price of traded goods is reinforced. Consequently, there is a shift of resources from the traded-goods industries to the sector producing nontraded goods. Real gross national product (GNP)—and, if there is slack in the labor market, employment—rises if the nontraded-goods sector absorbs more resources than those released by the traded-goods sector.[1] Then, the increase in domestic demand (weighted by its

[1] Guitián (1976) showed that this is likely to be the case when the share of the nontraded-goods sector in total output is smaller than that of the traded-goods sector.

Table 1. *Protection in Selected Economic Sectors of the Federal Republic of Germany, 1982*

| Sector | Type of Protection | Degree of Protection (In percent)[a] |
|---|---|---|
| Agriculture | Tariff with quota, import licensing, variable duties and subsidies | 233.5 |
| Coal mining | Quota, variable subsidies | 137.5 |
| Iron and steel | Quota, voluntary export restraint, minimum pricing | 30.1 |
| Shipbuilding | Subsidies | 16.2 |
| Textiles | Quotas, import licensing | 38.3 |
| Clothing | Quotas, import licensing | 46.3 |

Sources: Weiss (1985), OECD (1985), and author's estimates.
[a] Calculated as the sum of the rate of effective protection and the ratio of subsidies to value added.

share in GNP) will exceed the sum of the increase in imports and the decrease in exports (each also weighted by its respective share in GNP).[2]

The smooth adjustment of the German economy to an appreciation of the deutsche mark, however, is likely to be hampered by several sectoral policies and rigidities. First, the system of variable subsidies and import levies in the agricultural sector and in the coal-mining industry is designed so that, in addition to providing considerable protection against external competition, it offsets the price effects of a currency appreciation for these sectors (Table 1). As a result, output and employment in these sectors are not reduced by the appreciation. In addition, a given nominal appreciation of the deutsche mark has a smaller effect on the domestic price level, domestic demand, and the resource allocation in the economy. Thus, for a given nominal appreciation, the real exchange rate appreciates more—so that exporters in the unprotected industries face a sharper decline in the external demand for their products (or a

[2] Growth of GNP is given by $gnp = (DD/GNP)dd + (X/GNP)x - (M/GNP)m$, with $DD$ denoting domestic demand, $X$ exports, $M$ imports, and lowercase letters standing for percentage changes. Partial analysis would suggest that GNP falls in response to an appreciation because of the negative influence from trade. In contrast, general equilibrium analysis suggests that there are forces that militate against a decline of GNP. For instance, the improvement in the terms of trade and the decline in the price level elicited by the appreciation are likely to boost real private consumption through income, wealth, and real balance effects. Higher real consumer expenditures and the need to improve competitiveness in the traded-goods sector would support real investment, and a fiscal policy that follows medium-term nominal expenditure targets would temporarily lead to higher real public consumption.

greater squeeze on their profits). In other words, unprotected exporters have to carry a larger burden of the adjustment. Whether the deterioration of the real trade position is smaller than in the absence of these protective policies depends on the size of net exports in the protected sectors relative to those in the unprotected sectors and on the price elasticities of export and import demand.

Second, import quotas, voluntary export restraints, and other nontariff barriers impede the response of imports of various products (such as textiles, clothing, iron, steel, and ships) to an appreciation of the deutsche mark. Given the lesser competitive pressure from abroad in these sectors, the domestic prices of the goods are likely to decline less than they would in a regime of free trade. As described above, the results are smaller effects of the nominal appreciation on the general price level, domestic demand, and the reallocation of resources in the economy and a larger real appreciation and shifting of the burden of adjustment from import-competing to exporting companies and from the protected to the unprotected industries. In those industries that enjoy protection through subsidies, domestic prices have to follow domestic-currency prices of imported goods to maintain a constant share of imports in the domestic market. This linkage necessitates larger government expenditures on subsidies and thus requires either more government borrowing or measures to increase revenue. Increased government borrowing may contribute to higher interest rates (and, possibly, to a further appreciation of the currency) and, not unlike an increase in taxes, may raise the costs and reduce the competitiveness of the unprotected industries.

Third, the immobility of labor among industries and the numerous regulations that exist in the service sector (Table 2) might lower the supply response of the nontraded-goods sector to an improvement in the relative price of goods produced in this sector.[3] As a consequence, prices of nontraded goods are likely to rise by more than they would have otherwise, resulting in less of a fall in the domestic price level, a smaller increase in domestic demand, a larger real currency appreciation, and, probably, a greater squeeze on the traded-goods sector.

[3]There are several impediments to labor mobility, both on the demand and on the supply side. On the demand side, laws enacted for the protection of employees have over time increased the costs of layoffs for companies, with the result that employers have become reluctant to hire even when their business outlook is improving; often they prefer to invest with a view to increasing the productivity of the existing work force to meet higher demand. On the supply side, relatively generous unemployment benefits and a deeply rooted regionalism have tended to discourage laid-off workers from bearing the adjustment costs associated with a change to a new industry, region, or both. See Burda and Sachs (1987).

The importance of the industries affected by these protectionist practices, regulations, and rigidities for the German economy can be seen from Table 3. In the table agriculture and coal mining are consolidated into a sector producing "basic goods."[4] Iron, steel, textiles, clothing, and shipbuilding are aggregated into a sector dubbed "protected goods," and industries producing services that are less likely to be traded internationally, such as professional services, retail trade, and the like, are combined in a "nontraded-goods" sector. The remaining industries are aggregated into a "traded-goods" sector.[5]

In 1982 the industries most heavily protected from international competition (that is, industries producing basic goods and protected goods) accounted for about 9.5 percent of gross domestic product (GDP) and employment. Basic and protected goods held a share in total exports and imports of 15 percent and 25 percent, respectively, and imports accounted for 17 percent of the total use of these goods—in the traded-goods sector, the import penetration ratio was 14 percent. Within the nontraded-goods sector, services subject to a significant degree of government regulation (Table 2) accounted for about 55 percent of value added.[6] Notably, the return to productive factors was lower in the protected industries than in the rest of the economy. Differences in the return to labor were small relative to those in the return to capital, however, reflecting the strength and centralized organization of German trade unions. The basic-goods industries, with a relatively low return to capital, had the highest capital-labor ratio, whereas the nontraded-goods industries, which had the highest return to capital, were the most labor-intensive.

The nature and pervasiveness of certain protectionist practices and structural rigidities in the German economy would suggest that there are indeed impediments to the response of the economy to exchange rate changes. It is, however, impossible to give a quantitative assessment of the importance of these impediments without a numerically specified model that facilitates a "counterfactual" simulation—that is, the reaction of the German economy to an appreciation of the deutsche mark *without* the sectoral policies and structural rigidities that hinder the ad-

[4] Industries with similar characteristics were aggregated into sectors to facilitate the quantitative analysis that follows in Sections III and IV.

[5] Among the service industries listed in Table 2, only telecommunications and transportation were allocated to the traded-goods sector, given the potential (telecommunications) or actual (transportation) role of these industries in the international trade in services.

[6] The telecommunications and transportation industries that were classified as traded-goods industries accounted for about 12 percent of the value added of this sector.

Table 2. *Industrial and Sectoral Rules and Regulations in Germany, Mid-1980s*

| Industry or Sector | Type of Regulation | Likely Effect |
|---|---|---|
| Professional services | Access to industry regulated by state or professional organizations; limited price competition; regulated advertising | Monopolistic rents for the provider of these services, sluggish supply response to higher demand |
| Retail trade | Construction of shopping centers regulated by government; price competition regulated; opening hours for shops regulated | Limited price competition and shop opening hours imply welfare loss for consumers and probably lower consumption |
| Banking | Exemption from cartel law; competition regulated by credit law | Concentration and price collusion lead to monopolistic rents of banking industry |
| Insurance | Exemption from cartel law; certain insurance mandatory; insurance contracts regulated by state; market access regulated; profit margins regulated | Protection against external and domestic competition leads to monopolistic rents for insurance industry |

| | | |
|---|---|---|
| Capital markets | Cumbersome legal requirements for incorporated companies; limited access of medium-size and smaller companies to stock market; protection of mutual stock funds against external competition; prohibition of financial futures markets | Limited role of stocks both as a source of financing and in private portfolios |
| Telecommunication | State monopoly | Significantly higher prices for telecommunications services than in some other countries; limited access of foreign manufacturers of equipment to German market; sluggish supply response to higher demand |
| Energy | Local monopolies for the generation and distribution of energy; price regulation for private consumers | Limited competition of different energy sources; inefficiencies in energy production |
| Transportation | State monopoly for railways; limited access to and price regulation of the taxi and busing industry; price controls and limited access to trucking industry; price controls for shipping; limited access to and price regulation of airline industry | Monopolistic rents for existing companies; sluggish supply response to higher demand |

Source: Soltwedel and others (1986).

Table 3. *Stylized Structural Features of the German Economy, 1982*

| Feature | Basic-Goods Sector | Protected-Goods Sector | Traded-Goods Sector | Nontraded-Goods Sector |
|---|---|---|---|---|
| Value added (in percent of total) | 5.6 | 3.8 | 56.2 | 34.4 |
| Private consumption (in percent of total) | 14.1 | 5.2 | 45.3 | 35.4 |
| Public consumption (in percent of total) | — | — | — | 100.0[a] |
| Investment (in percent of total) | — | 2.7 | 79.9 | 17.4 |
| Exports (in percent of total) | 5.4 | 9.6 | 85.0 | —[b] |
| Export orientation (exports in percent of output) | 8.9 | 19.8 | 20.3 | —[b] |
| Imports (in percent of total) | 14.0 | 10.6 | 75.4 | —[b] |
| Import penetration (imports in percent of total use) | 17.3 | 16.6 | 14.0 | —[b] |
| Employment (in percent of total) | 4.2 | 5.3 | 54.3 | 36.1 |
| Fixed capital (DM per employed person) | 173,916 | 132,360 | 168,084 | 130,733 |
| Average annual remuneration (DM per employed person) | 32,046[c] | 34,939 | 37,710 | 36,027 |
| Rate of return to capital (in percent) | 6.1[d] | 4.6 | 13.4 | 14.8 |

Source: Statistisches Bundesamt (1987) and author's calculations.

[a] The German input-output table has a "government sector" that creates the goods used by government. This sector was included in the nontraded-goods sector.

[b] Some of the industries included in the nontraded-goods sector do export and import. For the following analysis, however, trade of these industries was disregarded.

[c] Excludes those self-employed in agriculture.

[d] Estimate.

justment. An analytical framework that allows counterfactual simulations is presented in the following section.

## II. Analytical Framework

In general, econometric models of an economy rely on historical evidence for the quantification of relationships among aggregated economic variables. Because these estimates depend on a given set of structural features, they are not suited to establishing counterfactual reactions of an economy to an exogenous shock, such as a currency appreciation, under *different* structural policy regimes. For this, a computable general equilibrium model of the sort described below is a better instrument. The advantage of computable general equilibrium models is that they are firmly based on microeconomic theory and that many parameter estimates are derived at the microeconomic level; such models are therefore likely to be more stable and less susceptible to the problem of "structural breaks."

The computable general equilibrium model used for the following illustrative exercise is comparative static and belongs to the type of so-called Johansen models; it follows closely the version developed by Dixon and others (1982). The model emphasizes the role of relative prices and substitution possibilities in explaining trade flows and the commodity composition of domestic activity. The essential postulates governing producer and consumer behavior are profit and utility maximization. The model distinguishes the four productive sectors described in the previous section (basic goods, protected goods, traded goods, and nontraded goods), four types of final demand (investment, government consumption, private consumption, and exports) that are satisfied either from domestic sources or from imports, and three types of primary inputs (labor, capital, and land). It is numerically specified using a 1982 input-output table for Germany and parameter estimates culled from the literature. The equations of the model can be grouped into equations for input demand, final demand, supply behavior, market equilibrium, with several miscellaneous equations defining macroeconomic aggregates.

### Input Demand

Producers are assumed to minimize the costs of production subject to a two-level production function. The first level imposes constant returns to scale and Leontieff complementarity between different types of inter-

mediate inputs and between intermediate and primary inputs. The second level allows for constant elasticity of substitution between imported and domestically produced intermediate inputs and between different types of primary factors.[7] The solution of this optimization problem yields a set of equations for producers' factor demand. Thus, in a given sector (sector $j$), demand for both domestically produced and imported intermediate inputs ($INTERINPUT$) depends on the activity level and the prices of imports and domestic products ($P$) (a full set of variable names is given in Table 4):

$$INTERINPUT(DOM, i, j) = F1[Z(j), P(DOM, i), P(IMP, i)], \quad (1)-(12)$$

where $i = 1, 2, 3$ and $j = 1, \ldots, 4$;

$$INTERINPUT(IMP, i, j) = F2[Z(j), P(DOM, i), P(IMP, i)], \quad (13)-(24)$$

where $i = 1, 2, 3$ and $j = 1, \ldots, 4$; and

$$INTERINPUT(DOM, 4, j) = F3[Z(j)], \quad (25)-(28)$$

where $j = 1, 2, 3, 4$.

Equations (25)–(28) relate input demand for nontraded goods (which are produced by sector 4) only to activity levels in the demanding industries, since there are no imports to substitute for domestic deliveries.

The equations for primary input demand (labor, capital, and land) relate each sector's demand to its activity level and to the prices of labor, capital, and land:[8]

$$LAB(j) = F4[Z(j), P(LAB), P(CAP), P(LAND)], \quad (29)-(32)$$

where $j = 1, \ldots, 4$;

$$CAP(j) = F5[Z(j), P(LAB), P(CAP), P(LAND)], \quad (33)-(36)$$

where $j = 1, \ldots, 4$; and

$$LAND(j) = F6[Z(j), P(LAB), P(CAP), P(LAND)], \quad (37)$$

where $j = 1$.

[7] In the manner of Armington (1969), it is assumed that domestically produced goods and imported goods are imperfect substitutes.

[8] Note that only sector 1 (basic goods) uses land as a productive factor.

## Final Demand

In what follows, final demand is divided into four components: investment, household consumption, government consumption, and exports.

*Investment*

Investors are assumed to minimize costs subject to a given level of investment. Thus, the model allows for substitution between imports and domestically produced investment goods when relative prices change. Total investment in real terms is derived from total nominal investment [$NINV(TOTAL)$] and the price index for investment goods ($IPI$):

$$INV(DOM,i) = F7[INV(TOTAL), P(DOM,i), P(IMP,i)], \quad (38)-(41)$$

where $i = 1, \ldots, 4$;

$$INV(IMP,i) = F8[INV(TOTAL), P(DOM,i), P(IMP,i)], \quad (42)-(44)$$

where $i = 1, \ldots, 3$; and

$$INV(TOTAL) = NINV(TOTAL) / IPI. \quad (45)$$

*Household Consumption*

Consumers are assumed to maximize their utility subject to an overall budget constraint. The resultant set of equations relates consumption demand for domestic and imported goods ($CONS$) to aggregate consumption and the prices of domestic and imported goods. Real aggregate consumption is derived from total nominal consumption [$NCONS(TOTAL)$] and the price index for consumer goods ($CPI$):

$$CONS(DOM,i) = F10[NCONS(TOTAL), P(DOM,1), P(DOM,2), P(DOM,3), P(DOM,4), P(IMP,1), P(IMP,2), P(IMP,3)], \quad (46)-(49)$$

where $i = 1, \ldots, 4$;

$$CONS(IMP,i) = F11[NCONS(TOTAL), P(DOM,1), P(DOM,2), P(DOM,3), P(DOM,4), P(IMP,1), P(IMP,2), P(IMP,3)], \quad (50)-(52)$$

where $i = 1, 2, 3$; and

$$CONS(TOTAL) = NCONS(TOTAL) / CPI. \quad (53)$$

Table 4. *Notation of Variables for the German Model*

| Variable | Interpretation | Number |
|---|---|---|
| *INTERINPUT(DOM,i,j)* | Sector *j*'s use of domestic intermediate inputs, delivered by sector *i* | 16 |
| *INTERINPUT(IMP,i,j)* | Sector *j*'s use of imported intermediate inputs of type *i* | 12 |
| *LAB(j)* | Use of labor by sector *j* | 4 |
| *CAP(j)* | Use of fixed capital by sector *j* | 4 |
| *LAND(j)* | Use of land by sector *j* | 1 |
| *Z(j)* | Total production in sector *j* | 4 |
| *INV(DOM,i)* | Investment demand for domestically produced goods of type *i* | 4 |
| *INV(IMP,i)* | Investment demand for imported goods of type *i* | 3 |
| *INV(TOTAL)* | Total investment | 1 |
| *CONS(DOM,i)* | Consumption of domestically produced goods of type *i* | 4 |
| *CONS(IMP,i)* | Consumption of imported goods of type *i* | 3 |
| *CONS(TOTAL)* | Total consumption | 1 |
| *GOV(DOM,4)* | Government consumption of domestically produced goods of type *i* | 1 |
| *EX(i)* | Exports of domestically produced goods of type *i* | 3 |
| *IMP(i)* | Imports of type *i* | 3 |
| *P(DOM,i)* | Price of domestically produced goods of type *i* | 4 |
| *P(IMP,i)* | Price of imports of type *i* | 3 |
| *P(LAB)* | Price of labor | 1 |
| *P(CAP)* | Price of capital | 1 |
| *P(LAND)* | Price of land | 1 |
| *FCP(EX,i)* | Foreign currency price of exports of type *i* in the world market | 3 |
| *FCP(IMP,i)* | Foreign currency price of imports of type *i* in the world market | 3 |

Table 4 (*concluded*).

| Variable | Interpretation | Number |
|---|---|---|
| *XRATE* | Exchange rate (measured in local currency per unit of foreign currency) | 1 |
| *MARKUP(i)* | Markup factor in foreign trade (covering transport, insurance, and the like) | 3 |
| *SUBSIDYRATIO(i)* | Unity plus the ad valorem rate of export protection | 3 |
| *DUTYRATIO(i)* | Unity plus the ad valorem rate of import protection | 3 |
| *LAB* | Supply of labor | 1 |
| *CAP* | Supply of capital | 1 |
| *LAND* | Supply of land | 1 |
| *NINV(TOTAL)* | Total nominal investment | 1 |
| *IPI* | Price index for investment goods | 1 |
| *NCONS(TOTAL)* | Total nominal consumption | 1 |
| *CPI* | Price index for consumer goods | 1 |
| *NGOV(DOM, 4)* | Nominal government consumption | 1 |
| *GDP* | Gross domestic product | 1 |
| *E* | Total exports | 1 |
| *M* | Total imports | 1 |
| *Y* | Real income | 1 |
| *EP* | Export price index (in foreign currency) | 1 |
| *MP* | Import price index (in foreign currency) | 1 |
| *NABS* | Nominal absorption | 1 |
| *TB* | Real trade balance | 1 |
| *P(LAB)R* | Real wage | 1 |
| Total | | 107 |

*Government Consumption*

Like private consumption, real government consumption is derived from nominal government consumption ($NGOV$) and the price index for goods consumed by the government. Because government services are solely provided by the "nontraded-services sector" (sector 4),[9] this relationship can be expressed as follows:

$$GOV(DOM, 4) = NGOV(DOM, 4) / P(DOM, 4) \quad (54)$$

*Exports*

The model describes total export demand as a function of world prices for the exported good, measured in foreign currency:[10]

$$EX(i) = F14[FCP(EX, i)], \quad (55)-(57)$$

where $i = 1, \ldots, 3$.

## Supply

The supply side of the model treats imports and domestic production.

*Imports*

As in the case of exports, the import supply of each good rises in response to an increase in the foreign currency price of imports:[11]

$$IMP(i) = F15[FCP(IMP, i)], \quad (58)-(60)$$

where $i = 1, \ldots, 3$.

*Domestic Supply*

Constant returns to scale and zero pure profits are assumed for all productive sectors.[12] Thus, the individual producer chooses the output level that equates marginal costs with the output price:

[9]The German input-output table has a "government sector" that creates the goods used by government. This sector is contained in the nontraded-goods sector of the model.

[10]The Armington (1969) assumption implies that goods are differentiated by source of production. Thus, German exporters face a downward-sloping foreign demand curve.

[11]Implicit in this treatment of import supply is the assumption that the rest of the world produces goods for the German market that are not complete substitutes for goods shipped to other markets. In other words, the Armington (1969) assumption also holds for import supply.

[12]The assumption of zero pure profits implies that there are no undistributed profits. Rents to productive factors, however, are not excluded.

$$P(DOM,i) = F16[P(DOM,j), P(IMP,w), P(LAB), P(CAP), P(LAND)], \quad (61)–(64)$$

where $j = 1, \ldots, 4$ but $j \neq i$; $w = 1, \ldots, 3$; and $i = 1, \ldots, 4$. Here, $F16$ is the marginal cost of production.

## Domestic and World Market Prices

Domestic and import prices for traded goods are determined by the respective foreign currency prices of those goods, the exchange rate, the markups in foreign trade (for transport, wholesale, retail services, and so forth), the subsidy ratio (defined as unity plus the ad valorem rate of subsidies) in the case of domestic goods, and the duty ratio (defined as unity plus the ad valorem rate of import protection) in the case of imports:

$$P(DOM,i) = FCP(EX,i) \cdot XRATE \cdot SUBSIDYRATIO(i) \cdot 1/MARKUP(i), \quad (65)–(67)$$

where $i = 1, \ldots, 3$; and

$$P(IMP,i) = FCP(IMP,i) \cdot XRATE \cdot DUTYRATIO(i) \cdot MARKUP(i), \quad (68)–(70)$$

where $i = 1, \ldots, 3$.

