A model of adjustment and growth: An empirical analysis

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An Empirical Analysis

Carmen M. Reinhart*

The concept of "growth-oriented adjustment," or the notion that economic growth is essential for the achievement of the twin goals of a sustained reduction in inflation and a viable balance of payments, has recently received the attention of policymakers and academics alike. Indeed, growth-oriented adjustment is considered a key characteristic of the policy packages that make up Fund-supported programs. Examples of the blossoming literature on the subject of growth-oriented adjustment can be found in Bacha and Edwards (1988), Blejer and Chu (1989), and Corbo, Goldstein, and Khan (1987).

Any analysis of the effects of policies on the targets of growth, inflation, and the balance of payments requires a consistent and unified framework. Further, because this issue is particularly relevant for developing countries, it is desirable that the framework be both sufficiently simple to allow its application where data are limited, and general enough to ensure its applicability to a diverse set of countries. The model developed by Khan and Montiel (1989), which merges a variant of neo-classical growth model frequently employed by the World Bank with the monetary approach to the balance of payments associated with the IMF, provides such an integrated framework.

However, the simplicity that makes a model more tractable from an operational standpoint may have several drawbacks as a result of the necessarily restrictive assumptions it employs. This paper assesses the

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2 See the references contained therein, particularly Michalopolus Khan (1987) also provides a broad survey of this literature.

3 For a more detailed discussion of the building block of this model, see Khan, Montiel, and Haque (1990).

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The framework describes a small open economy, representative of a developing country, that maintains a fixed exchange rate. Equations (1) through (7) define the basic identities of the model, as well as the budget constraints for the private and public sectors.

The private sector's budget constraint:

\[ Y - T - C - Sp = 0. \]  

The allocation of private savings:

\[ Sp = Po, dk, + dM^s, - dDp,. \]  

The government budget constraint:

\[ e_dF, + dDg, = G, + i_e, F, - T, - T_b. \]  

The sources of changes in the money stock:

\[ dM^s, = e, _ldR, + dD,. \]  

The composition of changes in domestic credit:

\[ dD, = dDg, + dDp,. \]  

Interest earnings on foreign reserves transferred to the government:

\[ T_{Br} = i_e, R_r. \]  

Gross national product:

\[ Y = Y - i_e, (F, - R). \]  

In order of appearance, the variables are defined as:

- \( Y \): Gross domestic product
- \( T \): Taxes from the private sector
- \( C \): Private consumption
- \( Sp \): Private savings
- \( Po \): Price of domestic output
- \( dk \): Change in the capital stock (investment)
- \( dDp \): Change in domestic credit to the private sector
- \( dDg \): Change in domestic credit to the public sector
- \( G \): Government purchases of domestic output
- \( F \): Foreign currency value of government foreign debt
- \( i \): Interest rate on foreign debt
- \( e \): Nominal exchange rate (number of domestic currency units per unit of foreign currency)

\( dM^s \): Change in the money stock
\( R \): Foreign currency value of reserves held by the central bank
\( dD \): Change in total domestic credit
\( T_b \): Interest earnings on foreign reserves transferred to the government

The \( d \)'s denote changes from time \( t - 1 \) to time \( t \), that is, \( dx = x_t - x_{t-1} \).

The centerpiece of the growth block of the model is a neoclassical production function. Capacity, or potential growth, depends on increases in total factor productivity, changes in the size of the labor force, and changes in the capital stock. Combining productivity changes that are technologically driven and changes in labor supply into one exogenous variable, 4 the production function takes the following form:

\[ dy, = n, + o, ldk", \]  

where the lowercase letters denote real magnitudes. The coefficient of investment, \( o, l \), is the marginal product of capital, and the constant term, \( n, \), denotes the combined effects of total factor productivity and the change in the size of the labor force. This production function specification is a more generalized version of the "incremental capital output relationship" (ICOR). 5

The second behavioral relationship in the growth block describes private savings. It is assumed that real private savings is proportional to real disposable income:

\[ s_{pr} = s(y - t), \]  

where \( s \) is a constant representing both the marginal and average savings rate.

The third component of the growth block links savings identically to investment. Substituting the definition of the money stock, the government's budget constraint, and the savings function into equation (2), the following expression for the change in the capital stock is obtained:

\[ dk, = s(y - t) + [t, - 8, - i_e, f, - p, ; R] + e, (dF, p, dR) t, \]  

where the first term represents real private savings, the second real public saving, and the third is the real current account deficit (real foreign savings).

4 They are combined for simplicity in the theoretical model (as in Khan and Montiel, 1989). This assumption is relaxed in the empirical work.

Since \( Y_t = Y_{t-1} + dY_t \) and \( P_{O_t} = P_o - 1 + dP_{O_t} \), capacity growth can be expressed as a function of domestic prices, reserves, and the exogenous variables and parameters:

\[
dY_t = (1 - sa^1r)\{ ao + al[\sigma (y, -1 - t)] + \}
\]

\[ (t - g) + \frac{c(dF - dR - i[F - R]t)}{P_{O_t} + dP_{O_t}}. \quad (11)
\]

The monetary block is also defined by three relationships, starting with the flow supply of money (equation (16))

The second relationship is the flow demand for money, here simplified by the assumption that velocity is constant:

\[
dM_t = vP_t dY_t + vy, -1 dP_t, \quad (12)
\]

where \( P \) is the aggregate price level, defined below, and \( v \) is the inverse of the income velocity of money.