## Market Clearing

The model is closed by a set of equations that links demand and supply by imposing market clearing on factor and product markets.

### *Markets for Primary Factors*

The clearing of factor markets requires that the sum of the demand for labor and capital equals total supply.[13] The supply of land equals demand for this factor by the sector producing basic goods:

$$LAB = \sum_j LAB(j), \quad (71)$$

[13] Note that market clearing does not necessarily imply full employment of all factors. In fact, as outlined below, the model allows the fixing of factor prices at above full employment levels and the equilibrating of supply and demand at these prices.

where $j = 1, \ldots, 4$;

$$CAP = \sum_j CAP(j), \tag{72}$$

where $j = 1, \ldots, 4$; and

$$LAND = LAND(1). \tag{73}$$

*Domestic Production*

The clearing of the product markets for output from the four sectors requires that total domestic production satisfy aggregate demand:

$$\begin{aligned} Z(i) = \sum_j INTERINPUT(DOM, i, j) + INV(DOM, i) \\ + CONS(DOM, i) + GOV(DOM, i) \\ + EX(i), \end{aligned} \tag{74)–(77}$$

where $i, j = 1, \ldots, 4$.

## Miscellaneous Equations

The model also includes equations that define macroeconomic aggregates, such as GDP, aggregate exports and imports, and the like (definitions of all variables, as noted earlier, appear in Table 4):

$$\begin{aligned} GDP = CONS(TOTAL) + INV(TOTAL) \\ + GOV(DOM, 4) + E - M \end{aligned} \tag{78}$$

$$E = \sum_i EX(i); \qquad i = 1, \ldots, 3 \tag{79}$$

$$M = \sum_i IMP(i); \qquad i = 1, \ldots, 3 \tag{80}$$

$$Y = F81(EP/MP, GDP) \tag{81}$$

$$EP = \sum_i w(x, i) FCP(EX, i); \qquad i = 1, \ldots, 3 \tag{82}$$

$$MP = \sum_i w(m, i) FCP(IMP, i); \qquad i = 1, \ldots, 3 \tag{83}$$

$$\begin{aligned} CPI = \sum_i w(cd, i) P(DOM, i) + \sum_j w(cm, j) P(IMP, j); \\ i = 1, \ldots, 4; \qquad j = 1, \ldots, 3 \end{aligned} \tag{84}$$

$$IPI = \sum_i w(id, i)P(DOM, i) + \sum_j w(im, j)P(IMP, j);$$
$$i = 1, \ldots, 4; \qquad j = 1, \ldots, 3 \tag{85}$$

$$NCONS = F86(NABS) \tag{86}$$

$$NINV = F87(NABS) \tag{87}$$

$$NGOV = F88(NABS) \tag{88}$$

$$TB = EP \cdot E - MP \cdot M \tag{89}$$

$$P(LAB)R = P(LAB) / CPI. \tag{90}$$

Equation (81), for example, defines real income as a function of real GDP and the terms of trade. Equations (86)–(88) relate nominal private and public consumption and investment to nominal domestic absorption.[14] Equation (89) defines the real trade balance as the difference between exports and imports, corrected for terms of trade effects. Equation (90) defines the real wage rate as the nominal wage rate deflated by the consumer price index.

## Parameter Settings

Most of the parameters needed for the numerical specification of the model can be derived from the 1982 German input-output table (see Dixon and others (1982) for details). There are, however, several other parameters that have to be taken from econometric studies or, if not available, assumed. Table 5 shows the values of these parameters that were used for the simulations that follow.

The consumption parameters were derived from a linear expenditure system. The underlying household utility function was assumed to be additive; thus the uncompensated own-price elasticities ($n_{ii}$) and cross-price elasticities ($n_{ij}$ for $i \neq j$) can be derived as follows (see Lluch, Powell, and Williams (1977)):

$$n_{ii} = (\xi_i / w) - \xi_i \alpha_i [1 + (\xi_i / w)]$$
$$n_{ij} = -\xi_i \alpha_j [1 + (\xi_j / w)], \qquad \text{for } i \neq j.$$

[14] In the following experiments it is assumed that the shares of (private and public) consumption and investment in domestic absorption remain unchanged.

Table 5. *Key Parameter Settings for the German Model*

| Parameter | Basic Goods | Protected Goods | Traded Goods | Nontraded Goods |
|---|---|---|---|---|
| Expenditure elasticity[a] | 0.5 | 0.5 | 1.0 | 1.2 |
| Elasticity of substitution between domestic production and imports[b] | 1.0 | 1.0 | 0.9 | ... |
| Elasticity of substitution beween primary factors[c] | 0.3 | 1.0 | 1.0 | 1.0 |
| Price elasticities of import supply[d] | 2.0 | 2.0 | 1.3 | ... |
| Price elasticities of export demand[e] | −1.3 | −1.3 | −1.0 | ... |

[a] Based on Lluch, Powell, and Williams (1977, p. 54).
[b] Based on Lächler (1985, p. 85) and Fund staff calculations. These elasticities are assumed to be the same for all uses.
[c] A simple Cobb-Douglas production function was assumed to characterize the protected-, traded-, and nontraded-goods sectors, whereas the substitution elasticity for primary factors in the basic-goods sector was set at a level that brought the output supply price elasticity in line with estimates from the literature.
[d] The parameters give the percentage change of import supply in the respective sector in response to a 1 percent change in the foreign currency price of imports. These parameters enter equations (58)–(60) of the text.
[e] The parameters give the percentage change of export demand in the respective sector in response to a 1 percent change in the foreign currency price of exports. These parameters enter equations (55)–(57) of the text.

Here $\xi_i$ represents the expenditure elasticity and $\alpha_i$ the budget share for product $i$, whereas $w$ is the Frisch parameter. The Frisch parameter was set at $-1.83$.[15]

The elasticities of substitution between domestically produced and imported products were specified on the basis of an econometric study for Germany by Lächler (1985). On the supply side, a Cobb-Douglas production function was assumed for the protected-, traded-, and nontraded-goods sectors, and a constant elasticity of substitution function was assumed for the basic-goods sector; the elasticity of substitution between primary factors in the latter sector was specified such that the supply elasticity was broadly in line with estimates from the literature.

No sector-specific information was found in the literature for the price elasticities of import supply and export demand. Appropriate values for these parameters were therefore determined by numerous sensitivity analyses with the model.

[15] Using the relationship between per capita GDP and $w$ estimated by Lluch, Powell, and Williams (1977, p. 248).

### Solving the Model

The equations of the model are first transformed into a log-linear form that allows solving by simple matrix methods.[16] The model in the form described above consists of 107 variables and 90 equations. Thus, to arrive at a solution, 17 variables have to be assumed exogenously. The selection of the exogenous variables and the design of the simulations are described in the following section.

## III. Design of Experiments and Simulation Results

The selection of the exogenous variables of the model follows from the assumptions about the macroeconomic environment in which the exchange rate shock takes place and from the specific protectionist practices and structural rigidities that are to be analyzed. Although the macroeconomic environment was assumed to be the same for all experiments that were conducted, several different sectoral policies and rigidities were investigated that required changes in the set of exogenous variables. Table 6 provides an overview of the variables assumed exogenously in each of the simulations.

The simulations were intended to trace the short run (one- to two-year period) effects of a 10 percent increase in the nominal value of the deutsche mark (induced exogenously by a shift in international portfolio preferences) on the German economy. Thus, it was assumed that (1) capital and land are fixed factors of production in each sector, and investment does not add to the productive capital stock in an industry during the period under investigation; (2) proportional markups in foreign trade are constant; (3) real wages are constant and above full employment levels;[17] and (4) fiscal and monetary policy continue to follow the nominal targets of the authorities' medium-term economic strategy so that nominal domestic absorption is maintained unchanged. The last assumption implies that monetary policy supports nominal private consumption and investment by allowing monetary expansion to exceed nominal GDP growth when nominal GDP growth is reduced by a decline in the external surplus,[18] and that the government maintains growth of nominal expenditures unchanged even if, because of lower

[16]The design of the model ensures that there is a unique solution provided that the matrix to be solved is not singular (see Dixon and others (1982)).

[17]Real wages that are rigid and above full employment levels have been a common characteristic of most European countries during the 1980s.

[18]In principle, the decline in the domestic price level elicited by the exchange rate appreciation will increase real financial household balances, which in turn

Table 6. *Values of Exogenous Variables in the German Model*
(In percentage changes from base period)

| Variable | Baseline | Scenarios (1) | (2) | (3) | (4) |
|---|---|---|---|---|---|
| *CAP(j)* $j = 1, \ldots, 4$ | 0 | 0 | 0 | 0 | 0 |
| *LAND*(1) | 0 | 0 | 0 | 0 | 0 |
| *MARKUP(i)* $i = 1, \ldots, 3$ | 0 | 0 | 0 | 0 | 0 |
| *SUBSIDYRATIO*(1) | 0 | (en) | 0 | 0 | (en) |
| *SUBSIDYRATIO*(2) | 0 | 0 | 0 | 0 | 0 |
| *SUBSIDYRATIO*(3) | 0 | 0 | 0 | 0 | 0 |
| *DUTYRATIO*(1) | 0 | (en) | 0 | 0 | (en) |
| *DUTYRATIO*(2) | 0 | 0 | (en) | 0 | (en) |
| *DUTYRATIO*(3) | 0 | 0 | 0 | 0 | 0 |
| *XRATE* | −10 | −10 | −10 | −10 | −10 |
| *NABS* | 0 | 0 | 0 | 0 | 0 |
| *P(LAB)R* | 0 | 0 | 0 | (en) | (en) |
| *P(DOM,* 1) | (en) | 0 | (en) | (en) | 0 |
| *P(IMP,* 1) | (en) | 0 | (en) | (en) | 0 |
| *IMP*(2) | (en) | (en) | 0 | (en) | 0 |
| *LAB*(4) | (en) | (en) | (en) | 0 | 0 |
| Number of exogenous variables | 17 | 17 | 17 | 17 | 17 |

Note: The notation "(en)" indicates that the variable is endogenous in this experiment.

nominal income growth, direct tax revenues decline and the budget deficit widens.

The baseline simulation establishes the counterfactual reaction of the economy to the appreciation of the deutsche mark—that is, the likely developments in the absence of protectionist practices and structural rigidities. As shown in Table 6, in addition to the variables mentioned above, the subsidy and duty ratios were assumed to be unchanged for

will boost real consumption and contribute to a decline in the savings rate. Higher real consumer demand, together with a higher rate of return for capital, will then stimulate real investment. The role of monetary policy in this context is to support these effects by stabilizing nominal private absorption through monetary expansion in line with potential output growth and some acceptable and sustainable rate of price increases.

this simulation. Four alternative scenarios were designed to illustrate the effects of the protectionist practices and structural rigidities. In scenario 1, it was assumed that variable import levies and export subsidies isolate the basic-goods sector from the effects of the appreciation. Thus, the prices of the domestically produced and imported products of this sector were assumed to remain unchanged while the subsidy and duty ratios were endogenously determined by the model so as to offset the change in the exchange rate.[19] In scenario 2, it was assumed that quotas, voluntary export restraints, and other nontariff barriers present in the protected-goods sector prevent imports that compete with the goods produced by this sector from reacting to the appreciation.[20] Hence imports of these goods were assumed to remain unchanged while the duty ratio, which in this case measures the tariff equivalent of the nontariff barriers in this sector, was endogenously determined by the model. In scenario 3, it was assumed that government regulations and labor market rigidities prevent output and employment in the nontraded-goods sector from reacting to the appreciation. This, of course, is an extreme assumption that serves only as a benchmark for a more complex reality. However, the regulations on market access and competition in industries such as retail trade, financial services, and professional services, and the (voluntary and systematic) restrictions to labor mobility all contribute to a sluggish supply response of the nontraded-goods sector to an increase in demand. Hence changes in the demand for goods produced by this sector lead to changes in the return to the productive factors employed there. By assumption, changes in the return to labor employed in the nontraded-goods sector affect the general wage level.[21] Thus, employ-

[19] Although these assumptions are in accord with the key principles of the European Community Common Agricultural Policy and the German support scheme for coal mining, the implementation of these policies is in reality slightly different. For example, the authorities are likely to take into account, at least partially, the effects of an appreciation on costs and factor incomes in the respective sectors when they set prices there. Moreover, subsidies are given to two main industrial users of coal—the steel and electricity industry—to compensate them partially for the use of high-priced German coal. In the case of steel, the subsidies are borne by the federal budget, and in the case of electricity the costs of the subsidies are passed on to the consumers (*Kohlepfennig*). These arrangements may alleviate the direct effects of the coal support scheme on the respective industries, but they do not change the final effects on the German economy. In either case, relative prices are distorted, and aggregate production costs increase.

[20] Protection for shipbuilding, which has been afforded largely in the form of subsidies, was not separately modeled. Instead, it was assumed that measures similar to those in the other protected industries were taken to reduce competition from imports.

[21] This assumption, which again is only a crude approximation of reality, reflects the low degree of intersectoral wage differentiation (see Table 3) and the

Table 7. *Alternative Patterns of Adjustment to a 10 Percent Appreciation of the Exchange Rate: Macroeconomic Results*

(In percentage changes from base period or baseline)[a]

| Macroeconomic Variable | Baseline | Deviations from Baseline Under Alternative Scenarios | | | |
|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) |
| Output | 1.8 | −1.0 | −0.2 | −4.3 | −4.0 |
| Absorption | 4.4 | −1.3 | −0.2 | −3.5 | −3.7 |
| Exports | −5.5 | 0.1 | −0.2 | −4.0 | −2.9 |
| Imports | 3.7 | −0.7 | −0.4 | −0.8 | −1.7 |
| Trade balance[b] | −27.2 | 5.5 | 2.6 | 5.4 | 11.8 |
| Employment | 2.8 | −1.6 | −0.3 | −6.8 | −6.3 |
| Consumer prices | −4.4 | 1.3 | 0.2 | 3.5 | 3.7 |
| Real exchange rate | 5.6 | 1.3 | 0.2 | 3.5 | 3.8 |
| Terms of trade | 2.8 | 0.5 | 0.4 | 4.4 | 3.9 |
| Real income | 2.6 | −0.9 | −0.1 | −3.1 | −2.9 |
| Real wage | — | — | — | 4.4 | 2.9 |

[a] Results for the baseline simulation indicate percentage deviations of endogenous variables from the values they would have attained in the absence of the exchange rate shock. Results for the alternative policy simulations indicate percentage changes from the baseline simulation.

[b] Absolute change in billions of 1982 deutsche mark.

ment is assumed to remain unchanged in the nontraded-goods sector while the real wage rate is determined endogenously in the model. Finally, in scenario 4, all of the above protectionist practices and structural rigidities together were assumed to influence the adjustment of the economy to the exchange rate shock.

The results of the baseline simulation and deviations from the baseline under the four alternative scenarios are presented in Tables 7 and 8. In interpreting these tables it is important to keep in mind that the results are contingent on the numerous model assumptions and the assumed parameter values. They are therefore more of the nature of controlled laboratory experiments than projections of actual developments of the German economy in response to an appreciation of the deutsche mark. The simulation results of the baseline scenario indicate the percentage

highly centralized organization of the German trade unions. This organization has contributed to the fast diffusion of wage increases from one industry to the other industries in the economy.

Table 8. *Alternative Patterns of Adjustment to a 10 Percent Appreciation of the Exchange Rate: Sectoral Results*

(In percentage changes from base period or baseline)[a]

| Sector | Baseline | Deviations from Baseline Under Alternative Scenarios | | | |
|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) |
| Output | | | | | |
| Basic goods | 0.1 | 1.3 | −0.1 | −2.1 | −0.2 |
| Protected goods | −1.5 | −1.3 | 0.5 | −5.3 | −4.3 |
| Traded goods | 0.7 | −1.1 | −0.2 | −4.5 | −4.2 |
| Nontraded goods | 4.2 | −1.3 | −0.2 | −4.2 | −4.2 |
| Employment | | | | | |
| Basic goods | 0.2 | 3.2 | −0.2 | −3.0 | −0.6 |
| Protected goods | −1.8 | −1.5 | 0.6 | −6.2 | −5.0 |
| Traded goods | 1.1 | −1.7 | −0.3 | −7.2 | −6.7 |
| Nontraded goods | 6.5 | −1.9 | −0.3 | −6.5 | −6.5 |
| Exports | | | | | |
| Basic goods | −6.8 | 13.8 | — | −0.6 | 10.6 |
| Protected goods | −6.4 | −1.3 | −0.9 | −5.8 | −5.9 |
| Traded goods | −5.4 | −0.6 | −0.1 | −4.0 | −3.4 |
| Imports | | | | | |
| Basic goods | 3.8 | −3.0 | −0.1 | −1.2 | −4.5 |
| Protected goods | 3.5 | −0.2 | −3.5 | −0.2 | −3.5 |
| Traded goods | 3.7 | −0.4 | — | −0.9 | −1.0 |
| Prices | | | | | |
| Basic goods | −5.5 | 5.5 | — | 0.3 | 5.5 |
| Protected goods | −6.4 | 0.6 | 2.4 | 2.6 | 4.5 |
| Traded goods | −4.9 | 0.5 | 0.1 | 3.5 | 2.9 |
| Nontraded goods | −3.0 | 0.6 | 0.1 | 5.0 | 4.0 |

[a] Results for the baseline simulation indicate percentage deviations of endogenous variables from the values they would have attained in the absence of the exchange rate shock. Results for the alternative policy simulations indicate percentage changes from the baseline simulation.

deviation of a variable, in response to the exchange rate shock, from the level it would have otherwise attained after all the domestic and international effects have worked their way through the economy. The results of the alternative policy simulations are reported as percentage deviations of the endogenous variables from the baseline simulation.

In the absence of protection and structural rigidities, a 10 percent appreciation of the exchange rate lowers domestic consumer prices by

about 4.4 percent (Table 7). With nominal domestic absorption maintained by macroeconomic policies, the decline in the consumer price level leads to a corresponding increase in real domestic absorption.[22] Import volumes are buoyed by higher domestic demand and the decline of the domestic currency price of imported goods relative to that of domestic products. The increase in imports is, however, smaller than that of domestic absorption because demand for imported inputs, which comprise about half of total imports, rises less than demand for imported consumer and investment goods.[23] Exports, in contrast, decline by around 5.5 percent because of the increase in prices expressed in foreign currency.[24] As a result, the real trade balance deteriorates by about DM 27 billion (in 1982 prices, equivalent to about 1.9 percent of GDP). The increase in domestic absorption, however, more than compensates for the lower exports and higher imports, so that GDP rises by about 1.8 percent; owing to the improvement in the terms of trade, real income increases by even more. With capital and land being fixed factors of production, the increase in aggregate output triggers an overproportionately large increase in employment.[25]

As a result of the deterioration in the external balance, nominal GDP falls by about 1¾ percent. Revenue of the government from direct taxes and social security contributions can be expected to decline by a similar

[22] Note that the increase in real domestic absorption is not explicitly explained by the model. The result is, however, in line with conventional wisdom: real private consumption increases as a result of higher real income and real balance effects, elicited by the decline in the price level and the expansionary effects of a monetary policy that follows nominal potential GDP growth rather than actual growth; real investment increases because of accelerator effects and a higher return to capital; and real government expenditures increase as the authorities stick to their medium-term nominal expenditure targets.

[23] The buoyancy of imports with respect to GNP is slightly greater than 2.0 and close to the historical average in Germany over the recent years. The (general equilibrium) elasticity of imports with respect to the real exchange rate is about 0.7 percent, a little higher than most econometric estimates of the partial real exchange rate elasticity of imports.

[24] The elasticity of exports with respect to the real exchange rate is about 1.0. Econometric studies have usually arrived at a value a little smaller than this. Part of the discrepancy can be explained by the assumed absence of protectionist practices and structural rigidities under the baseline simulation, which contributes to higher trade elasticities in the economy. Indeed, in scenario 4, the export and import elasticities decline to 0.9 and 0.2, respectively.

[25] Given the assumption of constant returns to scale, the percentage change in output equals the weighted average of the percentage changes of factor inputs plus any efficiency gains that may arise from a reallocation of factors among industries. In the case of Germany, there are only very small differences in the marginal returns to labor across industries, so that efficiency gains do not arise. Thus, the increase in employment is almost identical to the increase in output divided by the share of labor in total value added (0.63).

percentage,[26] so that the general government deficit increases by a little more than ½ percentage point of GDP.[27] With the ratio of investment to GDP up by a little less than ½ percentage point, the share of private savings in GDP declines by about ¾ percentage points. These changes in the savings-investment balance are in line with historical experience. Indeed, the projected increase in the fiscal deficit is of a similar magnitude as the actual increase for 1986–88, and the projected decline in the private savings rate is considerably smaller in absolute amount than the increase that took place in 1985–87.

A better insight into the way the economy adjusts to the exchange rate shock can be obtained from the sectoral results presented in Table 8. The appreciation leads to a large drop in domestic-currency prices of protected goods, the sector with the highest exposure to international trade.[28] This sector benefits relatively little from the increase in domestic absorption, and as a consequence it suffers relatively large losses in output and employment. The basic-goods sector is less dependent on foreign demand and is therefore able to maintain output and employment despite the sharp drop in exports and increase in imports. The traded-goods sector, in contrast, benefits from the appreciation despite greater competition from imports because the increase in domestic demand more than compensates for the decline in exports. The clear winner, however, is the nontraded-goods sector. As anticipated, the rise in domestic demand, and the decline in the domestic currency price of those goods that are traded internationally, leads to a significant improvement in the relative price for nontraded goods. This triggers an expansion of output and an increase in employment. Nevertheless, absolute prices fall also in this sector—although by a smaller amount than in the other sectors—because of the lower input and nominal wage costs.