The last relationship in the monetary block describes money market equilibrium:

\[
dM_t = dM_{t-1}. \quad (13)
\]

Defining the change in the aggregate price level, \( dP_o'' \) as a weighted average of the change in the price of importables, \( dP_o'' \), and the change in the price of domestic output, \( dP_o'' \), with weights \( \epsilon \) and \( 1 - \epsilon \), respectively, it can be written

\[
\begin{align*}
dP_o'' &= \epsilon dP_o + (1 - \epsilon) dP_o'. \\
\end{align*}
\]

Assuming that \( \epsilon \) and the foreign currency price of importables are constant, initial conditions are set so that \( \epsilon = P_0 = P_{o0} = 1 \) and that the law of one price holds, the following is obtained

\[
dP_o'' = PO_t^* dP_{O_t} + dP_o. \quad (14)
\]

Using equations (14) and (15), and the definitions of flow money demand and supply, and substituting them into the money market equilibrium condition (equation (13)) an expression for the change in domestic prices as a function of output, reserves, the exogenous variables, and the parameters of the system is obtained

\[
dP_o'' = [\epsilon(1 - \epsilon)[Y_{t-1} + dY_t][dR_t - vY_t - vY_{t-1}dR_t - vY_{t-1}dP_o], \quad (16)
\]

The Merged Model

Combining the growth block (equation (10)) with the monetary block (equation (16)) does not close the system, as there are two equations in three unknowns, \( dY_t, dP_o'', \) and \( dR_t \). The additional relationship that enables this system to be fully determined is the balance of payments identity:

\[
dR_t = X_t - Z_t - i(F - R) t + dF_t, \quad (17)
\]

where \( X_t \) and \( Z_t \) are the foreign currency value of exports and imports. Defining the trade balance in foreign currency terms, \( B_t = Z_t - X_t \), it is assumed that

\[
B_t = B_0 - a(e/P_{O_t} - 1) + bdy_t, \quad (18)
\]

where \( a \) and \( b \) are positive constants and \( B_0 \) is a constant whose sign is undetermined. Equation (18) implies that the trade balance improves in foreign currency terms when the real exchange rate depreciates \( (e/P_{O_t} > 1) \) or when real output falls. Recalling that \( F_t = \sim_1 + dF_t \) and, similarly, for \( R_t \), equations (17) and (18) yield an expression for the change in reserves:

\[
dR_t = (dF_t - Bo) + a'(et/P_{O_t} - 1) - b'dY_t - i'(F_{t-1} - R_t - 1), \quad (19)
\]

where \( a' = a/(1 - i), b' = b/(1 - i), i' = i/(1 - i), \) and \( Bo' = B_c/(1 - i) \).

Having obtained an expression for reserves (equation (19)) the system can be solved in terms of equation (10), which summarizes the growth block, and equation (16), which summarizes the monetary block. The substitution of equation (19) into equation (10) yields

\[
dY_t = [1 - sa^1r - albet/P_{O_t} - a(t/l)] + al
\]

\[ \{S(Y_{t-1} - t) + (t - g)t + -fB_0 - a(et/P_{O_t} - 1)] \}. \quad (20)
\]

Graphically, the growth block traces out the locus in Chart 1 that has been labeled \( GG \). Its slope, evaluated at \( dY_t = dP_o'' = 0 \), is

\[
\frac{(dP_o)}{(dY_t)} = f_3/(a' \epsilon ')
\]

where,

\[
r_3 = B_0 - a
\]

and

\[
f' = 1 - a(s + b) > 0.
\]

Because imports \( (Z) \) decline in the latter case.

\[ \text{See Robichek (1985).} \]

\[ \text{The underlying specification } M = vP_{O''}, \text{ assumes a constant interest rate.} \]

\[ \text{Type of restrictive assumption is not } \sim \text{se-tial to the model, as the analySIS carries through with a more general specIIification.} \]
If \( \tau \) is negative, the GG schedule is upwardly sloped as depicted in Chart 1.

Similarly, substituting reserves in the equation representing the monetary block (equation (16)) yields

\[
\frac{\partial P}{\partial t} = [v(1- \varepsilon)(Y_{t-1} + dY_t) + \partial' - i'(F_{t-1} - R_{t-1}) + dDt] - (b' + v)dY_t - veY_{t-1} + v'dY_t + a'(et/P_D - 1)].
\] (21)

Equation (21) traces a negatively sloped locus, labeled \( MM \) in Chart 1. The slope at \( dY_t = dP_D = 0 \) is given by

\[
\left. \frac{\partial P}{\partial Y} \right|_{MM} = -(b' + v)/\gamma < 0,
\]

where \( \gamma = a' + v(l - \varepsilon)\gamma_0 > 0. \)

The intersection of the GG and \( MM \) schedules in Chart 1 depicts the equilibrium values of output changes and domestic inflation.

**Parameters to Be Estimated**

The model outlined above is applied to a sample of seven countries. Table 1 lists the parameters that must be estimated to make it operational.

**II. Estimating the Parameters of the System and Testing the Underlying Assumptions**

**General Comments.**

To test the empirical validity of the model outlined above, the model is applied to a set of seven diverse developing countries: Chile (1976-87), Ghana (1969-87), Honduras (1969-87), Korea (1969-87), Myanmar (1969-87), Pakistan (1976-87), and Tanzania (1969-87).

The common approach to evaluating a model’s empirical performance involves a two-step process: the first is the estimation of the model as a system; the second uses the estimated system to generate either in-sample forecasts, out-of-sample forecasts, or possibly both; and the final judgment is based on a comparison between the “fitted” values and the actual values—the forecast errors.

One problem with this approach is that it generally provides little or no direct information about what particular assumptions of the model are inappropriate, or what equations were misspecified. The approach followed here, although similar to the one outlined above, varies in some important ways. The first step still is to obtain estimates for the seven parameters that characterize the system. However, this was accomplished by estimating each behavioral equation separately, using either ordinary

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a )</td>
<td>Captures total factor productivity and changes in the size of the labor force</td>
</tr>
<tr>
<td>( a' )</td>
<td>The marginal product of capital</td>
</tr>
<tr>
<td>( s )</td>
<td>The private savings rate</td>
</tr>
<tr>
<td>( v )</td>
<td>The inverse of income velocity</td>
</tr>
<tr>
<td>( \bar{a} )</td>
<td>The share of importables in the aggregate price level</td>
</tr>
<tr>
<td>( a' )</td>
<td>The sensitivity of the trade balance with respect to the real exchange rate</td>
</tr>
<tr>
<td>( b )</td>
<td>The sensitivity of the trade balance with respect to changes in output</td>
</tr>
</tbody>
</table>
least squares (OLS) or generalized least squares (GLS), as dictated by the data. The individual equation approach was preferred over the alternative approach—estimating the model as a system—as it allowed more efficient use of the limited data, particularly in cases where the available time series for the same country had uneven starting points. The sample period covered by the empirical work for the individual equations was the maximum allowed by the availability of the data.

To assess not just the general fit of the model but to be able to pinpoint where the specification weaknesses lie, an intermediate step was added to the evaluation process: the validity of a subset of the individual theoretical assumptions was tested. Particular attention was devoted to specifying output growth, savings behavior, and money demand, as the parameters in these equations are central to the analysis.

Finally, since the model was not estimated as a system, and because it was desired to highlight the effects of certain policies, the methodology adopted in this paper does not involve a direct comparison of the actual and fitted values of the endogenous variables. Instead, the estimated parameter values are used to construct reduced-form policy multipliers for each of the endogenous variables. The range of values these multipliers take, as the parameter values are allowed to vary, provide useful information on the robustness of the model's policy implications. Except for the production function, which includes a proxy for the labor force, the empirical work uses only those explanatory variables dictated by the theoretical model. In general, the specifications of the estimation equations allowed these explanatory variables to appear with a richer lag structure than that suggested by the theoretical model. In each case the data determined the relevant lag pattern for the explanatory variables. Details for each equation and each country are outlined in the remainder of this section.

How Well Can a Production Function Explain Output Growth? 8

To obtain estimates for the marginal product of capital, $a_1$, and the combined effects of changes in the size of labor and total factor productivity, $a_0$, a simple growth model was estimated that is derived from an aggregate neoclassical production function. As in Robinson (1971), International Monetary Fund (1988), and Khan and Reinhart (1990), the growth function estimated takes the form

$$DY_t = a_0 + a_1 (dk, l)_t - 1 + a_2 DL'' ,$$

(8a)

where the uppercase $D$'s indicate rates of change and $L$ denotes the labor force, here proxied by population. Because the data were allowed to determine the lag pattern for the investment-output ratio, the particular form that equation (8a) assumed for each country is presented in Appendix II. The estimates presented in Table 2 were obtained by applying ordinary least squares to a form such as equation (8a) and imposing constant returns to scale, so that $a_2 = (1 - a_1)$. 9

This exercise has a twofold purpose: first, it yields the relevant parameter estimates; second, it serves as a "test" of the usefulness of an aggregate production function in explaining actual output growth. As Table 2 indicates, the estimates for the marginal product of capital are reasonable in sign and magnitude across countries, averaging about 0.299 (these are the parameter values used in the subsequent comparative static exercises). Unfortunately, however, a neoclassical production function does not explain much of the variation in actual output. A large proportion of output variation remains unexplained, perhaps reflecting that the specification traces a production possibility frontier when in reality, a significant number of countries, particularly developing countries, are not operating at full capacity. As such, a host of macroeconomic and microeconomic factors, not embodied in the production function, can push actual output growth toward or away from its potential. While this variation of the incremental capital output relationship meets the criteria of simplicity, which makes it applicable even in countries with limited data, it has the considerable drawback of being unstable over time. Projections of output growth based on variants of a production function are routine subject to large and variable errors, and yet a neoclassical approach is preferred over the alternative approach—estimating the model as a system—as it allowed more efficient use of the limited data, particularly in cases where the available time series for the same country had uneven starting points. The sample period covered by the empirical work for the individual equations was the maximum allowed by the availability of the data.

Table 2. Production Functions: How Well Can These Explain Output Growth?

<table>
<thead>
<tr>
<th>Country</th>
<th>$a_0$ (t-stat)</th>
<th>$a_1$ (t-stat)</th>
<th>$a_2$ (t-stat)</th>
<th>$R^2$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>-0.07 (-2.25)</td>
<td>0.28 (2.60)</td>
<td>0.28 (1.79)</td>
<td>0.28</td>
<td>1.81</td>
</tr>
<tr>
<td>Ghana</td>
<td>-0.04 (-1.66)</td>
<td>0.12 (5.01)</td>
<td>0.14 (0.01)</td>
<td>0.17</td>
<td>1.10</td>
</tr>
<tr>
<td>Pakistan</td>
<td>-0.07 (-1.35)</td>
<td>0.62 (2.58)</td>
<td>0.71 (0.34)</td>
<td>0.62</td>
<td>1.51</td>
</tr>
<tr>
<td>Korea</td>
<td>0.08 (6.96)</td>
<td>0.08 (5.01)</td>
<td>0.74 (2.61)</td>
<td>0.08</td>
<td>1.12</td>
</tr>
<tr>
<td>Myanmar</td>
<td>-0.02 (-2.60)</td>
<td>0.23 (2.61)</td>
<td>0.17 (2.01)</td>
<td>0.23</td>
<td>1.38</td>
</tr>
<tr>
<td>Honduras</td>
<td>-0.05 (-6.60)</td>
<td>0.28 (2.01)</td>
<td>0.13 (6.08)</td>
<td>0.28</td>
<td>1.27</td>
</tr>
<tr>
<td>Chile</td>
<td>-0.07 (-2.60)</td>
<td>0.12 (6.08)</td>
<td>0.79 (2.83)</td>
<td>0.79</td>
<td>2.83</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are the t-statistics, $R^2$ is the coefficient of determination, and DW denotes the Durbin-Watson statistic. This exercise has a twofold purpose: first, it yields the relevant parameter estimates; second, it serves as a "test" of the usefulness of an aggregate production function in explaining actual output growth. As Table 2 indicates, the estimates for the marginal product of capital are reasonable in sign and magnitude across countries, averaging about 0.299 (these are the parameter values used in the subsequent comparative static exercises). Unfortunately, however, a neoclassical production function does not explain much of the variation in actual output. A large proportion of output variation remains unexplained, perhaps reflecting that the specification traces a production possibility frontier when in reality, a significant number of countries, particularly developing countries, are not operating at full capacity. As such, a host of macroeconomic and microeconomic factors, not embodied in the production function, can push actual output growth toward or away from its potential. While this variation of the incremental capital output relationship meets the criteria of simplicity, which makes it applicable even in countries with limited data, it has the considerable drawback of being unstable over time. Projections of output growth based on variants of a production function are routine subject to large and variable errors, and yet a neoclassical approach is preferred over the alternative approach—estimating the model as a system—as it allowed more efficient use of the limited data, particularly in cases where the available time series for the same country had uneven starting points. The sample period covered by the empirical work for the individual equations was the maximum allowed by the availability of the data.