Variable import levies and subsidies in the basic-goods sector neutralize the exchange rate effects on prices in this sector; consequently, prices for basic goods increase sharply relative to those for other goods (and in

[26] Indirect taxes will remain largely unaffected because they are related to nominal domestic absorption, which remains unchanged.

[27] This implies a largely neutral fiscal policy stance, since the decline in total government revenue is smaller than that of nominal GDP and the ratio of expenditures to potential nominal GDP remains broadly unchanged.

[28] Like the basic-goods sector, the protected-goods sector has a higher price elasticity of imports and exports, and a higher substitution elasticity between imported and domestically produced goods, than does the traded-goods sector. The export orientation of the protected-goods sector (measured as exports in percent of output) is only a little smaller than that of the traded-goods sector, but more than twice as high as that of the basic-goods sector. Also, its import penetration ratio is only slightly smaller than that of the basic-goods sector but substantially larger than that of the traded-goods sector.

relation to the baseline simulation) in the presence of these policies (Table 8, scenario 1). This leads to a rise in employment and output in this sector that far exceeds the domestic demand for basic goods. The surplus production has to be dumped in the world market if a buildup of stocks is excluded; hence, exports increase sharply.[29] The output and employment gains of the basic-goods sector are at the expense of the other sectors. Higher input and nominal wage costs (because of the assumption of constant real wages and the spillover effects from food prices into the consumer price index) lead to an increase in domestic prices that reduces foreign and domestic demand for products produced in these sectors. The resultant drop in output and employment in these sectors is larger than the rise in the basic-goods sector, so that GDP and aggregate employment decline by about 1.0 percent and 1.6 percent, respectively, in relation to the baseline simulation. Owing to somewhat higher exports and lower imports as well as a larger terms of trade gain, the trade balance declines by about DM 5.5 billion (equivalent to 0.4 percent of GDP) below the baseline simulations. The consumer price level and the real value of the deutsche mark rise by 1.3 percent against the baseline, which implies a corresponding fall in real domestic absorption.

If trade barriers prevent imports in the protected-goods sector from responding to the appreciation, relative prices, output, and employment increase in this sector compared with results in the baseline simulation (Table 8, scenario 2). The effects of these trade restrictions are, however, much smaller than those of the variable import levies and export subsidies used as an instrument of protection in the basic-goods sector. As a consequence, the effects on other sectors and the economy at large are also less severe than under scenario 1. Nevertheless, protectionist practices in the protected-goods sector are likely to result in a decline in GDP and domestic absorption of about 0.2 percent, a fall in aggregate employment of 0.3 percent, and an increase in the real trade balance of DM 2.6 billion (or 0.2 percent of GDP, Table 7) compared with the baseline scenario. In addition to shifting the burden of adjustment to other sectors of the economy, import protection in the protected-goods sector also has the effect of hurting exporting companies in this sector, as evidenced by the fall of almost 1 percent (against the baseline scenario) of exports of these protected goods.

More serious than the protectionist practices analyzed in scenario 2

[29]In reality, part of the increase in production would, of course, lead to stock accumulation and therefore to a smaller rise in exports than projected in this illustrative exercise.

are the labor market rigidities and regulations, which are assumed to prevent output and employment in the nontraded-goods sector from reacting to the shift in demand toward nontraded goods elicited by the exchange rate change (scenario 3). Indeed, with output failing to respond to higher demand, prices of nontraded goods increase by 5 percent against the baseline, which, because of the assumptions of zero pure profits and equalization of wage increases across sectors, leads to a real wage increase of almost 4.5 percent. Sharply higher wage costs result in higher domestic prices (and a larger real appreciation) than in the baseline simulation and in a deterioration of the international competitiveness of the economy. This leads to a drop in exports, output, and employment. As a result of the lower domestic activity level, imports also fall, and the real trade balance improves by almost DM 5.5 billion (0.4 percent of GDP) relative to the baseline scenario. The effects of the rigidities simulated in this scenario are so strong that real income, GDP, and aggregate employment all fall—not only in relation to the baseline simulation, but also in comparison with the base period.

Finally, when all the protectionist practices and structural rigidities so far considered are combined, the exchange rate shock, which under the baseline simulation led to an improvement in income and employment, has negative implications for the economy. As in the previous scenario, real income, GDP, and employment all decline in relation to both the baseline simulation and the base period. In addition, helped by protectionist trade policies, exports decline by less—and imports by more—than in scenario 3, so that the trade balance improves by almost DM 12 billion (or 0.8 percent) in relation to the baseline simulation. In the baseline case, a 1 percent increase in the real exchange rate led to a DM 4.9 billion deterioration of the real trade balance. In scenario 4, the same real exchange rate change is capable of inducing a change in the real trade balance of only DM 1.6 billion.

## IV. The Costs to Adjustment

Although the economy clearly would be better off if more liberal policies were followed, there are some groups of the population who are likely to lose, and it is the strong resistance of those groups that has prolonged protectionist policies and structural rigidities. Table 9 presents the change in the real return to productive factors as a result of the exchange rate shock under the baseline simulation and alternative scenarios. Under scenario 1, the return to capital and land in the basic-goods sector increases substantially over the baseline simulation. Simi-

Table 9. *Real Return to Productive Factors Under the Baseline and Alternative Scenarios*

(In percentage changes from base period or baseline)[a]

| Factor | Baseline | Deviations from Baseline Under Alternative Scenarios | | | |
|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) |
| Labor | | | | | |
| Total economy | — | — | — | 4.4 | 2.9 |
| Capital | | | | | |
| Basic goods[b] | 0.5 | 10.6 | −0.5 | −11.9 | 1.0 |
| Protected goods | −1.8 | −1.5 | 0.7 | −1.8 | −2.0 |
| Traded goods | 1.1 | −1.7 | −0.4 | −2.9 | −3.8 |
| Nontraded goods | 6.5 | −0.7 | −0.4 | −2.1 | −3.6 |

Note: Real returns are defined as nominal returns deflated by the consumer price index.

[a] Results for the baseline simulation indicate percentage deviations of endogenous variables from the values they would have attained in the absence of the exchange rate shock. Results for the alternative policy simulations indicate percentage changes from the baseline simulation.

[b] Return to capital and land.

larly, under scenario 2, the return to capital in the protected-goods sector increases, and under scenario 3 the return to those who are able to hang on to their jobs despite the decline in employment rises sharply. In contrast, when all protectionist practices and structural rigidities are combined, as in scenario 4, it is only the return to capital and land in the basic-goods sector and the return to those who manage to maintain their jobs despite the slowdown of economic activity that are higher than in the baseline simulation. The returns to fixed factors in all other sectors are lower—as is, of course, the return to those who have to rely on unemployment support as a result of the job losses generated under scenario 4. Seen from this perspective, it is not surprising that the strongest resistance against more liberal policies in Germany comes from the representatives of agriculture and the coal-mining industry and from those with a high degree of job security—that is, the employees and workers in the nontraded-goods sector who anticipate an increasing demand for their services.

## V. Concluding Remarks

The exercise conducted in this paper has illustrated how certain protectionist practices in Germany are capable of impeding the adjustment of the economy to an exogenous exchange rate shock. These distortions

are likely to lead to income, output, and employment losses as well as to a slowdown of the adjustment process itself. Inefficient domestic producers are protected at the expense of more efficient foreign and domestic suppliers; in addition to short-term welfare losses, this protection is also likely to have long-term consequences for the growth potential and the dynamics of the economy.

This paper has also illustrated how labor market rigidities and regulations are likely to combine with protectionist polices to generate an environment in which an appreciation of the exchange rate is a serious threat to economic growth and employment. In the absence of these distortions, and with appropriate macroeconomic policies, the economy would react positively to an appreciation of the exchange rate—with output, employment, real income, and absorption all up, and prices and the trade surplus down. Resistance to more liberal economic policies, however, is likely to come from well-organized interest groups that stand to lose if present policies are changed.

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# External Adjustment and the Strong Yen

## Recent Japanese Experience

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*The parameters of a conventional model of Japan's current account were found to be stable in the period of the steeply rising yen, end-1985 to end-1987. Thus, Japan's current account has been adjusting to the strengthening yen in accordance with established historical relationships—a conclusion substantiated by the model's reasonably accurate tracking of the current account in this period. Simulations of the model show that the rise in the yen has already made a substantial contribution to correcting Japan's external imbalance.* [JEL 431, 212]

JAPAN'S CURRENT account surpluses in the 1980s have been large both in nominal terms and as a percentage of gross national product (GNP). Furthermore, the persistence of large surpluses in the face of the recent sharp appreciation of the yen has called into question whether the process of external adjustment has been proceeding at a satisfactory pace. Specifically, many commentators have argued that sluggish adjustment of Japan's current account surplus has been due either to a lack of openness of the Japanese market or to abnormal trading practices by Japanese exporters. With these concerns in mind, this paper examines the developments in Japan's current account in the period following the start of the yen's rapid rise toward the end of 1985.

The paper concludes that, by and large, Japan's current account has been adjusting to the higher yen since 1985 according to established historical relationships. Export growth was slightly faster than might have been expected, but the effect of this on the trade surplus was offset

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by exceptionally strong import growth. Services account transactions are less well-explained than those of the traded-goods sector, but they too could have been broadly predicted on the basis of past behavior. The paper therefore concludes that the yen's recent appreciation has already exerted a significant corrective influence on the current account. In U.S. dollar terms, however, the current account has not declined appreciably because of the usual J-curve effects.

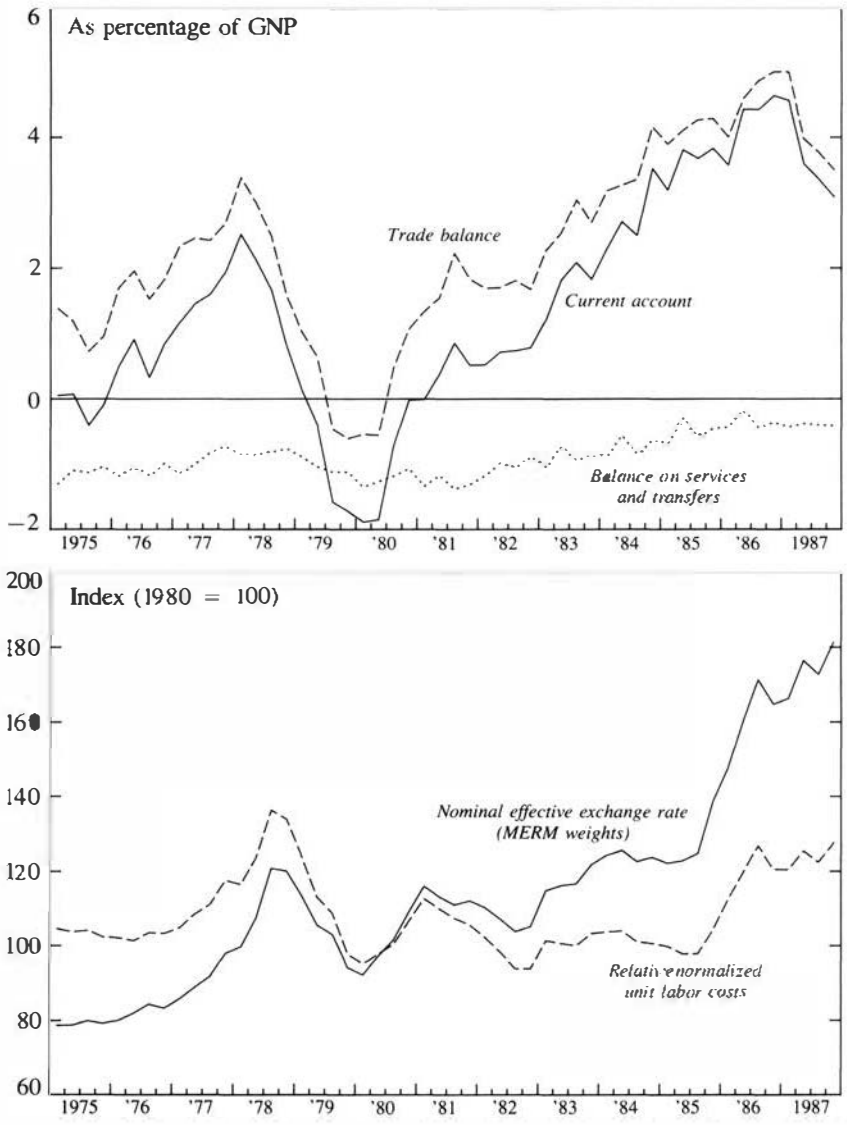
The paper is organized as follows. In Section I, recent developments in Japan's current account are described. Section II describes the specification and estimation of a fairly conventional model of current account transactions. This model is used as the vehicle in Sections III and IV to analyze developments in the current account since the yen began its steep ascent. Analysis is conducted in two parts. First, formal and informal evidence is examined for a break in behavior during the period 1985:4–1987:4. Second, simulations are conducted with the model to measure the extent to which exchange rate realignments have affected Japan's current account in the last two years. Conclusions are presented in Section V.

## I. Current Account Developments in the 1980s

Japan's current account was last in balance in 1980. Over the next five years, the current account recorded steadily increasing surpluses and, by 1985, the surplus amounted to 3½ percent of GNP. The rise was largely accounted for by a growing trade surplus, although the deficit on the services account also narrowed in this period mainly because of a rise in net investment income from the accumulated stock of foreign assets (Figure 1). The already large surplus was given fresh impetus in 1986 by the collapse in oil prices, and the surplus rose to 4¼ percent of GNP. The current account surplus began to decline as a ratio of GNP in 1987, although its value in U.S. dollars remained roughly unchanged at $87 billion.

The buildup of the current account surplus in the first half of the 1980s took place against a background of improving Japanese competitiveness, but this pattern changed markedly toward the end of 1985 when the yen began to appreciate sharply against most currencies. The yen had already been appreciating against the dollar since February of that year—which is when the dollar began to fall in effective terms—but it was only after the Plaza Accord of September 1985 that the yen's effective value began to move sharply upward. The extent of the appreciation since then has been remarkable. Between the third quarter of 1985 and the end of

Figure 1. *Japanese Current Account and Competitiveness, 1975–87*




Source: International Monetary Fund, *International Financial Statistics* (Washington, various years); MERM refers to the Fund's Multilateral Exchange Rate Model.

1987, the yen rose by 45 percent in nominal effective terms according to weights assigned in the International Monetary Fund's Multilateral Exchange Rate Model (MERM), and by 76 percent against the dollar. In terms of relative normalized unit labor costs, the appreciation was over 30 percent, pushing the real exchange rate to the heights of its short-lived peak in 1978.

The appreciation of the yen had a powerful effect on real trade flows. The rapid growth in real exports seen in the first half of the 1980s was brought to an abrupt halt, and import growth accelerated sharply. Measured in 1980 prices, the real trade surplus declined by about 3 percent of GNP in two years. However, the nominal trade and current account surpluses remained at high levels because of terms of trade gains.

## II. A Model of Japan's Current Account

In this section a model of current account transactions is developed, and econometric estimates are presented. The framework of analysis reflects the elasticities approach, rather than one that emphasizes savings and investment behavior.[1] The model forms the basis for the empirical analysis, described in Sections III and IV, of current account adjustment to the strong yen.

### Model Specification

The structure of the model's main sectors—exports, imports, and services—is first described. Equation estimates are then presented.

#### *Exports*

The demand for and supply of merchandise exports were modeled at the aggregate level because of the comparatively homogeneous composition of Japanese exports.[2] The market for a typical export good was assumed to be characterized by imperfect competition—Japanese exports are not perfect substitutes for foreign-produced goods—and supply decisions were assumed to be made on the basis of profit maximization. Two equations were specified: an export demand equation and a reduced-form price equation.

[1] For a discussion of these and other approaches to the determination of Japan's current account, see Ueda (1988).

[2] Practically all Japanese exports are manufactured goods.

The demand for exports is determined by the price of Japanese exports relative to competing goods and on a foreign income variable. This is a fairly conventional treatment (see, for example, Goldstein and Khan (1978)) although some researchers also have added cyclical terms (for example, Citrin (1985)). It was assumed that demand does not adjust instantaneously to either changing relative prices or income—for example, because of fixed contracts. The export demand equation is thus

$$x = x[a(L)(px/pw),\ b(L)yw], \tag{1}$$

where $x$ is export volume; $px$, export prices (in dollars); $pw$, competitors' prices (also in dollars); and $yw$, income in Japan's export markets. The notation $a(L)$ denotes a polynomial function in the lag operator $L$ (that is, $L^i Z_t = Z_{t-i}$).

In recent years, certain Japanese exports have been subject to voluntary export restraints (VERs).[3] To the extent that these restraints have been binding, export volume would have been lower than the free market level, whereas average prices would have been higher. Empirical tests were conducted to examine the importance of VERs at the aggregate level.

Under imperfect competition, a downward-sloping demand curve and production technology impose constraints on suppliers' pricing behavior. The usual first-order conditions for profit maximization lead to export prices being a markup on input costs, where the markup depends on the elasticity of demand for exports. Except in restricted cases,[4] export prices can then be written as a reduced form of input costs and the arguments of the export demand equation. Furthermore, in an intertemporal framework, where there are costs associated with changing prices or where exporters rationally take into account the sluggish adjustment of demand, it can be shown that export prices depend on the whole spectrum—past, present, and expected—of input costs, competitor prices, and any other factors that shift supply and demand (see Cuthbertson (1986)). An important component of the expected variables would be expectations about exchange rate movements that would affect

[3] The most important VER in value terms has been imposed on exports of automobiles to the United States (since April 1981) and, more recently, to the European Community and Canada. VERs have also been imposed on steel, textiles, certain machine tools, and forklift trucks. For an analysis of the effects of VERs on Japanese auto prices in the U.S. market, see Collyns and Dunaway (1987).

[4] For example, if the elasticity of demand and the marginal cost of production were both independent of quantity, export prices would be a constant markup on input costs.

the course of profits denominated in domestic currency. Some researchers (for example Froot (1988)) have argued that pricing behavior will differ in the face of permanent or transitory exchange rate changes. No attempt was made in the present paper to test this hypothesis, and all expectations were proxied by past values of explanatory variables. The export price equation thus resembles

$$px = px[d(L)pw,\ e(L)p,\ f(L)yw], \tag{2}$$

where $p$ represents domestic costs (proxied by domestic wholesale prices, in U.S. dollars).[5]

Careful attention was paid to both the equation's long-run and short-run properties. As regards the equation's long-run properties, it can be shown that prices depend on, among other things, a weighted average of foreign prices and domestic costs, where the weights reflect the relative size of export supply and demand elasticities (see Appendix I). The implied coefficient restrictions needed to produce this result—which has implications for the degree of long-run exchange rate "pass-through"—were tested empirically. As regards the short-run properties, some commentators (for example, Loopesko and Johnson (1987) and Hooper and Mann (1987)) have suggested that Japanese exporters react differently to an exchange rate depreciation than to an exchange rate appreciation. Such potential nonlinear behavior was also examined empirically.

*Imports*

Imports were disaggregated into four categories—mineral fuels, raw materials, food and drink, and manufactures—because demand behavior for each of these components is very different. Demand for each category was assumed to depend, with adjustment lags, on domestic activity variables and on the price of the import relative to domestic wholesale prices (both in U.S. dollars). That is,

$$m_i = m_i\,[g(L)y,\ h(L)(pm_i/p)], \tag{3}$$

where $m_i$ is the volume of import $i$, $pm_i$ is its price, and $y$ is domestic activity. Import prices were assumed to be exogenous.

In addition, Japan's imports are affected by various nontariff barriers. Quotas and domestic pricing policies play a particularly important role in determining agricultural imports, whereas exporters of manufactured goods to Japan frequently claim that they face intangible trade barriers (see Christelow (1985–86)). Furthermore, demand for mineral fuel im-

[5]This is a fairly commonly used proxy, although Cuthbertson (1986) and Citrin (1985) use a weighted average of labor and energy costs.

ports is strongly influenced by an energy policy that, given Japan's lack of fuel resources, heavily promotes conservation. Attempts were made to incorporate such factors in the import demand equations.

*Services*

The services account was divided into four subcategories: transport, travel, investment income flows, and other services.[6] For all categories except investment income, equations were specified for both payments and receipts. It was assumed that competitiveness is an important determinant of the demand for services, so these equations resembled trade volume equations (1) and (3) in structure. That is, demand for real service flows depends on activity and relative price terms:

$$sr_i/p_i = sr_i[k(L)yw,\ m(L)z] \tag{4}$$

$$sp_i/p_i^* = sp_i\ [n(L)y,\ q(L)z], \tag{5}$$

where $sr_i$ and $sp_i$ are, respectively, dollar receipts and payments for service category $i$; $p_i$, $p_i^*$ are price deflators (in dollars); and $z$ is a relative price term.

Net investment income was modeled as the average return (assumed to be exogenous) on the net stock of overseas assets. The stock of such assets is determined endogenously in the model, accumulating in line with the current account (compare Dunaway (1988)). This feature makes the model nonlinear because increases in the current account are compounded by larger inflows (at unchanged rates of return) of investment income from the augmented stock of net foreign assets.