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production function is one of the key relationships of the growth block of the theoretical framework. Given the empirical inadequacy of the "full capacity" assumption, one possible route for future research would be to incorporate persistent excess capacity (present in varying degrees in most developing countries). The theoretical model would then allow domestic and foreign "demand" variables to play a greater role in output determination. Empirically, this extension should help reduce the share of output fluctuations that remains unexplained.

Savings Behavior-Is the Savings Rate Constant?

The second behavioral relationship in the model's growth block is the specification of the personal savings rate. The theoretical model assumes that real private savings is proportional to real disposable income. Variables that proxy the private sector's rate of time preference are not included in this specification. Similarly, other scale variables, such as wealth, are also omitted.

Negative levels of private savings for some countries in the sample for a subset of the years in which the data are available precluded estimating a log linear savings function. Furthermore, the problem of heteroskedastic errors makes the use of levels inappropriate. Negative levels of private savings for some countries in the sample for a subset of the years in which the data are available precluded estimating a log linear savings function. Furthermore, the problem of heteroskedastic errors makes the use of levels inappropriate.

Equation (9), however, implies that the marginal and average savings rates are equal. The average private savings rate, reported in Table 3, is used as the measure of \( s_{12} \). While this average provides a convenient estimate of the savings parameter, it says nothing about the adequacy of assuming a constant stable savings rate. To assess the properties of savings behavior, in particular its stability, given these obstacles, consumption behavior was examined. Table 3 reports the results of an equation of the form:

\[
Dc_i = c_0 + D(y_{i-1} - t)^{D_i},
\]

where \( c \) represents real private consumption, \( c_0 \) is a constant term, \( c_1 \) is the average propensity to consume, and the \( D_i \)'s indicate rates of change. The results of equation (21) were used to test the assumption of a constant savings rate. If the savings rate is constant, the null hypothesis of \( c_0 = 0 \) and \( c_1 = 1 \) should hold in the data. In other words, to maintain the savings rate constant, income and consumption would have to increase at equal rates. This test of stability was preferred over the more traditional approaches, such as the Chow test, because in many instances splitting the sample was not advisable, given the limited number of observations available.

The results of an F-test comparing the residuals of the unconstrained (equation (21)) and the constrained equations indicate that in only one of the seven countries in the sample was the savings rate variable making the assumption of a constant and stable savings rate reasonable for most instances. In effect, the constrained equation imposes the condition that the savings rate is stable while the unconstrained does not. If the savings rate is indeed unstable, then imposing the constraints would generate large errors relative to the errors of an unconstrained specification, and this would be apparent in the F-tests that compare the two versions of equation (21). The drawback of this test is that, even if the savings rate is found to be unstable, as for Honduras, this result could stem from misspecification-in particular the omission of the real rate of interest-from behavioral instability. If the interest rate belongs in the savings function, as several studies suggest (see, for example, Rossi (1988)), the constant term in a specification such as equation (21) could simply be picking up the systematic influence of the omitted variable.

### Table 3. The Savings Rate’s

<table>
<thead>
<tr>
<th></th>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
<th>Chile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.03</td>
<td>-0.25</td>
<td>0.07</td>
<td>0.31</td>
<td>0.16</td>
<td>0.21</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

**Is the Savings Rate Constant?**

<table>
<thead>
<tr>
<th>Equation</th>
<th>Unconstrained</th>
<th>Constrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y_{i-1} )</td>
<td>(0.049) (1.92) (0.08) (0.944) (0.952) (278)</td>
<td>(1.73)</td>
</tr>
<tr>
<td>( c_0 )</td>
<td>0.76</td>
<td>1.07</td>
</tr>
<tr>
<td>( c_1 )</td>
<td>0.07 (3.01) (8.441) (10.70) (5.446) (14.861) (4.125) (31.82)</td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.32</td>
<td>0.49</td>
</tr>
<tr>
<td>( DW )</td>
<td>1.54 (1.98) (1.954) (1.354) (1.87) (1.31) (1.78)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Figures in parentheses are the t-statistics. **R** is the coefficient of determination, and **DW** denotes Durbin-Watson statistic. **SSE** is the sum of squared residuals of the estimated equation, and the F-statistic tests for the significance of the difference between the unconstrained and the constrained versions of the equation. The sample period is 1961-66, except in Chile for which the 1973-86 sample is used.
Money Demand—is Velocity Constant?

After obtaining estimates for the three parameters describing the growth block of the model and after evaluating the relative merits of the assumptions underscoring that portion of the merged model, the same test is performed for the monetary sector. The key behavioral relationship is the specification of money demand. As equation (14) indicates, it is assumed that since opportunity cost variables do not affect the demand for money, the income velocity of money is constant. As with the savings parameter, the historical averages of the ratio of money to income are used to approximate $v$, the inverse of the income velocity of money, and are reported for both narrow and broad definitions of money in Table 4.

To "test" the validity of the constant velocity assumption, a generalized version of equation (14) is taken, which (a) includes a constant term (which under the null hypothesis of constant velocity should be insignificantly different from zero); and (b) does not restrict the coefficients of output and prices to be identical, allowing for economies of scale in cash balances. This generalized specification is

$$DM_t = do + dDY_t + dDP_t,$$  \hspace{1cm} (14a)

where $do$ is a constant term that represents $D(Dv)$, the rate of change in income velocity. This equation was estimated over the seven countries in the sample (using both narrow and broad definitions of money) both imposing and not imposing the restriction that $d_1 = d_2$. The results are presented in Table 4. At one end of the spectrum are Korea and Chile, with an insignificantly constant term in all specifications, indicating that the null of no change in velocity cannot be rejected. At the other end, for Ghana and Pakistan, all specifications indicate that velocity is not constant. More generally, it is easier to reject the null hypothesis of constant velocity for broad definitions of money (five out of seven countries) than for narrowly defined money (only two out of seven). The almost uniform poor fit of equation (14a) is another indication of the variability of velocity changes, since, where the rate of change in velocity is constant, equation (14a) would be an identity.

As with the savings rate, these results must be interpreted with care. They do not imply widespread instability in the demand for money, but rather suggest that a specification such as equation (14) is likely to be too restrictive. In particular, it seems reasonable to expect that a developing country, becoming increasingly monetized over time, would show secular

\begin{table}[h]
\centering
\begin{tabular}{lcccccc}
\hline
\textbf{Money plus Quasi Money} & Tanzania & Ghana & Pakistan & Korea & Myanmar & Honduras & Chile \\
\hline
\textbf{Average} & 0.31 & 0.25 & 0.37 & 0.31 & 0.29 & 0.21 & 0.22 \\
\textbf{Narrow Money} & 0.204 & 0.19 & 0.25 & 0.10 & 0.25 & 0.11 & 0.07 \\
\textbf{Is Velocity Constant?} & & & & & & & \\
\hline
\textbf{Money plus Quasi Money} & & & & & & & \\
\textbf{Unrestricted} & 0.11 & 0.1-4 & 0.1-4 & 0.11 & 0.06 & 0.12 & 0.17 \\
& (1.87) & (3.35) & (5.25) & (1.23) & (2.09) & (-4.72) & (1.81) \\
d. & 0.77 & 0.39 & 0.53 & 0.70 & 0.29 & 0.57 & 0.09 \\
& (1.27) & (0.90) & (1.5-4) & (1.17) & (0.62) & (1.50) & (0.13) \\
d. & 0.25 & 0.41 & -0.32 & 0.57 & 0.32 & -0.13 & 0.8-4 \\
& (1.07) & (3.87) & (-1.59) & (1.62) & (1.61) & (-0.68) & (7.83) \\
$$R'$$ & 0.10 & 0.42 & 0.16 & 0.17 & 0.12 & 0.13 & 0.88 \\
& 2.10 & 1.57 & 2.02 & 0.91 & 1.18 & 1.78 & 1.46 \\
\textbf{Restricted} (d = d.) & 0.13 & 0.41 & 0.16 & 0.11 & 0.06 & 0.13 & 0.15 \\
& (2.58) & (3.49) & (5.69) & (1.29) & (2.26) & (5.60) & (1.60) \\
d. & 0.23 & 0.41 & -0.13 & 0.60 & 0.32 & -0.03 & 0.86 \\
& (0.98) & (3.96) & (-0.66) & (2.10) & (1.72) & (-0.16) & (8.15) \\
$$R'$$ & 0.05 & 0.42 & 0.02 & 0.17 & 0.12 & 0.00 & 0.87 \\
& 1.99 & 1.57 & 1.92 & 0.90 & 1.20 & 1.77 & 1.86 \\
\textbf{Narrow Money} & & & & & & & \\
\textbf{Unrestricted} & 0.07 & 0.11 & 0.1-4 & 0.10 & 0.03 & 0.08 & 0.08 \\
& (0.93) & (2.52) & (-4.87) & (1.29) & (0.78) & (2.92) & (0.01) \\
d. & 1.08 & 0.38 & 0.69 & 0.48 & 0.26 & 0.74 & 0.20 \\
& (1.23) & (0.79) & (1.75) & (0.92) & (0.46) & (1.82) & (0.32) \\
d. & 0.37 & 0.50 & -0.40 & 0.47 & 0.62 & 0.07 & 0.82 \\
& (1.20) & (4.22) & (-1.86) & (1.5-4) & (2.5-4) & (0.35) & (8.15) \\
$$R'$$ & 0.11 & 0.46 & 0.23 & 0.14 & 0.25 & 0.01 & 0.91 \\
& 2.06 & 1.62 & 1.29 & 1.78 & 1.71 & 2.05 & 1.73 \\
\textbf{Restricted} (d = d.) & 0.10 & 0.11 & 0.15 & 0.10 & 0.02 & 0.09 & 0.07 \\
& (1.53) & (2.56) & (5.6-4) & (1.33) & (0.62) & (0.37) & (0.81) \\
d. & 0.33 & 0.50 & -0.15 & 0.48 & 0.57 & 0.17 & 0.8-4 \\
& (1.11) & (4.31) & (-0.73) & (1.89) & (2.52) & (0.82) & (9.18) \\
$$R'$$ & 0.06 & 0.46 & 0.02 & 0.14 & 0.23 & 0.03 & 0.89 \\
& 1.95 & 1.65 & 1.1-4 & 1.78 & 1.81 & 2.01 & 2.27 \\
\hline
\end{tabular}
\caption{Velocity Behavior}
\end{table}

This assumption, of course, extreme.