## Equation Estimates

All equations were estimated by ordinary least squares with quarterly data for the period 1975–87.[7] Log-linear specifications with fairly general dynamic structures were used throughout. A full listing of the estimated equations is contained in Appendix II.

*Exports*

In line with other researchers, this study finds Japanese export demand to be less sensitive to relative prices than to world activity. The

[6]The last category was defined residually and is made up in large part by fees and royalties. Unilateral transfers were assumed to be exogenous.

[7]Instrumental-variables estimates of the export volume and price equations were tried in order to avoid potential bias arising from simultaneity. The results were little different from the ordinary least-squares results presented here; for export volumes, only predetermined variables enter the equation.

long-run relative price elasticity is estimated to be just under −1.1, which is somewhat lower than most estimates based on earlier data periods, but more recent studies have reported broadly comparable results.[8] However, the long-run elasticity of exports with respect to world activity—a weighted average of trading partners' GNP—was found to be just over 2.0.[9] No significant shift in export demand could be found in the period after 1981, which might otherwise have indicated an important role at the aggregate level for VERs. Various constant shift or trend dummies were added to the basic equation, but, although their coefficients in general had the expected (negative) sign, *t*-statistics were always insignificant.

Dynamic adjustment of demand to a change in world activity or relative prices takes place over a period of about two years, although 80 percent of the adjustment process is completed by the end of the first year. The stickiness of volumes implies that a rise in Japanese export prices is accompanied by a rise in export value in the short run. Because the long-run price elasticity is greater than unity, however, rising prices eventually lead to falling export value.

Export prices were found to depend positively in the short run on domestic costs (proxied by wholesale prices), competitors' prices, and world GNP (Table 1). In the long run, however, export prices depend only on domestic costs. By implication, long-run export supply is perfectly elastic (see Appendix I).

The particular mix of short- and long-run properties arises from an error-correction specification of the equation dynamics.[10] Changes in export prices depend on changes in competitors' prices, domestic wholesale prices, and world GNP as well as on the lagged ratio of the level of export prices to wholesale prices. The last of these terms, the "stabilizer," can be interpreted as past profitability: it ensures that if export prices fall below domestic costs they eventually must rise to restore profitability. A further term in the lagged ratio of export prices to competitors' prices—past competitiveness—was initially included in the specification but was found to be statistically insignificant. Had it been significant, export prices would have been a weighted average of

[8]For example, the average price elasticity of studies on Japanese exports reported in Goldstein and Khan (1985) is −1.4, although the spread of results is quite wide. More recently, William Helkie at the Federal Reserve Board has estimated the price elasticity at just over −1.1 (reported in Loopesko and Johnson (1987)), and Ueda (1988) has estimated the elasticity at close to −0.9.

[9]Compare this figure with an average of 2.6 reported in Goldstein and Khan (1985) and with 1.6 estimated by Helkie (reported in Loopesko and Johnson (1987)).

[10]See Davidson and others (1978). The specification of the export price equation in this paper is similar to that in Masson and others (1988).

Table 1. *Dollar Export Price Elasticities*

| Elasticity | Short-Run Impact | Long-Run Impact |
|---|---|---|
| With respect to: | | |
| Competitors' prices | 0.36 | — |
| World GNP | 0.99 | — |
| Domestic wholesale prices (in yen) | 0.54 | 1.00 |
| Dollar-yen exchange rate | 0.54 | 1.00 |

wholesale and competitors' prices in the long run. Also statistically insignificant were dummy variables to capture the effects of VERs.

The immediate pass-through of a yen appreciation to export prices is, other things being equal, just over one half, although it eventually rises to unity.[11] The other-things-equal qualification is important because observed pass-through (actual percentage change in foreign-currency-denominated export prices divided by the percentage change in the yen) will depend on developments in world prices and world GNP as well as on domestic costs and the level of profitability. For example, in a general equilibrium framework domestic costs in yen would fall with an appreciating exchange rate, and this would limit the long-run increase in export prices.

Some observers have suggested that dollar-denominated Japanese prices are stickier when the yen appreciates than when it depreciates. Tests were carried out to examine the validity of this proposition by measuring the statistical significance of several additional nonlinear terms in the estimated price equation. These terms were products of either changes in competitors' prices or domestic wholesale prices multiplied by a dummy variable that was unity for an exchange appreciation or zero otherwise. Such nonlinear terms, involving either real or nominal exchange rate changes, were found to be statistically insignificant. This finding provides counterevidence to the proposition that short-run pass-through depends on the direction of exchange rate changes.[12]

*Imports*

All import categories showed some sensitivity to relative prices and domestic activity, and, for the three primary goods categories, time

[11] Pass-through is about 70 percent after one year, and 95 percent by the end of three years.

[12] Loopesko and Johnson (1987) reported the opposite finding, using a similar methodology. However, they incorporated in their price equation a nonlinear variable that was a function of the dependent variable. Hence, there is reason to suspect that the coefficient estimate of this variable was heavily biased.

Table 2. *Long-Run Import Demand Elasticities*

| Import Category | Elasticity with Respect to: Relative prices | Domestic demand | Industrial production |
|---|---|---|---|
| Manufacturing[a] | −0.91 | 1.84 | 0.99[b] |
| Raw materials | −0.27 | — | 1.24 |
| Mineral fuels | −0.11 | — | 1.04 |
| Food and drink | −0.55 | 0.45 | — |
| Total imports[c] | −0.55 | 0.88 | 0.89 |

[a] Excluding nonmonetary gold.
[b] Elasticity with respect to the operating ratio in manufacturing.
[c] Based on 1987 shares of each category in total imports.

trends and dummy variables also helped the econometric explanation. Aggregate imports have a relative price elasticity of just under −0.6, which is below the range of estimates reported in Goldstein and Khan (1985) but slightly higher than recent estimates by Helkie at the Federal Reserve Board.[13] Two measures of domestic activity were used—real total domestic demand and industrial production—and the long-run elasticity of aggregate imports with respect to each variable was found to be about 0.9. Therefore, if domestic demand and industrial production were to increase together, the long-run elasticity of imports with respect to domestic activity could be as high as 1.8. This would be in excess of most other estimates for Japanese imports but lower than typical estimates of the income sensitivity of U.S. imports.[14] This latter factor is often cited as one of the reasons for the persistence of the present U.S. trade deficit.

The low aggregate price elasticity of imports is due to the low price elasticities of commodity imports (Table 2). Least sensitive to relative price changes are mineral fuel imports, but raw material and food and drink imports were also found to be quite price-inelastic. By contrast, the price elasticity of manufacturing imports (−0.9) is more comparable to recent estimates of the price elasticity of U.S. imports.[15]

Typically, each import category was found to be sensitive to one but

[13] The mean price elasticity reported in Goldstein and Khan (1985) is −1.0 (range of −0.7 to −1.2). Helkie (reported in Loopesko and Johnson (1987)) estimated the elasticity at under −0.5.

[14] Goldstein and Khan (1985) reported elasticities for Japanese imports in the range 0.8–1.7; Helkie's estimate was 1.1. Dunaway (1988) estimated the income elasticity of U.S. imports at 2.5.

[15] For example, Dunaway (1988) estimated the price elasticity of U.S. imports to be −1.0.

not both of the activity variables. The exception was manufacturing imports, which, reflecting the amalgamation within the category of consumer and capital goods, were found to be sensitive to both domestic demand and industrial production (proxied by the operating ratio in manufacturing). It was also found that the short-run elasticities with respect to the industrial production variables exceeded the long-run elasticities in both the raw materials and manufacturing goods equations. This suggests that domestic producers build up inventories of imported inputs and intermediate goods when there is an acceleration in demand.

Time-trend variables were also significant in the commodities imports equations. A negative time trend was found to play an important explanatory role in the mineral fuels equation; it most likely reflects long-term energy conservation. The time trend in the food and drink equation (which was assumed to begin in 1982) captures the positive effects of a relaxation of agricultural quotas and other restrictions. A liberalization dummy was not required in the manufacturing equation—although a time trend that started in the second half of 1985, included to capture the effects of the most recent recent market-opening measures (the Action Program, July 1985–March 1988), had a positive sign but was statistically insignificant.

*Services*

Relative price and income effects were found for most components of the services account (see Table 3). Payments were found to be more price-sensitive than receipts, but the average long-run income elasticities of both payments and receipts were close to unity. The price elasticity on payments is large enough to ensure an eventual deterioration of the services balance (excluding investment income) in the face of a real exchange rate appreciation. In general, the services equations had higher standard errors than the trade equations—perhaps reflecting, in part, a lack of adequate price deflators.

The large long-run price elasticity of the transport payments equation is perhaps a misleading indicator of this category's sensitivity to changing competitiveness. This equation is dominated by a strong autoregressive term, which implies that adjustment to a change in relative prices is spread out over a very long period. Indeed, after two years, only about one fourth of the adjustment is complete. Long-run activity effects could not be found in either the transport payments or receipts equations, although both were sensitive in the short run to changes in Japanese exports. Japanese overseas travel payments were found to be more sensitive to relative prices than travel receipts, although the latter were more sensitive to income.

Table 3. *Long-Run Elasticities of Service Transactions*

| Service Transaction | Elasticity with Respect to: Relative prices | Domestic real GNP | World GNP |
|---|---|---|---|
| Payments | | | |
| Transport[a] | −6.09 | — | — |
| Travel | −1.86 | 0.97 | — |
| Other | −0.18 | 1.53 | — |
| Weighted average[b] | −2.68 | 0.86 | — |
| Receipts | | | |
| Transport[c] | — | — | — |
| Travel | −0.45 | — | 2.39 |
| Other | −0.73 | — | 1.69 |
| Weighted average[b] | −0.40 | — | 1.01 |

[a] Short-run elasticity with respect to export volume of 0.51.
[b] 1987 component shares, excluding investment income.
[c] Short-run elasticity with respect to export volume of 0.54.

## III. Current Account Adjustment and the Strong Yen: Was There a Structural Break?

Some commentators have suggested that Japan's current account has been extraordinarily slow to adjust in the face of the large appreciation of the yen. In particular, interest has focused on whether Japanese exporters went to exceptional lengths to maintain market share and whether Japanese import restrictions have unduly suppressed import demand. If either factor had been important, it should be possible to find evidence of a structural break in the behavior of external transactions during 1986 and 1987. Tests for such a break were conducted at two levels. First, formal econometric tests were carried out on the equations described in the previous section. Second, an informal examination was made of the model's ability to forecast current account developments in 1986 and 1987.

### Parameter Stability Tests

Two tests of parameter stability in the period 1985:4 through 1987:4 were carried out on the model equations. The first, the familiar Chow test, is known to have fairly weak power. Hence, forecast tests of the kind suggested by David Hendry (1980) were also performed. These are biased toward rejection of the hypothesis of parameter stability and thus

Table 4. *Parameter Stability Tests of Current Account Equations, 1985:4-1987:4*

| Equation | Parameter Stability Tests[a] | | |
|---|---|---|---|
| | Pass at 95 percent confidence level | Pass at 99 percent confidence level | Fail |
| Export volume | *C,H* | — | — |
| Export prices | *C,H* | — | — |
| Manufacturing imports | *C,H* | — | — |
| Raw materials imports | *C,H* | — | — |
| Mineral fuels imports | *C,H* | — | — |
| Food and drink imports | *C,H* | — | — |
| Transport payments | — | — | *C,H* |
| Travel payments | *C,H* | — | — |
| Other service payments | *C,H* | — | — |
| Transport receipts | *C,H* | — | — |
| Travel receipts | — | — | *C,H* |
| Other service receipts | *C* | *H* | — |

[a] *H* indicates a test result for the Hendry forecast test (Hendry (1980)); *C* indicates a test result for the Chow test (Chow (1960)).

provide a much more stringent test for a structural break. Of course, passing a Chow or Hendry test—although a necessary requirement of parameter stability—is not a sufficient condition to rule out a structural break in behavior. But it should also be borne in mind that the turbulent events of 1986–87—which include sharp currency changes and the collapse in international oil prices—provide a tough background for these tests.

Most of the equations pass both these tests (Table 4). All the trade equations pass the tests at the 95 percent confidence level, providing evidence that trade behavior did not deviate significantly from historical relationships during the period. The results for the services account equations, however, are mixed. The equations for travel payments, other service payments, transport receipts, and other service receipts all have stable parameters, but the equations for transport payments and travel receipts fail both the Chow and Hendry tests.[16] Therefore, apart from a few components of the services account, there is no statistical evidence of a break in behavior during the period of the rising yen.

[16]Travel receipts account for less than 5 percent of total service receipts, but transport payments make up about one fourth of total payments.

Table 5. *Current Account Forecast Errors, 1985:4–1987:4*
(Predicted minus actual, as percentage of actual)

| Item | Mean Percentage Error | | |
|---|---|---|---|
| | Single equation errors | | Model errors |
| | Static forecast | Dynamic forecast | |
| Export volume | −2.01 | −4.12 | −4.91 |
| Export prices | 0.65 | 1.58 | 1.58 |
| Import volume | — | — | −2.79 |
| Manufacturing[a] | −1.66 | −2.03 | −2.03 |
| Mineral fuels | −3.51 | −3.51 | −3.51 |
| Raw materials | −2.97 | −4.66 | −4.66 |
| Food and drink | −0.67 | −0.69 | −0.69 |
| Service payments[b] | 2.15 | 8.53 | 7.51 |
| Service receipts[b] | 4.42 | 18.74 | 16.57 |

[a] Excluding nonmonetary gold.
[b] Excluding investment income.

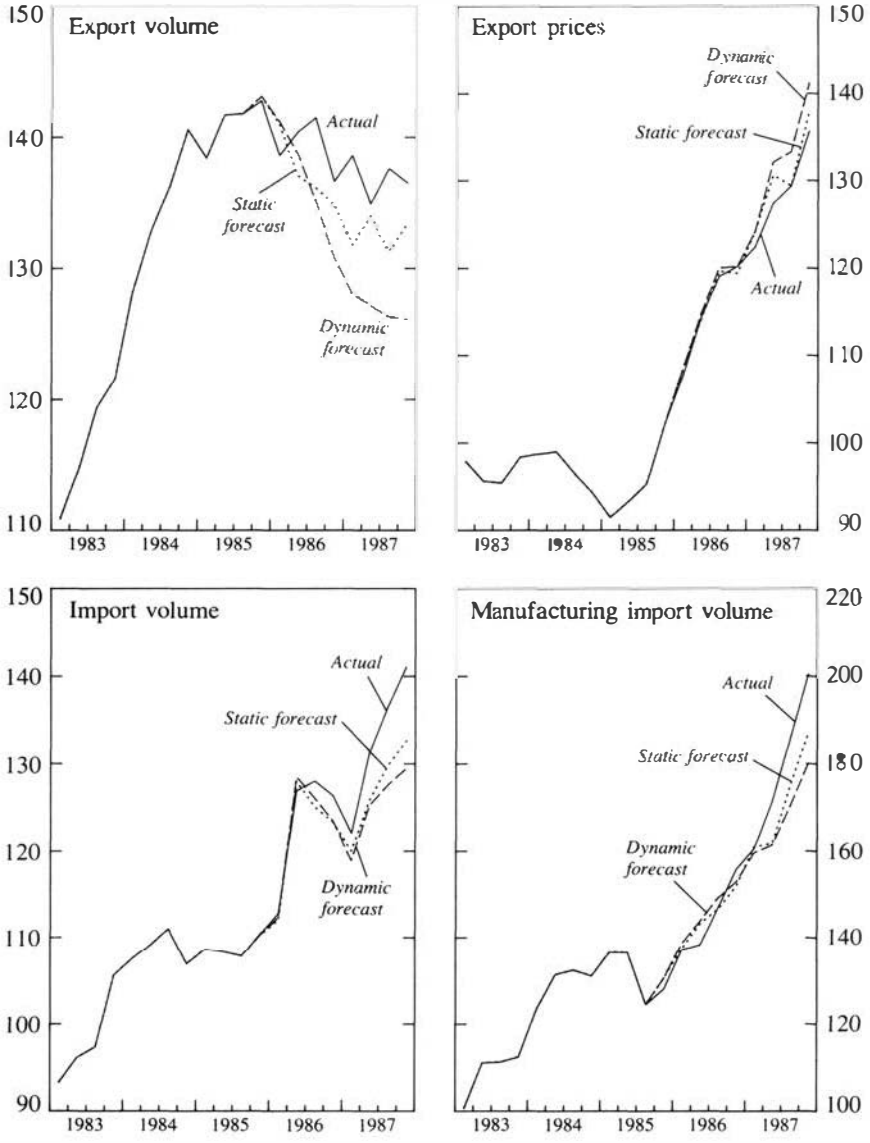
## Forecast Performance

An examination of the forecasting record of the current account model from 1985:4 through 1987:4 provides a less formal analysis of whether there was a break in behavior. All the equations were first estimated by using a data sample that ended in the third quarter of 1985 and then were used to predict events in the subsequent two years. Three types of forecasts were made. The first two looked at the static and dynamic tracking of events in 1986 and 1987 of each individual equation; the third involved full dynamic simulation of the current account model.[17]

A key feature of the trade account forecasts is the overprediction of the fall in real exports in 1986 and 1987 while real import growth was stronger than might have been expected (Table 5 and Figure 2). For both real exports and imports, the errors were compounded in the dynamic forecasts by the carrying forward of previous errors in the lagged dependent variables. Nevertheless, the average errors of the trade volume forecasts were all less than two standard errors of the equation—even for the dynamic forecasts.

[17]The static forecasts assume that lagged dependent variables take on actual historical values. In the dynamic forecasts, lagged dependent variables assume previously predicted values. The principal simultaneous elements of the model are the feedback of predicted export prices onto export demand, the feedback from exports to transport payments and receipts, and the effects of the cumulated current account on investment income.

Figure 2. *Trade Equation Forecast Errors, 1983–87 (1980 = 100)*




Sources: Japan, *Summary Report on Trade of Japan* (Tokyo, various years) and author's calculations.

A possible factor behind the higher export growth might have been the consumer loyalty to Japanese goods that was created when Japanese exporters moved into dominant market positions in the early 1980s.[18] In contrast, the exceptional strength of import growth may have been due to the removal of trade restrictions that are not adequately captured in the equations. In this respect, it should be noted that the period of interest coincides with the authorities' latest Action Program to promote trade liberalization.

The model also predicted faster export price growth than that which occurred, although the average error is small and less than the standard error of the equation. The implied slower pass-through of the yen appreciation to export prices occurred despite export demand being more buoyant than predicted. This might have been expected to have put additional upward pressure on export prices. Notice also that, had export prices risen as much as the model predicted, export volume would have fallen by even more than the single equation predicted (compare the second and third columns of Table 5). Even so, the average error was less than twice the equation standard error.

The overprediction of export prices reduces the underprediction of export value stemming from sticky volume demand. In net trade terms, this error on the export side is, in turn, offset in large part by the underprediction of imports. Overall, the model predicted a slightly smaller trade surplus in 1986 and 1987 than actually occurred (Table 6).

Offsetting errors also occurred in the prediction of the services account. Both payments and receipts were overpredicted, particularly in 1986, with the worst errors being found on the transport components. Overall, the deficit on the services account was forecast to be lower in both 1986 and 1987, although the error is small in comparison with the size of the gross flows. Adding the errors on both services and trade accounts produces a current account prediction error of less than $2 billion in 1986 and only $5 billion in 1987—small errors relative to the size of the current account surpluses in these years.

In summary, it does not appear that current account transactions deviated significantly from historical behavior. On the contrary, the parameter stability tests find no evidence of a structural break—apart from some components of the services account. The model also tracks the large current account surpluses in 1986 and 1987 reasonably well.

[18] Support for this proposition is provided by evidence of falling export price elasticity over the course of the data sample period, which implies falling substitutability of Japanese exports for competing goods. For the truncated sample (ending in the third quarter of 1985), the long-run price elasticity was −1.3 compared with −1.1 for the full sample—although the change is not statistically large enough to cause failure of the parameter stability tests.

Table 6. *Model Dynamic Forecast Errors*
(Predicted minus actual; in billions of U.S. dollars)

| Item | 1985 | 1986 | 1987 |
|---|---|---|---|
| Trade balance | 0.14 | −3.45 | −5.17 |
| Services balance | 0.53 | 1.58 | 0.11 |
| Current account balance | 0.67 | −1.88 | −5.07 |

## IV. Effects of the Yen's Appreciation

The continuing rise of Japan's current account surplus during 1986 and 1987, while the yen appreciated sharply, should not be taken to imply that external adjustment was not taking place. Rather, the pertinent question would seem to be what Japan's external surplus would have been had there been no realignment of exchange rates. To answer this question, the current account model was simulated under the assumption that exchange rates had remained at their third quarter 1985 levels.[19]

In what follows, a basic simulation is described, followed by a discussion of the sensitivity of the results to changing one of the more contentious underlying assumptions. Both sets of results are presented as differences from a baseline forecast constructed from the model's tracking of history. In contrast to the previous section, the model equations used in the simulations were all estimated over the full data sample (1975–87). As a consequence, the tracking errors of the components of the current account are all quite small, especially in relation to the size of the simulated changes.

### Basic Simulation: No Exchange Rate Realignment

If there had been no realignment of exchange rates, the world economic environment would have doubtless been very different in 1986 and 1987. In particular, maintenance of unchanged exchange rates would have required a different international economic policy mix that, in turn, would have had important consequences for relative growth and inflation rates. The absence of a full general equilibrium model of the world's economy precludes a detailed analysis of the world environment under unchanged exchange rates. Instead, some simplifying assumptions were made about those variables that directly affect Japan's external transactions.

[19] The "no realignment" assumption of this section is interpreted as no change in both yen and U.S. dollar effective exchange rates.

*Additional Assumptions*

The first assumption was that interest rates, world GNP, Japanese total domestic demand, and Japanese industrial production were unchanged from their historical values. Japan's real GNP was determined endogenously in the simulations as the sum of domestic demand and (endogenous) external demand. To the extent that changes in world GNP and Japanese domestic demand under no realignment would have been in the same direction, there would be partially offsetting effects on the current account. If both world GNP and domestic demand had been 1 percent higher in 1986–87, it is estimated that the current account would have been about $3 billion higher in these years. Interest rates only affect investment income in the model. If interest rates had been 1 percentage point higher, the current account would have been $1–2 billion higher in 1986–87. The effects of relaxing the assumption regarding industrial production are discussed in the second part of this section.

The second assumption concerned the effect on competitors' dollar traded-goods prices of the simulated stronger dollar. On the basis of simple regressions, it was assumed that a 10 percent increase in the dollar's effective value reduces export- and import-weighted dollar prices of competitors' manufactured traded-goods prices by 5.6 percent and 4.5 percent, respectively, over the course of a year. Furthermore, from the analysis of Sachs (1985) it was assumed that a 10 percent effective appreciation of the dollar leads to a 7.5 percent fall in dollar commodity prices, with adjustment being spread over one year.

The third assumption was to link Japanese wholesale prices by way of a simple regression equation to imported mineral fuel and raw material prices (measured in yen), and to actual minus potential GNP (see Appendix II for details). In this way, the impact of the yen's appreciation on the sharp decline in wholesale prices was captured. The long-run elasticity of each of the imported price terms was about 0.1. The effects of the exchange rate realignment on other domestic and world price variables, which play a relatively minor role in the model, were assumed to be of second-order significance.

*Effects on Competitiveness*

In the simulation, the deterioration of Japan's export competitiveness in 1986–87 is sharply reduced (Table 7). However, the improvement in competitiveness is considerably smaller than the simulated nominal yen depreciation because of the short-run stickiness of export prices and because competitors' dollar export prices fall with the assumed stronger dollar. Similarly, the competitiveness of imports worsens, but by less

Table 7. *Basic Simulation: Assumptions and Competitiveness Effects, 1985:4–1987:4*

(Percentage difference from baseline)

| Item | 1985 | 1986 | 1987 |
|---|---|---|---|
| Dollar-yen exchange rate | −3.0 | −29.6 | −39.9 |
| U.S. dollar effective exchange rate | 1.7 | 20.5 | 36.7 |
| Yen wholesale prices | 0.3 | 4.6 | 9.4 |
| U.S. dollar export prices | −1.8 | −20.0 | −30.6 |
| World manufactured traded-goods prices: | | | |
| Export-weighted | −0.4 | −7.1 | −15.4 |
| Import-weighted | −0.9 | −8.9 | −14.1 |
| U.S. dollar commodity prices | −0.2 | −8.4 | −18.8 |
| Export competitiveness[a] | −1.4 | −13.8 | −17.9 |
| Import competitiveness[b] | −2.7 | −19.1 | −19.4 |
| Japanese real GNP | −0.1 | 0.4 | 2.3 |

[a] Japanese export prices relative to world manufactured traded-goods prices (export-weighted). Japanese export prices are endogenously determined in the model.

[b] Japanese wholesale prices relative to import prices.

than the simulated nominal yen depreciation, because of the drop in dollar-denominated commodity and world manufactured goods prices.

The simulation result can be inverted to arrive at a measure of how much the actual increase in Japanese export prices between the fourth quarter of 1985 and the end of 1987 can be attributed to the rising yen. The outcome is summarized in Table 8, where a distinction is made between the direct impact of exchange rate changes and their indirect effects—that is, those attributable to lower domestic wholesale prices and higher competitors' prices. It was found that more than the actual dollar increase in Japanese export prices in this period could be attributed to the yen's appreciation, despite the offsetting effect of the yen's rise on domestic wholesale prices.[20]

*Effects on the Current Account*

The implied improvement in competitiveness in the simulation would have had a dramatic impact on real trade flows. Instead of stagnating,

[20]This result suggests that the yen's appreciation had a strong effect on export prices during 1986–87. Nevertheless, the observed pass-through of the yen appreciation to export prices was only about 55 percent in this period compared with about 70 percent during the 1977–78 appreciation. One factor limiting the pass-through was the collapse in oil prices. Had oil prices not fallen, the model estimates that the pass-through would have risen to 60 percent. This is a conservative estimate because no account is taken of the effects of oil prices on the price of competitors' manufactured goods prices.

Table 8. *Effect of the Yen's Appreciation on Japanese Export Prices*

(Cumulative percentage change)

| Item | 1985:4–1987:4 |
|---|---|
| Actual U.S. dollar price change | 42.4 |
| Total exchange rate effect | 50.6 |
| Direct | 57.2 |
| Indirect | −4.2 |
| Lower wholesale prices | −8.1 |
| Higher competitors' prices | 4.0 |

export volumes would have grown at a 6 percent annual rate, whereas import growth would have been more than halved (Table 9). Imports of manufactures would have been most affected because of their comparatively high price sensitivity; at the other end of the scale, mineral fuel imports would have been only about 2 percent lower. Overall, the real trade surplus would have continued to grow steadily in 1986 and 1987 instead of declining.

The effects of exchange rate realignments on the nominal surplus are confused by the familiar problem of choice of units of measurement. Measured in dollars, the simulated nominal trade surplus was $12 billion lower in 1986 but close to its actual historical level in 1987 (Figure 3). This result can be interpreted as a measure of the J-curve effect; or, if

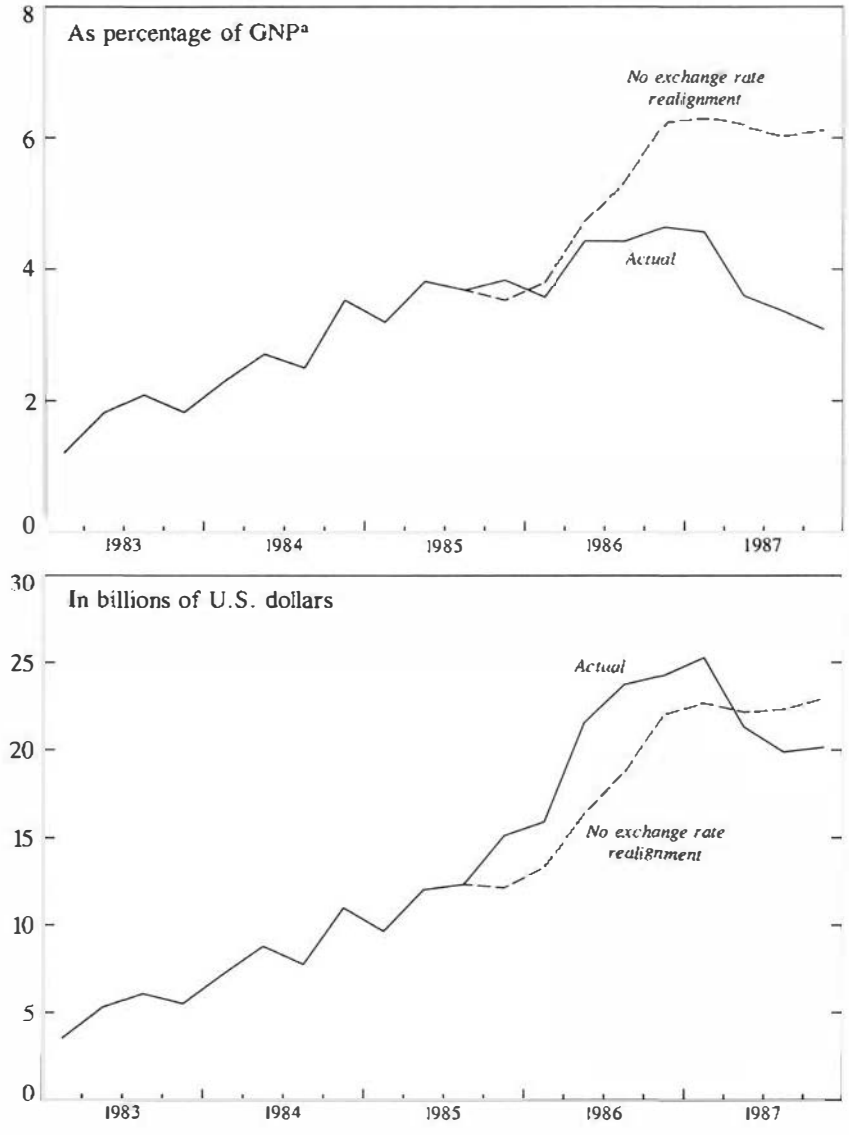
Table 9. *Basic Simulation: Effects of Exchange Rate Realignment on Japan's Current Account, 1985:4–1987:4*

(Predicted minus actual; in billions of U.S. dollars)[a]

| Item | 1985 | 1986 | 1987 |
|---|---|---|---|
| Exports | −3.23 | −29.67 | −40.13 |
| Volume[b] | — | 7.2 | 18.6 |
| U.S. dollar price[b] | −1.8 | −20.0 | −30.6 |
| Imports | −0.53 | −17.48 | −38.78 |
| Volume[b] | — | −5.0 | −9.5 |
| U.S. dollar price[b] | −0.4 | −9.2 | −18.5 |
| Trade balance | −2.70 | −12.19 | −1.35 |
| Service balance | −0.86 | −3.18 | 4.47 |
| Current account balance | −3.56 | −15.37 | 3.11 |
| (in trillions of yen) | (−0.38) | (2.54) | (9.11) |
| Ratio of current account balance to GNP[c] | −0.1 | 0.7 | 2.5 |

[a] Unless otherwise specified.
[b] Percentage difference between predicted and actual levels.
[c] Percentage point difference between predicted and actual.

Figure 3. *Japanese Current Account, 1983–87*




Sources: Bank of Japan, Balance of Payments Monthly (various issues) and author's calculations.

[a] Seasonally adjusted annual rate.

the result is turned on its head, part of Japan's trade surplus in 1986, measured in dollars, was due to the yen's appreciation.

A somewhat different picture emerges when the trade surplus is measured in yen. Because of the assumed lower value of the yen in the simulation, a lower dollar trade surplus converts to a higher yen surplus in both years. The extent of the increase in domestic currency terms is substantial: it is equal to some 2½ percentage points of GNP in 1987. This result is in broad agreement with the simulation properties of the EPA World Model (Japan (1988)).[21]

The disappearance of the J-curve in domestic currency can be explained in terms of the familiar Marshall-Lerner conditions. These show that adjustment of the trade balance to an exchange rate change depends not only on the price elasticities of exports and imports but also on the initial value of the trade surplus.[22] Correction of a trade surplus by exchange rate appreciation is more difficult in foreign currency terms when exports initially exceed imports—as was the case in Japan in 1985—but the converse is true for correction in terms of domestic currency.

J-curve effects were also found for the simulated services balance. The deficit on the services account widened in 1986 relative to the base forecast before strengthening in 1987. The J-curve effect in 1986 is compounded by lower net investment receipts because of a slower accumulation of net overseas assets. Unlike the trade balance, there is a J-curve effect in both dollars and yen.

When the results for the trade and services accounts are summed, the model predicts that the current account would have been some $15 billion lower in 1986 had there been no exchange rate realignment, but the current account would have been slightly higher in 1987. Stated

[21] In the EPA model, a 10 percent improvement in competitiveness leads to a reduction in the current account by about 1 percent of GNP.

[22] If full pass-through of an appreciation to prices is assumed, the Marshall-Lerner condition for a yen appreciation to lower the dollar trade surplus is

$$ML(\$) = 1 - E_x - E_m/R < 0;$$

to lower the yen surplus, the condition is

$$ML(¥) = 1 - R \cdot E_x - E_m < 0,$$

where $E_x$ and $E_m$ are the price elasticities of exports and imports, respectively, and $R$ is the initial ratio of real exports to imports. For Japan, $R$ was about 1.3 at end-1985, $E_x$ was 1.1, and $E_m$ was 0.6. Therefore, $ML(\$) = -0.56$ and $ML(¥) = -1.03$, implying that the Marshall-Lerner condition is more comfortably satisfied in yen than in dollars. The ease at which the Marshall-Lerner condition is satisfied determines the speed of trade surplus reduction after an exchange rate appreciation.

another way, about one sixth of Japan's dollar current account surplus in 1986 can be attributed to the stronger yen, and it was not until about mid-1987 that exchange rates began working to reduce this measure of the surplus.

Although for some purposes it is desirable to measure the current account in a foreign currency, the choice of the dollar gives a misleading picture of the extent of external imbalance because of its rapidly declining value. A more relevant measure of the current account surplus is its ratio to GNP. Measured this way, Japan's current account would have increased appreciably more in the last two years in the absence of exchange rate realignment. This would have meant that any subsequent external adjustment would have been even more protracted and probably would have required substantially greater exchange rate changes. The results here stand in contrast to the views of some researchers (for example, Ueda (1988)) who have concluded that exchange rate movements have played a relatively minor role in recent current account developments.

## No Exchange Rate Realignment and Higher Industrial Production

Stagnant export demand, brought about by the appreciating yen, was a major cause of weak Japanese industrial production in 1986–87. Hence, with no exchange rate realignment, industrial production would almost certainly have been stronger and, in turn, the demand for imports would have been higher. To measure the potential magnitude of this indirect effect of the exchange rate on imports, a variant of the basic simulation was constructed in which, in addition to the assumptions made for the basic simulation, it was assumed that industrial production grew in line with its historical trend. The main results are summarized in Table 10.

Industrial production was assumed to grow by nearly 5 percent in each of 1986 and 1987 instead of declining slightly in 1986 and growing by less than 4 percent in 1987.[23] This stronger growth in industrial production would have further reduced the fall in real imports stemming from the assumed lower real value of the yen by about 4–5 percent. As a con-

[23] In addition, this assumption was interpreted to imply that there was no fall in the operating ratio in manufacturing from its level in the third quarter of 1985.

Table 10. *Effect of Exchange Rate Realignment and Higher Industrial Production, 1985:4–1987:4*

(Predicted minus actual; in billions of U.S. dollars)

| Item | 1985 | 1986 | 1987 |
|---|---|---|---|
| Trade balance | −3.2 | −17.5 | −6.9 |
| Services balance | −0.9 | −3.3 | 4.0 |
| Current account | −4.1 | −20.7 | −2.9 |
| (as percentage of GNP) | (−0.2) | (0.4) | (2.1) |

sequence, the trade balance would have been a further $5 billion lower in both 1986 and 1987 than in the basic simulation. The effect on the current account would have been slightly greater because of a loss of net investment income from abroad. Altogether, the J-curve effects are thus deeper and more prolonged when the indirect effects of the exchange realignment on Japanese industrial production are taken into account. Nevertheless, the simulation still predicts that Japan's current account surplus would have been substantially higher—by more than 2 percent of GNP in 1987—had there been no realignment.

## V. Conclusions

The first main conclusion of this paper is that recent developments in Japan's current account balance have broadly followed historical relationships. The conclusion was reached through formal statistical tests that find little evidence of a break in the behavior of the equations of a conventional current account model. Furthermore, these same equations can track, with only a small amount of underestimation, Japan's current account surpluses in 1986 and 1987.

The second main conclusion is that Japan's current account surplus would have been considerably larger—as much as 2 percent of GNP—if the yen had not appreciated. Put another way, the recent exchange rate changes have already exerted a significant corrective influence on external imbalances. However, part of the reason that Japan's current account has not declined much when measured in U.S. dollars is the existence of J-curve effects. These J-curve effects added to the surplus in 1986, and it was not until the second half of 1987 that the current account began to decline because of the yen's appreciation.

# APPENDIX I

## Long-Run Restrictions on the Export Price Equation

In the text, equation (2) is a reduced-form market-clearing price. The demand and supply functions can be written, assuming log-linear specifications, as

$$x^d = -\alpha_1(px - pw) + \alpha_2 yw \tag{6}$$

$$x^s = \beta_1 (px - p), \tag{7}$$

where $\alpha_1$ is the elasticity of demand and $\beta_1$ the elasticity of supply. Equating supply and demand and solving for price yields

$$px = \alpha pw + (1-\alpha)\, p + \beta yw, \tag{8}$$

where

$$\alpha = \frac{\alpha_1}{\alpha_1 + \beta_1}, \qquad \beta = \frac{\alpha_2}{\alpha_1 + \beta_1}.$$

That is, export prices are a weighted average of competitor prices ($pw$) and factor costs ($p$), where the weights depend on the relative size of demand and supply elasticities. It is found that $\alpha = \beta = 0$ in the long run. Hence, for a finite demand elasticity ($\alpha_1$), the long-run elasticity of supply must be perfectly elastic ($\beta_1 \to \infty$).

# APPENDIX II

## Equation Estimates

The full-sample estimates of the trade and services account equations are presented below. All equations were estimated by ordinary least squares with quarterly data over the period 1975–87 and with variables in logarithms. DH is the Durbin $h$-statistic, DW the ordinary Durbin-Watson statistic, SE the standard error, and $\bar{R}^2$ the coefficient of determination adjusted for degrees of freedom; $t$-statistics appear in parentheses. A full set of mnemonics for variables and the main data sources used are given in Appendix III.

Exports

$$\begin{aligned} X = {} & 0.663\ X_{-1} - 0.367\ (PX_{-1} - PWX_{-1}) \\ & (9.31) \qquad (5.33) \\ & +0.689\ YW_{-1} - 1.594 \\ & (4.71) \qquad (4.43) \end{aligned} \tag{9}$$

$$\bar{R}^2 = 0.988 \qquad \text{SE} = 0.028 \qquad \text{DH} = 0.44$$

$$\Delta PX = 0.357\ \Delta PWX - 0.155\ (PX_{-1} - WP_{-1}) \quad (2.31)\ (3.84)$$
$$+ 0.543\ \Delta WP + 0.993\ \Delta YW - 0.233 \quad (9.31)\ (2.40)\ (3.95) \qquad (10)$$
$$\bar{R}^2 = 0.765 \quad SE = 0.016 \quad DW = 2.01$$

Imports

$$MRM = 0.664\ MRM_{-1} - 0.092\ (PMRM_{-1} - WP_{-1}) \quad (5.80)\ (1.83)$$
$$+ 1.142\ IP - 0.727\ IP_{-1} - 0.017\ TT + 32.249 \quad (4.20)\ (2.48)\ (1.71)\ (1.75) \qquad (11)$$
$$\bar{R}^2 = 0.789 \quad SE = 0.035 \quad DH = 0.17$$

$$MMF = -0.107\ (PMMF_{-1} - WP_{-1}) + 1.044\ IP \quad (8.01)\ (8.33)$$
$$-0.048\ TT + 94.995 \quad (8.64)\ (9.07) \qquad (12)$$
$$\bar{R}^2 = 0.693 \quad SE = 0.031 \quad DW = 1.93$$

$$MFD = 0.343\ MFD_{-1} - 0.358\ (PMFD_{-1} - WP_{-1}) \quad (2.78)\ (4.52)$$
$$+ 0.293\ RTDD_{-1} + 0.021\ DUMMY - 1.106 \quad (2.12)\ (3.99)\ (0.82) \qquad (13)$$
$$\bar{R}^2 = 0.970 \quad SE = 0.034 \quad DH = -1.03$$

$$MMN = 0.562\ MMN_{-1} - 0.397\ (PMMN_{-1} - WP_{-1}) \quad (6.41)\ (4.37)$$
$$+ 0.804\ RTDD_{-1} + 1.078\ ORM \quad (4.27)\ (4.81)$$
$$- 0.645\ ORM_{-1} - 10.523 \quad (2.73)\ (5.00) \qquad (14)$$
$$\bar{R}^2 = 0.990 \quad SE = 0.032 \quad DH = 0.56$$

Services

$$(SPTRAN - PYW) = 0.966\ (SPTRAN - PYW)_{-1} + 0.207\ (PY - PYW)_{-1} \quad (21.55)\ (4.96)$$
$$+ 0.517\ (X - X_{-1}) + SEAS \quad (3.31) \qquad (15)$$
$$\bar{R}^2 = 0.907 \quad SE = 0.037 \quad DH = 0.78$$

$$(SPTRL - PWC) = 0.620\ (SPTRL - PWC)_{-1} - 0.707\ (PWC - CP)_{-1} \quad (7.23)\ (4.60)$$
$$+ 0.369\ GNP_{-1} + SEAS \quad (2.95) \qquad (16)$$
$$\bar{R}^2 = 0.951 \quad SE = 0.080 \quad DH = -2.01$$

$$(SPO - PYW) = \underset{(4.91)}{0.568}\,(SPO - PYW)_{-1} + \underset{(3.55)}{0.660}\,GNP_{-1} + \underset{(1.47)}{0.078}\,(PY - PYW)_{-1} + SEAS \tag{17}$$

$\bar{R}^2 = 0.968$ SE = 0.046 DH = 1.04

$$\Delta(SRTRAN - PY) = \underset{(3.31)}{0.419}\,\Delta(SRTRAN - PY)_{-1} + \underset{(2.03)}{0.542}\,\Delta X + SEAS \tag{18}$$

$\bar{R}^2 = 0.284$ SE = 0.064 DH = 0.85

$$(SRTRL - CP) = \underset{(2.44)}{0.378}\,(SRTRL - CP)_{-1} + \underset{(1.69)}{0.280}\,(PWC - CP)_{-1} + \underset{(3.61)}{1.483}\,YW_{-1} + SEAS \tag{19}$$