\footnote{When both restricted and unrestricted versions coincide, they are rejected.}
changes in the income velocity of money. The significance of the constant term in many of the specifications presented in Table 5 may well arise as much from such institutional changes as from omitting other explanatory variables such as the nominal interest rate, inflationary expectations, and exchange rate changes. However, the results indicate that future extensions to the theoretical and empirical work should include more comprehensive specifications of money demand. In summary, the assumption of constant velocity, like the assumption of fully employed resources in the growth block, appears to be a weak link in the merged model.

The remaining parameter in the monetary component of the model is $\varepsilon$, the weight of import prices in the general price level. This parameter was approximated by average share of imports in total (public plus private) consumption and is reported in Table 5.

### Trade Balance

Two external sector relationships close the system: the balance of payments identity (equation (17)) and the trade balance responses to output and real exchange rate changes (equation (18)). These two remaining parameters (in the trade balance equation) to be estimated link the "real" and "monetary" sectors. The remainder of this section outlines how estimates for the parameters $a$ and $b$ were obtained. Because the trade balance changes in sign across countries and across time, a log-linear version of equation (18) cannot be estimated. Also, to avoid the problem of heteroskedastic errors, levels were not used. Instead, the trade balance was decomposed into its components—exports and imports. The relative price and income elasticities of import demand and export supplies were estimated using some variant of:

$$\log(z_i) = \alpha_0 + \alpha_1 \log(y_i) + \alpha_2 \log(PZ/IPD_i)$$

for imports; and

$$\log(x_i) = \alpha_0 + \alpha_1 \log(y_i) + \alpha_2 \log(PX/IPD_i)$$

for exports. As for export demand, $y_i$ denotes real GDP of the industrial country. The specific form that equations (22) and (23) assume for each country varies according to the lag pattern the data reveal. These details are in Appendix II.

Proxies for $a$ and $b$ were constructed by weighting the "disaggregated" factor–factor estimates (obtained by applying generalized least squares to a one-equation model) by the sample period averages of imports and exports, respectively. The results of the estimation of import demand and export supply as well as the derivation of the relevant weights are reported in Table 6. In all seven countries, the real exchange rate elasticity, $a$, has the correct sign (negative), and an increase in domestic income worsens the trade balance—that is, $b$ is positive.

### III. Comparative Statics and Sensitivity Analysis

#### Summary of Findings in the Cross-Country Comparisons

Parametrizing the model is useful in comparing its ability to fit diverse circumstances, but is only an intermediate step in evaluating its usefulness in forecasting. The purpose of this section is to construct the policy multipliers associated with the estimated parameter values and to address two related issues—first, the sensitivity of these multipliers to various parameter values; and second, the relative precision of the forecasts for the target variables. Table 7 summarizes the point estimates of the parameters of interest and these values generate the "core" set of policy multipliers. Table 8 shows, only limited confidence can be placed in the set of policy multipliers.
estimates, since some of the parameters are unstable. Even in the instances in which the hypothesis of stability cannot be rejected, the precision of these point estimates tends to be quite low (that is, the standard errors tend to be large). For any analytical purposes, a band of parameter values must be considered. The upper and lower bounds of such a band were calculated by respectively adding to and subtracting from the point estimates one half of a standard error.

Chart 2 illustrates the configuration of the real and monetary sectors that the averages from the sample suggest. The actual numerical values of the slopes of the GG and \( MM \) schedules (and the range defined by the parameter band) are presented in Table 9 for the sample countries. The remainder of this section considers three policy exercises: an increase in domestic credit; an increase in government spending; and a devaluation.

Since the model is static, the effects of policy are evaluated by comparing the pre-shock and post-shock steady states—that is, the relevant policy multipliers are calculated.

In all cases considered, the sensitivity of these multipliers to changing parameter values is assessed. The policy implications of the model are said to be robust if the range of values assumed by the multiplier remains narrow despite changes in the parameters. This section concludes with a discussion of the relative predictability of the target variables.

### Table 8. Testing the Assumptions of the Model

<table>
<thead>
<tr>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
<th>Chile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can constant velocity ( h_c ) be rejected?</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Broad</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Narrow</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Can a constant savings rate ( h_s ) be rejected?</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

What percentage of output variation is explained by a production function?

<table>
<thead>
<tr>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
<th>Chile</th>
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<tbody>
<tr>
<td>Point estimate</td>
<td>22</td>
<td>28</td>
<td>74</td>
<td>3.94</td>
<td>20</td>
<td>9</td>
</tr>
</tbody>
</table>

### Table 9. Graphics of the Empirical Model

*Increase in Domestic Credit*

An increase in the rate of domestic credit expansion (assumed to flow freely to the private sector) creates a flow excess supply of goods. At the initial equilibrium of output, this shift induces an increase in the price level \( h' C' \), in turn,
increases money demand. However, for a given level of import prices, the domestic price rise also produces a real exchange rate appreciation and a worsening in the current account deficit. The latter is mirrored by an increase in foreign savings and an increase in investment and output growth. Ultimately, inflation rises, output growth increases, and the balance of payments worsens.  