$\bar{R}^2 = 0.904$ SE = 0.106 DW = 2.10

$$(SRO - PY) = \underset{(1.57)}{0.294}\,(SRO - PY)_{-1} + \underset{(3.28)}{1.190}\,YW - \underset{(2.61)}{0.518}\,(PY - PYW)_{-1} + SEAS \tag{20}$$

$\bar{R}^2 = 0.837$ SE = 0.093 DW = 2.05

Wholesale Prices (used in simulations)

$$\Delta(WP + E) = \underset{(6.47)}{0.445}\,\Delta(WP + E)_{-1} + \underset{(4.59)}{0.059}\,\Delta(PMMF + E) + \underset{(3.52)}{0.065}\,\Delta(PMRM + E) + \underset{(2.00)}{0.314}\,(GNP - GNP^*) \tag{21}$$

$\bar{R}^2 = 0.851$ SE = 0.008 DH = −0.63

## APPENDIX III

### Data Sources and Mnemonics for Variables

The principal data sources were *Economic Statistics Monthly*, Bank of Japan (Tokyo); *Summary Report on Trade of Japan*, Japan Tariff Association (Tokyo); *Balance of Payments Monthly*, Bank of Japan (Tokyo); and *International Financial Statistics*, International Monetary Fund (Washington). Where not available, seasonally adjusted data were created by the author using the X-11 program. Mnemonics for variables were as follows:

*CP* The consumer price index (1980 = 100) multiplied by dollar-yen exchange rate

| | |
|---|---|
| *DUMMY* | A food imports liberalization dummy; 1982:2 = 0.25, 1982:3 = 0.5, and so on |
| *E* | The yen-dollar exchange rate |
| *GNP** | Potential GNP (constructed) |
| *GNP* | Real GNP, in 1980 yen |
| *IP* | Industrial production, seasonally adjusted (1980 = 100) |
| *MFD* | The volume of food and drink imports, seasonally adjusted (1980 = 100) |
| *MMF* | The volume of mineral fuel imports, seasonally adjusted (1980 = 100) |
| *MMN* | The volume of manufacturing imports, excluding nonmonetary gold, seasonally adjusted (1980 = 100) |
| *MRM* | The volume of raw material imports, seasonally adjusted (1980 = 100) |
| *ORM* | The operating ratio in manufacturing (1980 = 100) |
| *PMFD* | The implicit dollar deflator for food and drink imports, seasonally adjusted (1980 = 100) |
| *PMMF* | The implicit dollar deflator for mineral fuels imports, seasonally adjusted (1980 = 100) |
| *PMMN* | The implicit dollar deflator for manufactured imports, seasonally adjusted (1980 = 100) |
| *PMRM* | The implicit dollar deflator for raw materials imports, seasonally adjusted (1980 = 100) |
| *PWC* | An import-weighted average of trading partners' consumer prices in dollars (1980 = 100) |
| *PWX* | The weighted average of competitors' dollar export unit values (1980 = 100) |
| *PX* | The implicit dollar deflator for exports, seasonally adjusted (1980 = 100) |
| *PY* | The GNP deflator (1980 = 100) |
| *PYW* | The weighted average of competitors' GNP deflators, in dollars (1980 = 100) |
| *RTDD* | Real total domestic demand, in 1980 yen |
| *SEAS* | Seasonal dummies |
| *SPO* | Service payments, other (excluding investment income), in millions of U.S. dollars |
| *SPTRAN* | Service payments, transport, in millions of U.S. dollars |
| *SPTRL* | Service payments, travel, in millions of U.S. dollars |
| *SRO* | Service receipts, other (excluding investment income), in millions of U.S. dollars |
| *SRTRAN* | Service receipts, transport, in millions of U.S. dollars |
| *SRTRL* | Service receipts, travel, in millions of U.S. dollars |
| *TT* | Time trend (1975:1 = 1975.25, 1975:2 = 1975.50, and so on) |
| *WP* | The overall wholesale price index (1980 = 100), multiplied by the dollar-yen exchange rate |
| *X* | Export volume, seasonally adjusted (1980 = 100) |
| *YW* | An export-weighted average of partner countries' GNP (1980 = 100). |

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# Trade Reform Under Partial Currency Convertibility

## Some Suggestive Results

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*The macroeconomic implications of trade reform in the presence of capital account restrictions are discussed. Such restrictions are modeled by recognizing the prior constraints on free currency convertibility that are imposed under a multiple exchange rate system. The results indicate that the preferred sequence of liberalization need not be of the commonly advocated "current account first" variety, and that real depreciation rather than real appreciation is a more probable outcome following domestic tariff liberalization.* [JEL 133, 420, 431]

THE EXPERIENCES of some developing countries (especially the Southern Cone countries of Latin America—Argentina, Chile, and Uruguay) with vigorous attempts at economic liberalization have raised the issue of the preferred order of liberalization. In an ideal, frictionless world without externalities, distortions, or other economic and political constraints, this question is very simply answered—all markets and sectors are best liberalized simultaneously. But in the less than perfect real world, simultaneous liberalization of all sectors is often infeasible for various reasons, so that the question naturally arises as to which form of liberalization should first be pursued (from the point of view of the ensuing effects on various domestic macroeconomic variables or on an explicit welfare index).

This question has not escaped the attention of economists, and an

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extensive literature has recently accumulated on this subject (see Edwards (1984) for a survey). Several authors (McKinnon (1973, 1982), Frenkel (1982, 1983), Krueger (1983)) have advocated a Chile-type "current account first" order of liberalization of the external account.[1] Thus, these authors argue that the more prudent strategy is to liberalize the external capital account only after restrictions on the current account, as well as restrictions in the domestic financial sector, have been removed. An opposite and distinctly minority point of view, however, was expressed by Lal (1984), who proposed that full currency convertibility be restored (that is, that the external capital account be liberalized) before commercial reform. The latter sequence was pursued by Argentina and Uruguay during their liberalization efforts.[2] Finally, Khan and Zahler (1983) reported—on the basis of a small-scale simulation model—that the sequencing strategy is essentially irrelevant with respect to consequent domestic price and output behavior in the long run, so that there is no a priori presumption preferring one strategy over another.

The purpose of this paper is to re-examine the desirability of the frequently proposed "current account first" sequence of liberalization in the context of a simple macroeconomic theoretic framework. To this end, a model is constructed and analyzed of an open economy characterized by both commercial restrictions (in the form of nominal tariffs) and repression in the external financial sector. The latter is conveniently modeled by recognizing prior restraints on free currency convertibility that result from the use of a multiple exchange rate system. Such a scenario is extremely common in developing countries. With the apparent exception of Aizenman (1985), however, the literature on

[1] Chile followed this order of liberalization. The Chilean experiment's failure was due perhaps not to an incorrect sequence of liberalization but to improper macroeconomic management during the reform period. See Edwards (1985) for a detailed discussion of the Chilean case.

[2] The Argentine and Uruguayan efforts also resulted in failure, although, again, extraneous factors may have contributed (see Dornbusch (1983), Hanson and de Melo (1983), and Sjaastad (1983)). Khan and Zahler (1985) listed in general terms the likely reasons for the failure of both types of liberalization strategies. A primary reason is the pursuit of inconsistent domestic policies during the reform effort. More specifically, the inconsistency is in the form of domestic real appreciation that was permitted to develop and thereby undermine the longer-term goals of liberalization (noted also in Edwards (1987)). Dornbusch (1986) appears to suggest that the intervening real appreciation may have been the result of a calculated political stance rather than unintentional mismanagement. The results of the present analysis indicate that a domestic tariff reduction is more likely to lead to real depreciation rather than to appreciation. This in turn would suggest that, to the extent that real appreciation did actually occur, it can be attributed to factors other than domestic tariff reform. These extraneous overriding factors are styled as "inconsistent policies" in Khan and Zahler (1985).

liberalization appears to have neglected the type of capital controls implied by the use of such multitier exchange rate systems and has instead modeled external financial repression by means of explicit restraints on international capital flows (as for example, in Khan and Zahler (1983)).

In the present framework, the policymaker restricts free convertibility according to the type of transaction for which foreign currency is demanded (earned). In the typical case, a commercial exchange rate applies to current account transactions, and a (usually more depreciated) financial rate governs capital account items.[3] In actual practice, however, the inconvertibility restrictions are substantially eroded by intermarket transactions (leakage) between the exchange markets stemming from both legally compelled and fraudulent transactions.[4] Thus, the actual degree of currency inconvertibility is often less severe than is immediately apparent, since at least some exchange regulations may be legally avoided or unlawfully circumvented. This aspect of external financial restrictions in general, or of multiple exchange rate regimes in particular, would seem to be an important one and is explicitly incorporated in the present paper. It is noteworthy that the theoretical literature on the subject of economic reform has universally ignored this issue.

The model developed in the paper is used to examine the macroeconomic effects of a reduction in tariff rates (both domestic and external) given the presence of external financial restrictions, as characterized by the use of imperfectly segmented dual exchange markets. In keeping with the knowledge that real world constraints most often limit policymakers to second-best adjustments, this paper evaluates the macroeconomic implications of commercial reform (tariff reduction) under alternative positive degrees of external financial repression.[5] Such a scenario would seem to characterize the liberalization attempts of many countries more realistically than one in which commercial reform under financial repression is compared with a situation of tariff liberalization when *no* financial restrictions remain (as in Aizenman (1985), for example).

[3] No less than 18 countries were reported by the International Monetary Fund to be employing legal dual exchange markets in 1985–86. In addition, at least two dozen other countries authorized the use of multiple rates for various limited transaction categories over the same period.

[4] Illegal trade transactions have, of course, been recognized in the literature on smuggling; see, for example, Pitt (1984) and Branson and de Macedo (1987). These authors do not, however, deal with intermarket transactions that are the result of sovereign compulsion and are not concerned with the issues of reform and liberalization.

[5] From a microeconomic welfare point of view, such second-best comparison may well be treacherous. However, as Krueger (1983) and Edwards (1984) have pointed out, on a macroeconomic level there are indeed well-founded conjectures about the effect that partial liberalization (that is, a second-best adjustment) will lead to a determinate effect on welfare.

Although a detailed statement of the results of this paper unfolds in the text, the following summary observations are in order now. First, when free currency convertibility is restricted by means of a dual exchange rate regime involving a pegged commercial rate and a floating financial rate, domestic tariff liberalization leads to financial nominal appreciation coupled with price deflation and an increase in output. Because the nominal commercial exchange rate is fixed, the price deflation necessarily implies commercial real depreciation. The effect on the financial real exchange rate, however, is far less clear and seems largely to depend on the penalty costs associated with fraudulent cross-transactions between the two exchange markets, although the degree of legally compelled leakage also plays a contributory role. Specifically, financial real appreciation is a probable outcome in very limited circumstances. These results (with respect to the financial real exchange rate) are in sharp contrast to those obtained by other authors such as Aizenman (1985) and Khan and Montiel (1987).

The present paper also indicates that tariff liberalization that occurs under more severe financial restrictions generates larger output increases as well as greater financial nominal appreciation; however, such tariff liberalization may also lead to sharper or reduced domestic price movements, depending again on the penalty costs referred to above. Thus, if the policymakers' preference function is defined in terms of price, output, and real commercial rate adjustments, it is clear that a general unqualified statement about the sequencing of commercial versus financial reform cannot be made. Further elaboration of specific circumstances in which the desirability of a particular sequencing scenario can be clearly indicated is provided in the paper.

Finally, although the discussion in this paper involves a dual exchange rate system wherein the commercial exchange rate is fixed, the principal substantive results carry over to the two-tier-float variant as well. This variant is not discussed in the paper because of its limited applicability to developing countries.

In what follows, Section I describes the analytical framework, and the implications of tariff reform under varying degrees of external financial repression are discussed in Section II. The concluding section deals with some of the implications of the analysis and with areas for extension.

## I. Analytical Framework

Consider an economy characterized by the presence of both commercial and financial restrictions. Commercial repression takes the form of an ad valorem tariff imposed on domestic imports. In addition, it is

assumed that domestic exporters are also subject to a tariff imposed by the foreign country. Thus, domestic commercial reform consists of reducing the domestic tariff rate, whereas worldwide commercial liberalization involves the simultaneous reduction of both domestic and foreign tariffs. Along with commercial repression, the domestic economy is also encumbered by financial restrictions in its external capital account. To model the latter, it is assumed that the policymaker imposes restrictions on free convertibility of foreign assets by the use of an officially sanctioned dual exchange rate system. Under this two-tier regime, current account items are subject to a commercial exchange rate, and capital account items are to be settled at a (depreciated) financial exchange rate.

A key feature of the model to be presented is that the actual degree of currency inconvertibility in the economy is substantially less severe than its apparent degree, owing to both legal and fraudulent cross-transactions between the two exchange markets. This phenomenon of leakage between the two markets has been analytically modeled in an earlier paper by Bhandari and Decaluwe (1987). The present paper represents a departure from the earlier work in that the framework is specifically amended to permit evaluation of competing economic reform sequences. There are also substantive differences between the earlier work and the present paper: for example, asset accumulation equations in the present context are specified in terms of beginning-of-period, ex ante equilibrium rather than in end-of-period, ex post terms. This modification permits considerable simplification and avoids troublesome problems of nonlinearities in the model.

The model involves a relatively uncomplicated structure. Domestic output is limited to a single final commodity. The price of domestic output (that is, the exportable commodity) is endogenously determined.[6] The country in question is small in the market for imports, however, so that the foreign currency price of importables is exogenously given. It is assumed that domestic financial liberalization has already proceeded to such an extent that the country's residents have free access to a worldwide capital market dealing in internationally issued, one-period, riskless government securities. The assumption that domestic financial re-

[6]Thus, the country in question is assumed to possess some market power with respect to its exports. Typical examples of such a situation may include, say, Brazil with respect to the market for its coffee exports. The model can easily be modified so as to eliminate the distinction between exports and imports by the use of an appropriate purchasing power parity relation in place of the aggregate demand specification. This modification is merely a special case of the more general scenario employed here and does not yield any additional insights.

form has already been accomplished is a standard one made by most other authors writing in this area (see Khan and Zahler (1983)).[7] The menu of assets available to the country's residents is limited to domestically issued money and the internationally issued security. There is no currency substitution, no physical capital accumulation, and no transaction or transport costs. All markets clear continuously, and expectations are rationally formed. The central authorities intervene continuously to defend a specific commercial (official) exchange rate. Meanwhile, the financial (parallel) exchange rate is permitted to float freely. As indicted previously, the convertibility restraints that are imposed by the use of the two exchange markets are less onerous than is apparent in view of the presence of intermarket transactions.

The principal element in the description of such an economy is the specification of aggregate demand. In accord with prevailing economic reality in the countries reported to be maintaining dual exchange rate arrangements, the analysis distinguishes commercially settled export and import (as well as service account) items from those that occur in the parallel (financial) market. Examination of the data for relevant countries clearly reveals that specified proportions of both export and import items (as well as service account proceeds) are assigned by law to the financial exchange market.[8] This variety of leakage thus, is, legally compelled. In addition, given a relatively depreciated financial (commercial) exchange rate, exporters (importers) find it profitable to circumvent exchange regulations by illegally surrendering (acquiring) export receipts (import exchange) at the more favorable financial rate.[9] For present purposes, it is the separation of trade items into commercially settled and financially settled components that is important, not the distinction between legal and illegal transactions.

Total exports comprise commercially settled exports ($X'$) and financially settled exports ($X''$); that is,

$$X = X' + X''.$$

Define $(1 - \alpha)$ as the initial value of the ratio of financially settled exports to total exports; that is,

$$(1 - \alpha) \equiv (X''/X')^{\circ},$$

[7]The issue of reform in domestic financial markets is dealt with in McKinnon (1973) and Mathieson (1979, 1980), among others.

[8]See International Monetary Fund, *Annual Report on Exchange Arrangements* (Washington, various years).

[9]There are virtually no reported cases wherein the commercial rate is relatively depreciated in relation to the financial rate. Isolated instances of such relative depreciation have sometimes been noted during periods of exchange rate turbulence or of substantial exchange rate realignment.

where the degree symbol (°) denotes an initial value. For expositional purposes it is convenient to interpret the initial value $(1-\alpha)$ as the policy-controlled or legally compelled extent of export leakage. The *actual* extent of total leakage, in contrast, is an endogenous variable that is determined by the relevant factors affecting commercially settled and financially settled transactions. For example, an increase in the exchange rate spread induced by financial depreciation will lead to an increase in the volume (and proportion) of export transactions settled in the financial market. The degree of import leakage is defined as

$$(1-\beta) \equiv (Q''M'')^{\circ}/(Q'M' + Q''M'')^{\circ},$$

where $Q'$ and $Q''$ denote, respectively, the real tariff-ridden commercial and real tariff-ridden financial exhange rates; that is,

$$Q' \equiv [\bar{E}P^*(1+t)/P], \qquad Q'' \equiv [FP^*(1+t)/P],$$

where $\bar{E}$ and $F$ denote the nominal commercial and financial rates, respectively; $t$ is the domestic ad valorem tariff rate levied on imports; $P$ and $P^*$ refer to domestic and foreign price levels; and $M'$ and $M''$ indicate physical volumes of commercially and financially settled imports, respectively. It can be shown that the aggregate demand function for the economy in question can be reduced to the following log-linear form:

$$\begin{aligned} y^d = {} & \gamma_1 y + \gamma_2 (w - p) + \delta_1(\bar{e} + p^* - p) + \delta_2(f + p^* - p) \\ & + \delta_3 t - \delta_4 t^* + \delta_5(f - \bar{e}), \end{aligned} \tag{1}$$

where lowercase letters denote logarithmic values. All parameters are defined positively as follows:

$$\gamma_1 \equiv c_1\left[\frac{C^{\circ}}{Y^{\circ}} - \beta e_m m_1' - (1-\beta)e_m m_1''\right]$$

$$\gamma_2 \equiv c_2\left[\frac{C^{\circ}}{Y^{\circ}} - \beta e_m m_1' - (1-\beta)e_m m_1''\right]$$

$$\delta_1 \equiv [\alpha e_x x_1' - \beta e_m + \beta e_m m_2'']$$

$$\delta_2 \equiv [(1-\alpha)e_x x_1' - (1-\beta)e_m + (1-\beta)e_m m_2'']$$

$$\delta_3 \equiv e_m[\beta m_2' + (1-\beta)m_2'' - 1]$$

$$\delta_4 \equiv e_x[\alpha x_1' + (1-\alpha)x_1'']$$

$$\delta_5 \equiv e_x[-\alpha x_2' + (1-\alpha)x_2''] + e_m[-\beta m_3' + (1-\beta)m_3''] = 0.$$

The following (logarithmic) hypothesized functions were used in deriving equation (1):[10]

$$c = c_1 y + c_2(w - p)$$

$$\ln X' \equiv x' = x'_1(\bar{e} + p^* - p) - x'_1 t^* - x'_2(f - \bar{e})$$

$$\ln X'' \equiv x'' = x''_1(f + p^* - p) - x''_1 t^* + x''_2(f - \bar{e})$$

$$\ln M' \equiv m' = m'_1 c - m'_2(\bar{e} + p^* - p) - m'_2 t + m'_3(f - \bar{e})$$

$$\ln M'' \equiv m'' = m''_1 c - m''_2(f + p^* - p) - m''_2 t - m''_3(f - \bar{e}).$$

As the above equations make clear, a depreciation of the tariff-adjusted real commercial exchange rate—that is, $\bar{E}P^*/P(1 + t^*)$—increases commercially settled exports in standard fashion (that is, potential J-curve effects are ignored). For reasons of convenience, the effects of pure real depreciation are delineated from those of a pure increase in the applicable tariff rate; clearly, the same elasticities apply with respect to both. In addition, another margin of substitution is also operative. A depreciation of the nominal financial rate relative to the commercial rate leads to a decrease in commercially settled exports as traders (illegally) divert export proceeds to the more favorable financial market. Similar considerations apply to the import functions $m'$ and $m''$, except that the effects of variations in the exchange rate spread are qualitatively opposite to those for exports. Thus, an increase in the exchange rate spread $(f - \bar{e})$ now encourages importers to use the more favorable commercial exchange market.[11] It is also clear that the magnitudes of the elasticities $x'_2$, $x''_2$, $m'_3$, and $m''_3$ are inversely related to the

[10] The following additional notation is involved in equation (1) and the accompanying unnumbered equations: $c$, logarithm of domestic consumption; $y$, logarithm of domestic output; $w$, logarithm of domestic nominal wealth; $C^\circ/Y^\circ$, average propensity to consume; $e_x$, initial ratio of total exports to income (that is, $X^\circ/Y^\circ$); $e_m$, initial ratio of total imports to income (that is, $(Q'M' + Q''M'')^\circ/Y^\circ$); and $c_1$, $c_2$, $x'_1$, $x''_1$, $x'_2$, $m'_1$, $m''_1$, $m'_2$, $m''_2$, $m'_3$, and $m''_3$ are parameters. It can also be shown that $x''_2 = [\alpha/(1 - \alpha)]\, x'_2$ and $m''_3 = [\beta/(1 - B)]\, m'_3$. Finally, it should be recognized that tariff revenue is properly included in gross income. Nevertheless, the discrepancy between income and output is disregarded in order to avoid additional problems of nonlinearity. The export functions are to be viewed as being linearizations of the following functions:

$$X' = X'\left[\frac{P(1+t^*)}{\bar{E}P^*}, \frac{F}{\bar{E}}\right], \qquad X'' = X''\left[\frac{P(1+t^*)}{FP^*}, \frac{F}{\bar{E}}\right].$$

Similar considerations apply to the import functions.