More formally, the increase in inflation is given by

$$\frac{a(dP_D)}{a(dD)} = (0 \cdot \gamma_1 > 0$$

and, as before,

$$\gamma_1 = 1 - a(s + b) > 0$$

The change in output growth is

$$\frac{a(dy)}{a(dD)} = -1 \cdot \gamma_2 \cdot (0 \cdot \gamma_1 > 0$$

and the change in the balance of payments is

$$\frac{a(dR)}{a(dD)} = \left( b \cdot \gamma_3 - a \cdot (0 \cdot \gamma_1 < 0.$$

Using the estimated parameter values and the corresponding parameter bands, the multipliers for the three target variables are reported in Table 10. As an example, in the sample average case, a 10 percent increase in the rate of growth of credit increases inflation by about 15 percent (the range is 12-19 percent), increases output growth by 2 percent, and worsens the balance of payments by 6 percent.

Note the large discrepancy between the inflation multipliers, which are highly variable in most instances, and the relatively close values for the multipliers for growth and the balance of payments. This suggests that the usefulness of the model, and/or the desirability of using credit as a policy instrument, will depend, to a large degree, on the form of the policymaker's objective function. If the primary objective of policy is to meet an inflation target, then this framework of analysis, given the underlying parameter values, may not be the best to employ. If, however, the primary policy objective is a balance of payments or growth target, the model is more useful.

---

**Table 10. A 10 Percent Increase in Domestic Credit**

<table>
<thead>
<tr>
<th></th>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
<th>Chile</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflation multiplier</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point estimate</td>
<td>115</td>
<td>31.3</td>
<td>9.7</td>
<td>8.8</td>
<td>111</td>
<td>28.7</td>
<td>1.8</td>
<td>15.3</td>
</tr>
<tr>
<td>Lower bound</td>
<td>15.3</td>
<td>37.8</td>
<td>12.8</td>
<td>9.2</td>
<td>1-4.1</td>
<td>36.3</td>
<td>-4.8</td>
<td>18.6</td>
</tr>
<tr>
<td>Upper bound</td>
<td>11.7</td>
<td>26.4</td>
<td>5.9</td>
<td>8.4</td>
<td>12.1</td>
<td>20.2</td>
<td>0.8</td>
<td>11.8</td>
</tr>
<tr>
<td><strong>Output multiplier</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point estimate</td>
<td>1.7</td>
<td>0.4</td>
<td>16</td>
<td>0.5</td>
<td>1.9</td>
<td>1.5</td>
<td>-4.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Lower bound</td>
<td>1.9</td>
<td>0.5</td>
<td>2.8</td>
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<td>1.9</td>
<td>1.1</td>
<td>3.5</td>
<td>1.6</td>
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<tr>
<td>Upper bound</td>
<td>2.1</td>
<td>0.4</td>
<td>-4.6</td>
<td>0.5</td>
<td>2.2</td>
<td>2.2</td>
<td>5.2</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Balance of payments multiplier</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point estimate</td>
<td>-6.2</td>
<td>-10</td>
<td>-5.6</td>
<td>-7.6</td>
<td>-6.1</td>
<td>-5.4</td>
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<td>Lower bound</td>
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<td>-1.4</td>
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<tr>
<td>Upper bound</td>
<td>-6.1</td>
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<td>-5.8</td>
<td>-9.1</td>
<td>-6.2</td>
</tr>
</tbody>
</table>

*The upper and lower bands refer to adding to and subtracting from (respectively) the underlying structural parameter values the multipliers themselves by one half of a standard deviation.*

---

**Increase in Government Spending**

An increase in government spending, maintaining taxes and the rate of change in domestic credit at initial levels, shifts the GG schedule in Chart 2 to the left. The rise in fiscal spending translates into a higher deficit and, therefore, less public savings. The decline in savings reduces capital accumulation and output growth. As output growth falls, reducing the flow demand for money and creating an excess supply, inflation must rise to ensure that the money market clears. With output falling and prices rising, the impact of the fiscal expansion on the balance of payments is theoretically ambiguous and must be determined by the data. The effects of a change in real government spending on inflation growth and the balance of payments are listed below, while Table 11 summarizes the relevant set of policy multipliers.

\[ \frac{a(dP_D)}{a(g)} = \left( \frac{O}{O_1} \cdot \frac{a(b' + \gamma)}{\gamma} \right) > 0, \]

\[ \frac{a(dy)}{a(g)} = -0 \cdot 1 \cdot \gamma \cdot a < 0 \]

and

\[ -a(dR) = \frac{\alpha_1}{\gamma_3} \cdot (b' - a'(b' + \gamma) + \gamma). \]

---

16 See Khan and Montiel (1989) for a detailed discussion.
Table II. A 10 Percent Increase in Government Spending(*)

<table>
<thead>
<tr>
<th></th>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
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<tbody>
<tr>
<td><strong>Inflation multiplier</strong></td>
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<td>-4.3</td>
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<td>Upper bound</td>
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<td><strong>Balance of payments multiplier</strong></td>
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<td>Point estimate</td>
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<td>2.3</td>
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<td>Upper bound</td>
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<td>0.4</td>
<td>4.9</td>
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<td>2.3</td>
</tr>
</tbody>
</table>

(*) The upper and lower bounds refer to adding to and subtracting from (respectively) the underlying structural parameters and the multipliers by one half of their standard deviation.

\[
\frac{a(dP_o)}{a(de)} = (f_l - y) - \frac{1}{2} (x_{11} + v) > 0
\]

for growth:

\[
\frac{a(dy)}{a(de)} = -\frac{1}{2} (f_l - y) - v Y_o < 0
\]

and the balance of payments:

\[
\frac{a(dR)}{a(de)} = \frac{1}{2} (f_l - y) - v Y_o > 0.
\]