[11] Recall that certain export and import transactions are officially assigned by law to the financial market by the exchange authorities. Thus, financially settled imports ($M''$) are nonzero despite the fact that the financial exchange rate may be relatively depreciated compared with the commercial rate.

penalty costs attributable to such fraudulent transactions, with high penalty costs resulting in low values of these elasticities (and conversely). The concept of penalty costs is rather an amorphous one; at the very least, penalty costs subsume both the probability of detection and the severity of punitive sanctions. Nevertheless, it is assumed that, whatever their underlying determinants, penalty costs (and hence the elasticities $x_2'$, $x_2''$, and so forth) are properly identifiable. The next set of equations describes aggregate supply, the price index, money market equilibrium, and a statement of international capital mobility.

The supply of domestic output is governed by the following supply function:

$$y^s = \bar{y} + b\,(p_t - E_{t-1}, q_t), \tag{2}$$

where $y$ is the trend level of output, $q$ is the consumer price index (to be defined below), and $E$ is an expectations operator, with the subscript indicating the period in which the expectation is formed. It is straightforward to derive equation (2) on the basis of a firm's profit-maximizing behavior if it is assumed that nominal wages are fully indexed to the expected price index. The price index $q$ is based on domestic currency prices of domestic and foreign goods and is defined by

$$q = gp + (1-g)[\beta(\bar{e} + p^* + t) + (1-\beta)(f + p^* + t)], \tag{3}$$

where $0 < g < 1$. It can readily be shown that

$$(1-g) = \frac{e_m}{(C/Y)}.$$

The logarithm of the expected opportunity cost of holding domestic money as opposed to internationally issued securities can be shown to be approximated by

$$i_t = i_t^* + (E_t, f_{t+1} - f_t) + \omega\bar{i}^*(\bar{e} - E_t, f_{t+1}), \tag{4}$$

where $\bar{i}_t^*$ is the mean value of the foreign interest rate and $\omega$ measures the proportion of foreign interest receipts repatriated through the commercial market. Thus, $1-\omega$ measures the prevailing degree of service account leakage. In consonance with the earlier assumption about the degrees of merchandise trade leakage $\alpha$ and $\beta$, $\omega$ is also treated in what follows as a parameter that varies only with the policy-controlled extent of external financial repression. Domestic money market equilibrium is defined in logarithmic terms by

$$m_t - P_t = -\lambda i_t + y_t. \tag{5}$$

Next, domestic nominal wealth can be approximated in logarithmic form by

$$w_t = d_1 m_t + (1 - d_1)(f_t + k_t), \tag{6}$$

where $d_1 \equiv (M/W)^\circ$ is an arbitrary linearization point and $k$ is the logarithm of the domestically held stock of foreign assets. By assumption, the principal on foreign securities is acquired at the financial rate, but interest proceeds on these securities—a current account item—may be repatriated through either market, depending on the values of $\omega$.

The final ingredient of the model is the specification of the accumulation processes governing the economy. Specifically, the model involves two distinct sources of accumulation—money (or reserve) accumulation and foreign asset accumulation. Note that the accumulation of foreign assets occurs despite the flexibility of the financial rate and is attributed solely to the presence of cross-market transactions. Hence, total wealth accumulation occurs by means of two components of saving in this model. One component is the commercially settled trade surplus $(X' - Q'M')$, which results in money (reserve) accumulation. The other component of saving is the financially settled trade balance $(X'' - Q''M'')$, the counterpart of which is foreign asset accumulation.

Thus, the accumulation equations that express the equality of planned saving (of each type) with the appropriate component of real wealth accumulation can be shown by the following:[12]

$$d_1[(E_t, m_{t+1} - m_t) - (E_t, p_{t+1} - p_t)] = \psi'[h_1(\bar{e} + p^* - p) - h_2 y - h_3(w - p) - h_4(f - \bar{e}) + h_5 t - h_6 t^*] \tag{7}$$

$$(1 - d_1)[(E_t, f_{t+1} - f_t) + (E_t, k_{t+1} - k_t) - (E_t, p_{t+1} - p_t)] = \psi''[g_1(f + p^* - p) - g_2 y - g_3(w - p) + g_4(f - \bar{e}) + g_5 t - g_6 t^*], \tag{8}$$

where $\psi'$ and $\psi''$ are stock-flow conversion factors defined as

$$\psi' \equiv (X' - Q'M')^\circ/(W/P)^\circ, \qquad \psi'' \equiv (X'' - Q''M'')^\circ/(W/P)^\circ$$

and the coefficients $h_i$ are given by

$$h_1 \equiv (x_1' + \eta' m_2' - \eta')/(1 - \eta')$$

$$h_2 \equiv \eta' m_1' c_1/(1 - \eta')$$

$$h_3 \equiv \eta' m_1' c_2/(1 - \eta')$$

$$h_4 \equiv (x_2' + \eta' m_3')/(1 - \eta')$$

$$h_5 \equiv \eta'(m_2' - 1)/(1 - \eta')$$

$$h_6 \equiv x_1'/(1 - \eta'),$$

[12] Details regarding the derivation of this equation are available from the author on request. The procedure is similar to that described in Flood and Marion (1982).

where $\eta' \equiv (\beta e_m/\alpha e_x)$. The $g_i$ coefficients are defined analogously to the $h_i$, with $x_1'$, $m_1'$, $m_2''$, and $\eta''$ replacing $x_1'$, $m_1'$, $m_2'$, and $\eta'$, respectively, and where $\eta'' \equiv (1-\beta)e_m/(1-\alpha)e_x$. As may be verified, these equations are consistent with the requirement that total planned saving equals aggregate expected real wealth accumulation.

The model is completed by specifying the nature of the processes governing variations in domestic and foreign tariffs. Although a dichotomy between the possible transitory and permanent components of tariffs may be interesting in that it may involve issues of the credibility of the reform (as, for example, considered by Calvo (1987)), for present purposes it proves sufficient to hypothesize that all variations in tariffs (both domestic and foreign) are of the permanent variety and that, although changes in domestic tariffs are fully perceived, those relating to foreign tariffs are only imperfectly anticipated by domestic residents (because of the higher costs of acquiring information on the actions of foreign governments). In this sense, the model incorporates the fact that domestic information sets contain spatially diverse information with respect to domestic versus foreign variables.[13] Accordingly, the domestic and foreign tariff structures are given by

$$t_t = \bar{t} \tag{9}$$

$$t_t^* = \bar{t}^* + v_t^* \tag{10a}$$

$$v_t^* = v_{t-1}^* + \xi_t^*, \tag{10b}$$

where $\bar{t}^*$ and $\xi_t^*$ respectively denote the perceived and unanticipated components of foreign tariffs.

The next section discusses the implications of tariff reform under varying degrees of external financial repression.

## II. Implications of Trade Reform Under Alternative Degrees of External Financial Repression

To isolate the effects of domestic and external tariff reform on the domestic economy, the model described above is solved by the use of the familiar rational expectations technique. Given the relatively complicated form of the model, however, the resultant expressions turned out to be analytically cumbersome. Thus, it proved more useful to explore the properties of the model by means of numerical methods. Accord-

[13] Several recent models recognize the possibility of differentiated information; see, for example, Flood and Hodrick (1985).

Table 1. *Effects of Trade Reform Under Varying Degrees of Capital Controls*

| Penalty Cost Parameter | Nominal Financial Rate (and Spread) | Price Level | Real Commercial Rate | Real Financial Rate | Output Level |
|---|---|---|---|---|---|
| $x_2' = m_3' = 1.0$ | | | | | |
| $\alpha = 0.10$ | −0.1154 | −0.1761 | 0.1761 | 0.0607 | 0.6185 |
| $\alpha = 0.50$ | −0.0744 | −0.1882 | 0.1882 | 0.1138 | 0.5660 |
| $\alpha = 0.90$ | −0.0182 | −0.2395 | 0.2395 | 0.2213 | 0.5082 |
| $x_2' = m_3' = 0.01$ | | | | | |
| $\alpha = 0.10$ | −0.5009 | −0.5292 | 0.5292 | 0.0283 | 0.6144 |
| $\alpha = 0.50$ | −0.4487 | −0.3933 | 0.3933 | −0.0554 | 0.5540 |
| $\alpha = 0.90$ | −0.3533 | −0.2793 | 0.2793 | −0.0740 | 0.5040 |
| $x_2' = m_3' = 0.05$ | | | | | |
| $\alpha = 0.10$ | −0.4413 | −0.4747 | 0.4747 | 0.0333 | 0.6150 |
| $\alpha = 0.50$ | −0.3728 | −0.3518 | 0.3518 | −0.0211 | 0.5564 |
| $\alpha = 0.90$ | −0.2026 | −0.2614 | 0.2614 | 0.0588 | 0.5059 |
| $x_2' = m_3' = 0.10$ | | | | | |
| $\alpha = 0.10$ | −0.3842 | −0.4224 | 0.4224 | 0.0381 | 0.6156 |
| $\alpha = 0.50$ | −0.3078 | −0.3161 | 0.3161 | 0.0083 | 0.5585 |
| $\alpha = 0.90$ | −0.1321 | −0.2530 | 0.2530 | 0.1209 | 0.5068 |
| $x_2' = m_3' = 10.0$ | | | | | |
| $\alpha = 0.10$ | −0.0144 | −0.0836 | 0.0836 | 0.0692 | 0.6196 |
| $\alpha = 0.50$ | −0.0087 | −0.1522 | 0.1522 | 0.1435 | 0.5681 |
| $\alpha = 0.90$ | −0.0019 | −0.2375 | 0.2375 | 0.2356 | 0.5084 |

ingly, the model was solved numerically for various hypothetical sets of scenarios corresponding to alternative values of the penalty cost parameters $x_2'$ and $m_3'$. For each scenario, the effects of a 1 percent reduction in the domestic tariff rate and the effects of 1 percent reduction in both the perceived and unperceived components of foreign tariffs on various domestic variables (such as the nominal financial rate, the price level, output level, and both real exchange rates) were computed. The results were separately computed for alternative values of the leakage parameters $\alpha$, $\beta$, and $\omega$ ranging from $\alpha = \beta = \omega = 0.10$ to $\alpha = \beta = \omega = 0.90$ for each configuration of penalty costs. The results are presented in Table 1.[14]

[14] Space constraints preclude the presentation of results for variations in foreign tariffs. A brief description of these results, however, is given at the end of the paper. Additional details are available in a longer version of the paper, which may be obtained from the author.

The first block of entries in Table 1 (the first three rows) represent the results in the benchmark case, which is designed to facilitate comparison and involves the following parameter values:

| | | |
|---|---|---|
| $\lambda = 10.00$ | $x_2' = 1.00$ | $c_1 = 0.80$ |
| $b = 3.00$ | $m_1' = 0.80$ | $c_2 = 0.10$ |
| $e_x = 0.25$ | $m_1'' = 0.80$ | $d_1 = 0.80$ |
| $e_m = 0.20$ | $m_2' = 0.75$ | $\bar{i}^* = 0.04$ |
| $x_1' = 0.75$ | $m_2'' = 0.90$ | $(C/Y)^\circ = 0.90.$ |
| $x_1'' = 0.90$ | $m_3' = 1.00$ | |

Thus, the interest rate semielasticity of money demand ($\lambda$) is assumed to be 10, corresponding to an interest elasticity of 0.50 and a semiannual nominal interest yield of 5 percent (the horizon of the model is assumed to extend over six months). The output supply curve parameter is given by $b = 3$. It can be shown that $b = (1 - \theta)/\theta$, where $1 - \theta$ is the share of labor in the productive process; most empirical studies indicate that this share is approximately 0.75. The initial shares of exports and imports to income (that is, $e_x$ and $e_m$) are assumed to be 0.25 and 0.25, respectively. Note that these values correspond to an arbitrary initial linearization point, so that the implied assumption of an initial trade surplus is fairly innocuous (although necessary in order to proceed with the required log-linearization of the model). The elasticities of commercially settled exports and imports with respect to the real exchange rate ($x_1'$ and $m_2'$) are assumed to be 0.75 each. These numbers are in broad conformity with the results typically reported (see, for example, Goldstein (1980)). No empirical evidence is available for the real exchange rate elasticities of financially settled exports and imports (that is, $x_1''$ and $m_2''$); the parameters here are assumed to be 0.90 each. The elasticity of imports with respect to consumption is fixed at 0.80 for both commercially and financially settled imports. Similarly, the income elasticity of consumption ($c_1$) is 0.80, but the wealth elasticity of consumption ($c_2$) is known to be much smaller and is assumed to be 0.10. The average propensity to consume (that is, $C/Y$) is 0.90, and the initial ratio of money to wealth (that is, $d_1$) is 0.80. Finally, the mean value of the semiannual foreign interest rate, $\bar{i}^*$, is 4 percent.

In the benchmark case (the first portion of Table 1), the penalty cost parameters ($x_2'$ and $m_3'$) are fixed at unity.[15] Other scenarios involve lower and higher values of these elasticities, respectively, and the results cor-

[15] Note that once $x_2'$ and $m_3'$ are chosen, values for $x_2''$ $m_3''$ are implied by the relations defined earlier.

responding to these cases are reported in the remaining portions of Table 1. For each scenario, the effects on selected domestic variables are computed and presented for several alternative values of the leakage parameters $\alpha$, $\beta$, and $\omega$.

An increased degree of financial repression in the external sector of the domestic country involves a more regimented and more effectively administered dual exchange rate system wherein, as a result, the degree of currency inconvertibility is increased. Thus, such circumstances involve higher penalty costs (lower values of $x_2'$ and $m_3'$), so that the separate exchange markets are more effectively policed and, in addition, larger fractions of current account transactions are assigned by law to the financial market. Accordingly, such a regime could be described by the first row in the second block of Table 1. By contrast, a liberalized external financial section means that the regime in question functions more closely as a unified rate system. Thus, penalty costs associated with private cross-transactions are low; at the same time, official segmentation of the two markets is also limited. Thus, this scenario could be represented by the last row in the last block of Table 1. Other comparisons within each block of the table are also of interest.

First, consider the results stated in the first block of Table 1 for the benchmark case. Inspection of these results reveals that domestic tariff reform—as represented by a decrease in the domestic tariff rate $\bar{t}$—leads to nominal financial appreciation coupled with price deflation, which in turn stimulates output.[16] Because the commercial exchange rate is pegged, the price deflation leads a fortiori to commercial real depreciation. At the same time, the financial real exchange rate also undergoes depreciation, with the extent of the financial real rate in general exceeding that of the commercial real rate.

These qualitative properties obtain regardless of the values of the leakage parameters (see the various rows in the first block of Table 1) and may be reconciled with the structural model as follows.[17] A decline in the domestic tariff rate ($\bar{t}$) stimulates domestic aggregate demand through equation (1), since $\delta_3 > 0$. At the same time, the expected domestic price index ($E_{t-1}, q_t$) declines (see equation (3)), so that aggregate supply is also stimulated (equation (2)). In net terms, however, excess supply is created in the goods market and is consequently eliminated by means of a combination of price deflation and real commercial and

[16] It also can be shown that the yield on securities denominated in domestic currency increases after domestic tariff reform.

[17] These results obtain irrespective of the value of penalty cost parameters $x_2'$, $m_3'$, and so on—with the exception of the financial real exchange rate, which may either depreciate or appreciate depending on the values of these penalty costs.

financial depreciation.[18] In the final equilibrium, real output is higher after the reduction in tariffs. Because output is stimulated, the money market is characterized by excess demand after tariff reform (notwithstanding the price deflation); as result, the yield on assets denominated in domestic currency increases to ensure the continued maintenance of money market equilibrium. The increase in the domestic asset yields is consistent with the nominal financial appreciation that is observed in every case. Finally, since the nominal commercial rate is fixed, a decline in the nominal financial rate must lead to a decline in the exchange rate spread $(f - \bar{e})$.

When the domestic economy is characterized by increasing legislated financial repression (in the sense of lower values of $\alpha$, $\beta$, and $\omega$, which, it will be recalled, are the officially sanctioned degrees of leakage), then for fixed levels of penalty costs, domestic tariff reform is accompanied by exacerbated effects on the nominal financial rate and output levels, but the responses of the price level and both real exchange rates are qualitatively muted—that is, a trade-off is apparent. A decrease in the value of $\alpha$ leads to a decline in $\delta_3$ (for the hypothesized values of $m_2'$ and $m_3''$), so that a given reduction in the tariff rate now stimulates aggregate demand less than previously. Because there is no change in the degree of the supply-expansive effect of a decline in a $\alpha$ (equations (2) and (3)), it is clear that the resultant excess supply in the goods market is reduced with lower values of the official leakage parameters $\alpha$, $\beta$, and $\omega$. Not surprisingly, then, the extents of the observed price deflation and commercial and financial real depreciation are reduced. Finally, because the extent of price deflation is reduced, the net excess demand created in the money market is greater, thus calling forth a sharper increase in the domestic asset yield and, hence, a sharper nominal financial appreciation to ensure continued money market equilibrium.

The last block of entries in Table 1 states the results for much higher values of the elasticities $x_2'$ and $m_3'$—that is, for much lower values of

[18]Note that some of these results—in particular, the observed real financial depreciation—stand in sharp contrast to those obtained by various previous authors such as Khan and Montiel (1987) and Aizenman (1985), who found that commercial reform results in real financial appreciation. The former authors, however, obtained that result in the context of a unified fixed-rate regime, whereas in Aizenman (1985) dual exchange markets are indeed incorporated but are assumed to be perfectly segmented. As will be seen below, the present analysis indicates that the response of the real financial rate after domestic tariff reform is fairly complex and is nonlinear in $\alpha$ for specified low values of $x_2'$ and $m_3'$ (that is, the penalty costs). When real appreciation is observed, it occurs for intermediate values of $\alpha$ only (see the third block of entries in Table 1). However, for higher values of the parameters $x_2'$, $m_3'$, financial real depreciation is observed for all values of $\alpha$.

penalty costs associated with fraudulent cross-transactions. A glance at Table 1 clearly reveals that there is no qualitative difference between the responses listed in the first and last blocks of the table. In particular, note that the nature of various trade-offs associated with alternative values of $\alpha$ remains unchanged across these subtables.

When penalty costs are substantially higher (that is, lower values of $x_2'$ and $m_3'$) than in the benchmark case, then in the case of the financial real exchange rate these results are qualitatively affected, whereas for other variables the responses associated with changing values of $\alpha$ are altered. Specifically, the second and third blocks of Table 1 reveal that real financial depreciation occurs as a result of a tariff reduction for values of $\alpha$ that are low or high. For intermediate values of $\alpha$, however, financial real appreciation is observed (see the third subtable). Table 1 also reveals that increasing officially sanctioned leakage (as characterized by lower values of $\alpha$) is now accompanied by larger absolute price declines, whereas (it will be recalled) in the benchmark case lower values of $\alpha$ led to reduced price realignments. The effect on the nominal financial rate is similar in all the results reported: lower values of $\alpha$ are associated with sharper nominal financial appreciation in every case.

The complex nature of these results indicates that the issue of the preferred order of liberalization is not one for which a simple unambiguous statement is possible. For example, if an increased degree of financial repression is characterized by low values of $x_2'$ and $m_3'$ (that is, high penalty costs) along with low values of $\alpha$ (that is, high official leakage), then a comparison of the first row in the second block of Table 1 with the last row in the relevant portion of the last block reveals that the "current account first" sequence is preferable only if the policymakers' preference function were defined exclusively in terms of domestic price-output movements.[19] Alternative welfare criteria clearly affect this property, however. For example, if the policymaker were to regard real financial depreciation as a substantially favorable development, then it is clear from the same comparison that trade reform is best initiated *after* some measure of external financial liberalization has already been achieved (see Table 1, last row). This sequence is also desirable if attention is to be paid to eliminating the exchange rate spread.

Thus, the general point that emerges is that a "current account first" sequence is preferable if the policymakers' objective function is limited to domestic price-output targets. By contrast, if the policymakers' sole

[19]Thus, sharper price declines and output increases are observed in the first row of the second block in Table 1 (the financially repressed economy) than in the last row of the last block (the liberalized case).

concern were with external competitiveness or with the exchange rate spread, then the "capital account first" scenario should be chosen.[20] In the general case wherein both domestic and external targets matter, the choice between competing reform sequences depends on the relative weights attached by the policymaker to the various targets. This finding contrasts with that of Khan and Zahler (1985), wherein the sequencing strategy is apparently irrelevant (in the stationary state).

The effects of external tariff reform are represented by $\bar{t}^*$ and $\xi_j^*$. Space considerations preclude presentation of the results here, but a decrease in foreign tariffs, whether anticipated or unanticipated, leads in all cases to domestic price inflation coupled with an output increase. The domestic price inflation a fortiori implies commercial real appreciation. These properties obtain for all values of penalty costs and for all degrees of officially sanctioned leakage. It can also be shown that an anticipated external tariff reduction leads to sharper price, output, and commercial real exchange rate adjustments than those from a corresponding unanticipated (from the domestic viewpoint) reduction in external tariffs. Beyond these general observations, the effects on the nominal and real financial exchange rates are apparently dependent on the nature of the external tariff reform (that is, whether domestically anticipated or unanticipated) as well as on the degrees of leakage and penalty costs.[21]

## III. Conclusions

This paper has discussed the implications of domestic tariff reduction in the presence of financial restrictions modeled as imperfectly segmented dual exchange markets. The principal results of the paper indicate that the commonly proposed "current account first" sequence of liberalization may not be a preferred strategy if any attention is to be paid by the policymaker to external competitiveness or to the exchange rate spread, and that financial real depreciation rather than real appreciation is a more probable outcome after domestic tariff liberalization. The results suggest, therefore, the need for caution on the part of countries embarking on liberalization programs, in the sense that the appropriate reform sequence can only be ascertained after careful assessment of domestic versus external targets for the country in question.

[20] Recall that, because certain trade transactions are settled in the commercial market, aggregate external competitiveness involves both the commercial and financial real exchange rates.

[21] Additional details may be obtained from a longer version of this paper, available from the author on request.

Finally, several caveats about the analysis should be noted. First, the results of this paper are based on numerical simulation and, although a wide variety of parameter values were used, the usual cautionary statements applicable to all simulation results are also applicable here. Second, it is apparent that the focus of this paper is solely on external (trade and financial) reform. In reality, of course, the domestic financial sector is also repressed along with the external sectors, so that the choice of an appropriate reform sequence is a more complex one, involving liberalization in three sectors of the economy (the domestic financial sector, the external financial sector, and the external trade sector). The development of a model wherein these issues can be examined rates high on the agenda for future work. Third, the present paper has chosen to characterize external financial repression as an imperfectly segmented dual exchange rate system (with its attendant implications for currency inconvertibility). It is also possible, however, to view external financial repression as the result of the imposition of specific capital controls (as, for example, in Khan and Zahler (1985)). Last, this paper has excluded considerations of both physical growth and external debt accumulation. A framework that is properly applicable to a longer horizon would clearly need to recognize such considerations. The need to develop such medium-term models is especially important in view of the Fund's recent emphasis on structural adjustment in its lending programs.

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## *Shorter Papers and Comments*

# Debt Relief and Adjustment Incentives in a Financially Open Economy

## Comment on Corden

PHILIPPE CALLIER*

IN A RECENT *Staff Papers* article, Corden (1988) constructed a heuristic framework to analyze the effects of debt relief on the incentives to adjust. Corden's framework is particularly useful in disentangling the mechanisms by which debt relief can either increase the incentive of debtor countries to adjust (the "pro-incentive effect") or, on the contrary, reduce this incentive (the "disincentive effect"). The purpose of this note is to build on Corden's framework and to extend the analysis to the "financially open" economy—an economy in which domestic investment is not necessarily equal to saving and in which absorption is not constrained to be equal to production because capital flows can finance current account surpluses or deficits.

Corden rightly notes that the introduction of capital flows in the analysis does not alter the main argument (Corden (1988, p. 629, footnote 2)). Nevertheless, this extension is quite fruitful. First, it enables one to break the identity between "more investment" and "less consumption" and thus reintroduces explicitly, at the core of the analysis, the main incentive countries have to protect their creditworthiness. An important implication of the extension proposed here is that, first, endogenous relief, in addition to reducing the cost of a "debt crisis" to debtors and existing creditors, also preserves the role of capital markets in efficiently allocating current world saving. Second, it adds another channel by which higher real rates of interest may be responsible for endogenous

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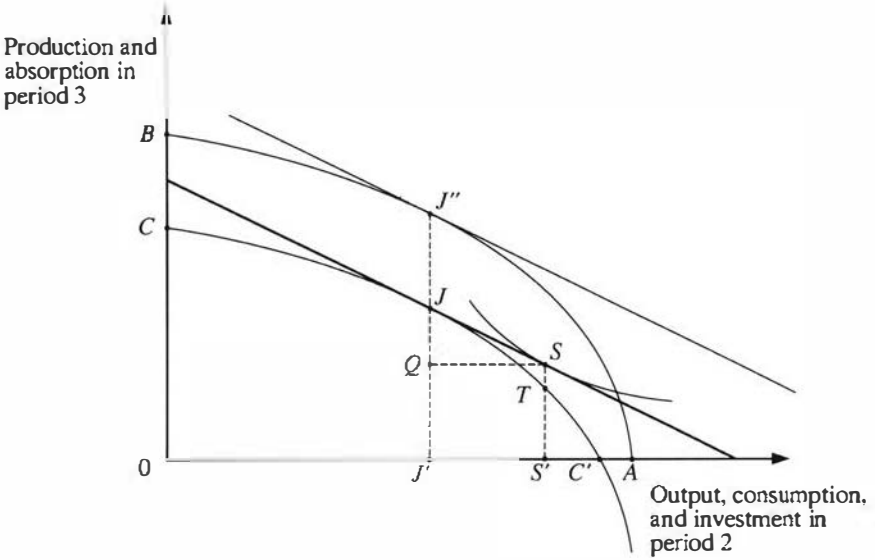
relief (a situation in which creditors have no choice but to recognize that the debtor's capacity to pay falls short of its commitments). Third, the extension has implications for the specific forms of relief that may be appropriate to maximize the pro-incentive effect of each dollar of relief granted to borrowers.

## I. The Financially Open Economy

Countries that preserve their creditworthiness have access to world capital markets and are therefore able to choose a level of absorption different from that of the national product. For these countries, the combinations of present consumption levels and future absorption capacity are not identical to the schedule representing domestic production net of service of the outstanding debt (the $CC'$ schedule of Corden's diagrams). Figure 1 extends to the case of the financially open economy the framework proposed by Corden.

As in Corden, there are three periods: the past (period 1), from which the country has inherited a given stock of outstanding debt; the present

Figure 1. *The Financially Open Economy*



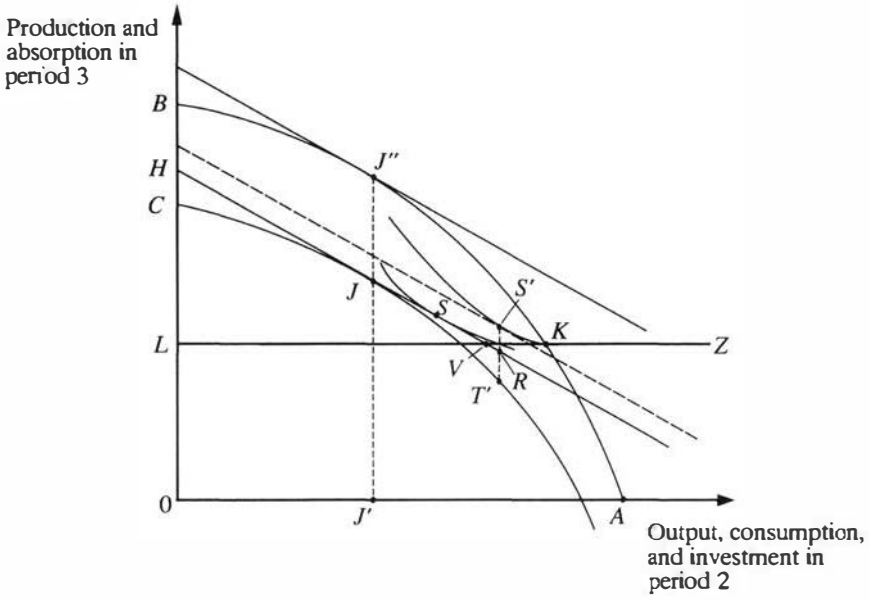
(period 2), during which decisions have to be made about consumption, investment, and possibly net new borrowing abroad; and the future (period 3), during which the debt service payments fall due. As in Corden, it is assumed that debt service payments falling due now (period 2) are refinanced, so that the country is not currently making any net transfer of real resources on account of the debt. The horizontal axis measures output ($0A$), consumption, and investment in period 2 (with investment being measured leftward from $A$). The vertical axis measures output and absorption in period 3. As in Corden, the curve $AB$ shows the levels of output in period 3 that correspond to various levels of investment in period 2; the curve $CC'$ shows what is left to the country from that output after deduction of the full service of the debt inherited from the past (period 1).

If the country is able to borrow and lend on world markets at the given real rate of interest $r$, its opportunity set is determined by the intertemporal budget constraint of slope $-1/(1+r)$ tangent to $CC'$ in Figure 1. The tangency point, $J$, determines the level of investment $AJ'$ necessary in period 2 to produce in period 3 an output $J'J''$, which, after the transfer of resources necessary to service the old debt, would leave an amount $J'J$ that the country can use for current absorption (consumption and investment in period 3) or to service new loans contracted in period 2. Consumption in period 2 would be determined by the tangency point $S$ between the relevant indifference curve of the decision maker and the budget constraint. At $S$, consumption in period 2 is $0S'$. Absorption in period 2 ($0S' + AJ'$) exceeds domestic production ($0A$) by an amount $J'S'$, corresponding to a noninterest current account deficit financed by new capital inflows. The amount available for absorption in period 3 will be $S'S$ (equal to $J'Q$), leaving $QJ''$ to service both the old debt ($JJ''$) and the new debt ($QJ$). Note that the service of the new debt ($QJ$) is smaller than the additional output made possible by the investment of the real resources corresponding to the current account deficit financed by the new capital inflows. This additional output is $QJ + ST$, with $QJ$ going to foreign lenders and $ST$ available to the country for absorption or for servicing the old debt.

If, following Corden, the concepts of minimum consumption and of endogenous relief based on capacity to pay are now introduced, the frontier of the opportunity set facing the country becomes $HVKA$ in Figure 2.[1] Above the line $LZ$ corresponding to the minimum level of

[1] Endogenous relief is not necessarily identical to default in the *legal* sense. As explained by Corden, endogenous relief is simply the ex post recognition by creditors that the country is unable to service its debt fully. Endogenous relief is granted by creditors in preference to initiating formal default procedures so as

Figure 2. *The Case for Exogenous Debt Relief*




consumption $0L$, the frontier follows the budget line described earlier (segment $HV$). Below the line, the country stops servicing its debt as agreed and therefore loses access to international financial markets. The country finds itself in what one could call a situation of financial autarky, and its opportunity set is bounded by the production possibility frontier (segment $KA$). If $K$ is to the left of $V$, endogenous relief with financial autarky will always be inferior to creditworthiness and access to capital markets, and service of the debt will not be an issue. If, however, $K$ is to the right of $V$, the country will choose between financial autarky at point $K$ (with 100 percent endogenous relief) or creditworthiness at point $S$ depending on which point lies on the highest indifference curve.

If $K$ is the preferred point, we have Corden's case for exogenous relief by the creditors: by reducing unilaterally the debt service payments owed on the old debt, creditors can induce the indebted country to service its

to avoid the various additional costs that a formal default would entail. The two alternatives are similar, however, in that both formal default and endogenous relief force the country into financial autarky. In that sense, endogenous relief amounts to de facto default.

remaining obligations voluntarily. All that is needed is to shift the budget constraint out, by an appropriate reduction of debt service payments, so as to enable the country to reach a point such as $S'$ on (or just above) the indifference curve corresponding to point $K$.

## II. Exogenous Relief and the Efficiency of World Capital Markets

The scheme of "exogenous relief" advocated by Corden and applied to the case of the financially open economy in the previous section is a Pareto-efficient move on two grounds. First, as in Corden, it enables both the debtor and its creditors to be better off than in the alternative situation of endogenous debt relief: the debtor is offered the possibility of reaching a (marginally) higher level of welfare than under financial autarky at $K$, and the creditors recover some of the debt service payments owed to them rather than being faced with the loss of all their claims.

Second, exogenous relief, by putting the overall debt-servicing obligations of the country in line with its capacity to pay, enables the country to service fully any new loan to be contracted in period 2 to reach point $S'$ and, therefore, protects the country's creditworthiness. Thus, by voluntarily purging the system of the excess debt burden that would otherwise induce the indebted country to opt for financial autarky, exogenous relief helps to maintain the unity of the capital markets necessary for an efficient allocation of world saving according to its most productive uses throughout the world. This outcome contrasts with the case of default or endogenous relief, which would segment world capital markets and prevent free flows of capital to the destinations with the highest real returns.

This second implication is particularly relevant to creditors, for two reasons. First, as net savers they have an interest in ensuring that world capital markets function efficiently and, specifically, enable them to allocate their new saving to investments with the highest possible return. Second, and more directly relevant to their position as creditors of the old debt, the ability of the indebted country to continue to raise resources on world capital markets to finance investment opportunities with a rate of return in excess of the real rate of interest on world markets increases the country's capacity to service the old debt and therefore reduces the amount of exogenous relief necessary to prevent default or endogenous relief (Callier (1985, p. 60)). For example, in Figure 2, the additional resources available in period 3 as a result of the new borrow-

ings by the country in period 2 amount to $RT'$. Had the country lost access to capital markets, an additional amount of exogenous relief would have been needed to bring the country on or above the indifference curve corresponding to $K$. (The curve $CC'$ would have had to be shifted enough to become tangent to that indifference curve, whereas with access to capital markets this is not necessary.)

This second aspect of the concept of exogenous debt relief conceived by Corden is important because it goes beyond the questions of the adjustment incentive and of the redistribution of the costs of the debt crisis between debtors and creditors of the old debt. All economic agents who rely on the market mechanism for an efficient allocation of the world's savings—not only the indebted country and its creditors—have a stake in the success of exogenous relief in forestalling either unilateral default or endogenous relief.

## III. Changes in the World Real Interest Rate

The extension of the analysis to the case of the financially open economy introduces a new channel by which changes in the real rate of interest on world markets can trigger a situation resulting in either endogenous or exogenous debt relief.

Corden (1988, Section VI, pp. 641–43) shows that an increase of the real rate of interest may trigger a situation in which endogenous or exogenous relief arises *because of the expected increase in the cost of servicing the existing debt* resulting from the higher rate of interest. This expected increase in the cost of servicing the existing debt comes from the cost of refinancing the obligations (including interest payments) falling due in period 2, if any, and possibly from the existence of past loans contracted at variable rates. As noted by Corden, this increase in the expected cost of servicing the old debt can be represented in Figure 2 by a downward shift of the $CC'$ curve because the distance $BC$ increases. As can be seen from the diagram, the likelihood that, in the absence of exogenous relief, the indebted country will choose default or endogenous relief increases as the cost of servicing the outstanding debt grows.

Even if these effects did not apply (for example, because the country had contracted no loans at variable rates and had already arranged for a grace period expiring in period 3 only), however, the increase in the real rate of interest could still induce the country to default or to seek endogenous relief and financial autarky in the absence of exogenous relief. Abstracting from any possible effect of the higher real interest

rate on the cost of servicing the old debt, a higher rate of interest will imply a steeper budget line tangent to $CC'$, such as $H'V'$ in Figure 3, which will represent the *increase in the cost of contracting new loans to finance an increase in the current account deficit.* The effect of this steeper budget constraint is to move point $V$ to the left (to $V'$) and, as can be seen from the diagram, to create the possibility that the indebted country may choose financial autarky. Beyond the geometry, the logic of this mechanism is that the benefits of creditworthiness and access to world capital markets are reduced by the higher cost of borrowing, and a point will be reached at which these benefits of new borrowing will fall short of the costs of servicing the old debt (even if that cost remains constant). More relevant to the model, the increase in the cost of financing domestic investments by external borrowing reduces the amount of profitable investments that the country can make and therefore reduces its capacity to pay in the future.

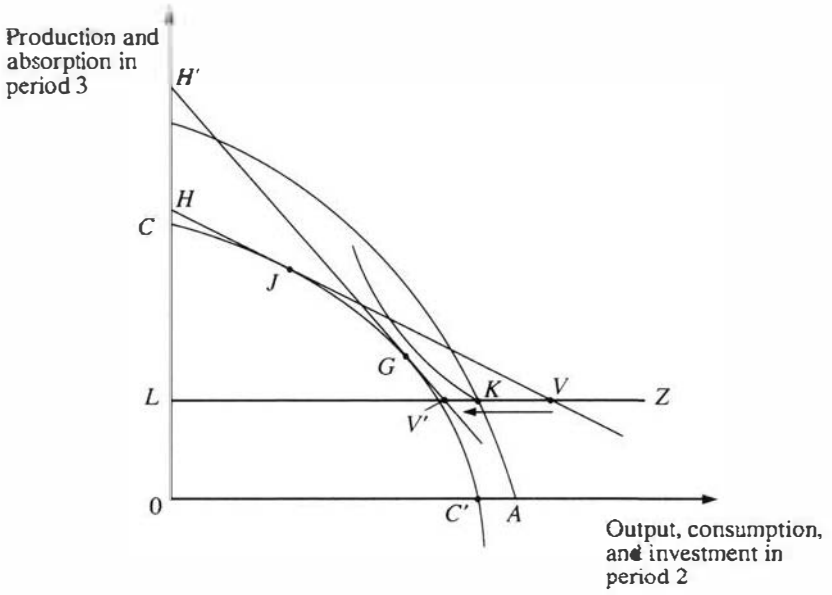
## IV. The Inefficiency of Relief in the Form of Subsidized Loans of Fresh Money

Exogenous relief can take the form of a direct reduction in the payments due to service the outstanding debt—for example, through a remission of a fraction of the principal or a rollback of the interest rate charged on this debt. This restructuring of the obligations arising from the old debt can be represented by a vertical shift of the curve $CC'$, as in Corden. Alternatively, another scheme that could be used in the context of a financially open economy to forestall default by the debtor or the need for endogenous relief by the creditors is the provision of new loans at an interest rate lower than the market rate to finance the noninterest current account deficit.

Figure 4 compares the two approaches. It establishes that the first approach (restructuring of the old debt) is preferable to the second approach (provision of new money at a subsidized rate) from the point of view of the costs to be borne by the agents granting the relief. In Figure 4 the highest attainable level of welfare consistent with full debt servicing is reached at point $S$. The situation prevailing at $S$ is inferior, from the viewpoint of the country, to financial autarky and endogenous relief on the ground of incapacity to pay at point $K$. Reducing the old debt through exogenous debt relief could bring the country to $S'$, however, on the same indifference curve as $K$. The amount of relief necessary to achieve this result can be measured by the vertical distance between the two parallel market interest rate lines passing through $S$ and $S'$. This distance is $JQ$.

Consider now the outcome of exogenous relief granted through sub-

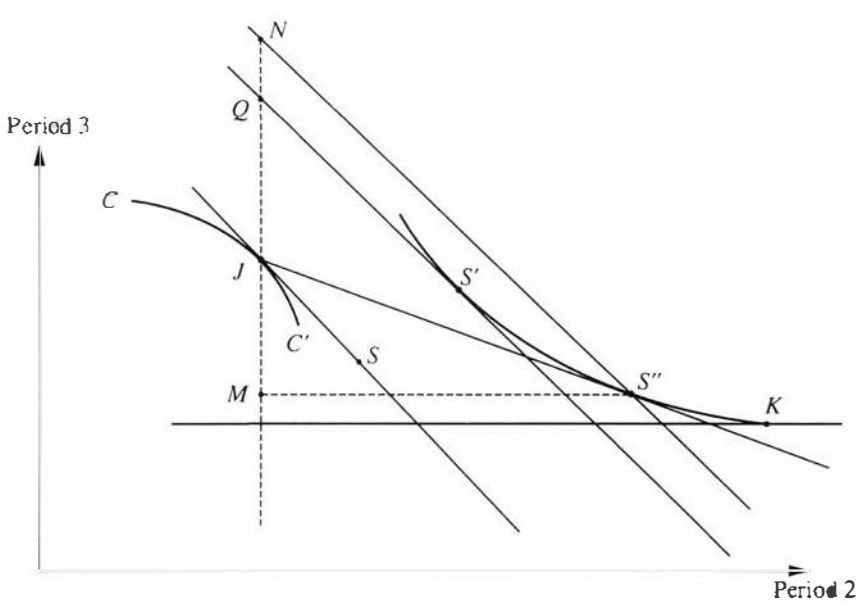
Figure 3. *Increase in the World Real Interest Rate*




sidized loans financing the noninterest current account deficit of the indebted country. If it is assumed that, by imposing appropriate conditionality, the lenders are able to avoid the distortions that would result from financing investments with a rate of return lower than the world real rate of interest, the new budget constraint still passes through point $J$, where the rate of return of the marginal investment is equal to the rate of interest on world markets. Its slope, reflecting the subsidy, is $-1/(1+r')$, where $r'$ is the subsidized real rate of interest charged on the new borrowings of the debtor country. The subsidized interest rate $r'$ can be chosen to enable the country to reach, at point $S''$, the same level of welfare as under financial autarky and endogenous relief (at $K$) or under exogenous relief through debt reduction (at $S'$).

The cost of the implicit interest rate subsidy necessary to bring the economy at $S''$ can be measured as follows. The current account deficit financed through subsidized loans amounts to the distance $S''M$ in Figure 4. The cost to the borrower of these resources will be a debt service payment of $MJ$ in period 3, but the opportunity cost of these resources to the lenders, computed at the world interest rate, is $MN$. The net cost to the lenders is therefore $JN$, which is higher than the cost $JQ$ implied by the first approach to debt relief.

Figure 4. *Debt Relief as Subsidized Interest Rate on New Money*




The reason for this higher cost of debt relief through interest rate subsidy is, of course, the curvature of the indifference curve: the substitution effect of lower rates of interest moves the optimum for the country downward to the right along the relevant indifference curve. The additional cost to the lenders results from the substitution of subsidized present consumption for future consumption that is due to the lower interest rate. By contrast, exogenous relief through a restructuring of the obligations arising from the old debt represents, in effect, a lump-sum grant that does not distort the borrower's decisions. Exogenous debt relief is therefore superior on efficiency grounds.

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