Table 12. A 10 Percent Devaluation

<table>
<thead>
<tr>
<th></th>
<th>Tanzania</th>
<th>Ghana</th>
<th>Pakistan</th>
<th>Korea</th>
<th>Myanmar</th>
<th>Honduras</th>
<th>Chile</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflation multiplier</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>6.4</td>
<td>6.1</td>
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<td>Point estimate</td>
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<td>-0.2</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td>Lower bound</td>
<td>-0.3</td>
<td>-0.1</td>
<td>-0.7</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-0.1</td>
<td>-0.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>Upper bound</td>
<td>-0.5</td>
<td>-0.1</td>
<td>-1.2</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.3</td>
<td>-0.4</td>
<td>-0.3</td>
</tr>
<tr>
<td><strong>Balance of payments multiplier</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point estimate</td>
<td>1.9</td>
<td>0.7</td>
<td>1.7</td>
<td>2.3</td>
<td>1.8</td>
<td>1.0</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Lower bound</td>
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<td>0.6</td>
<td>1.5</td>
<td>1.9</td>
<td>1.6</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Upper bound</td>
<td>2.1</td>
<td>0.8</td>
<td>1.8</td>
<td>2.7</td>
<td>1.9</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
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</table>

The upper and lower bounds refer to adding to and subtracting from (respectively) the underlying structural parameters and the multipliers by one half of their standard deviation.

Devaluation

A devaluation is both a real and a nominal shock, and consequently shifts both schedules in Chart 2. At the initial price of domestic goods, a devaluation increases the aggregate price level through an increase in the price of imports. This increases the flow demand for money. At the same time, the shift in relative prices induces lower consumption of the importable and higher production of the domestic good, leading to an improvement in the balance of payments and an expansion in the flow of money. If substitution effects are dominant, then the increase in the flow supply of money more than accommodates the rise in demand and the MM schedule shifts to the right; this effect is expansionary. If the "real" sector or the foreign component of savings is lower, owing to the improvement in the balance of payments; this reduces capital formation, halting the GG schedule to the left; this contractionary effect. As shown in Khan and Montiel (1984), the latter effect dominates, and output falls. Table 2 presents numerical multipliers of a devaluation; the partial derivatives are listed below:

\[
\frac{a(dP_o)}{a(de)} = (f_l - y) - \frac{1}{2} (x_{11} + v) > 0
\]

for growth:

\[
\frac{a(dy)}{a(de)} = -\frac{1}{2} (f_l - y) - v Y_o < 0
\]

and the balance of payments:

\[
\frac{a(dR)}{a(de)} = \frac{1}{2} (f_l - y) - v Y_o > 0.
\]
Two general characteristics are worth noting. First, the multipliers of a devaluation are relatively low when compared with those associated with credit and fiscal changes, suggesting it takes large devaluations to affect the target variables in any meaningful way. Second, as with monetary and fiscal policy—although not quite as pronounced—the effects of a devaluation on inflation are greater than those of output or the balance of payments, indicating that the desirability of either employing this framework, using devaluation as a policy tool, or both, depends on the relative importance to policymakers of the inflation target.

IV. Conclusions

The objective of this paper was to apply to a diverse group of developing countries a model that in principle is simple enough to be used operationally, in countries where data are limited and is comprehensive enough to enable a useful analysis and evaluation of growth-oriented policies to be undertaken.

The first step of this evaluation was to estimate the model and test its underlying assumptions. The estimated parameter values were in accordance with the theoretical priors, but two weak building blocks in the framework were identified: that output is assumed to expand at a rate determined by technology and endowment, and that the income velocity of money is assumed to be constant. The low explanatory power of a neoclassical production function suggests that future extensions to this framework should attempt to incorporate excess capacity, which characterizes most developing countries. Similarly, the empirical variability in velocity indicates the need for a less restrictive specification of money demand that allows for the secular effects of monetization in developing economies as well as for the impact of a variety of opportunity cost variables. Finally, the model is static and consequently does not incorporate the possibility of slow adjustment and the role of expectations in the analysis. The second part of the evaluation used the estimated parameter values to construct reduced-form multipliers and to analyze the effects of a variety of policy exercises. The robustness of the model’s policy implications were found to depend heavily on two factors.

First, robustness varies with the target variable considered. For output growth and the balance of payments, the range for multipliers is narrow, despite sizable variation in parameter values. For inflation, the range of values the policy multipliers assumed are quite broad. This suggests that the forecast errors are likely to be large if this model is employed to forecast the effects of policy changes on inflation. In effect, the usefulness of this model for policymaking (given the parameter values) depends crucially on the policymaker’s objective function. In general, the model is less useful if the primary objective of policy is to meet an inflation target, whereas if the balance of payments or growth are the principal targets, then the projected outcomes suggested by this model are more useful.

Second, the reliability of the policy implications depends on the policy instrument being considered. Based on the multipliers calculated in this paper, the effects of a devaluation (on all target variables) are less sensitive to parameter changes than the multipliers of changes in credit or fiscal policies.

While some possible extensions to the theoretical framework have already been mentioned, there are a number of ways in which the empirical work can be enriched. In particular, when maintaining a consistent methodology across countries is not a binding constraint, as it was in this paper, more efficient use can be made of the greater data availability. It would allow for more rigorous tests of parameter stability and would enable the estimation of the model as a system and a more formal assessment of forecasting errors.

In conclusion, the present model is a useful starting point for the design of growth-oriented policies, although its usefulness across countries is by no means universal. There are countries where none of the theoretical assumptions appear to be adequate—Honduras among them. Where, consequently, the effects of macroeconomic policies suggested by the model are subject to much uncertainty, others are countries where the assumptions appear to be adequate—Korea and Chile among them. Implications are relatively more robust. In general, analysis indicates that a reasonable next step in enhancing the operational usefulness of the model would be to relax some of the more rigid assumptions while attempting to keep the added degree of complexity to a minimum.

APPENDIX I

Data Definitions and Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>International Monetary Fund, International Financial Statistics' and World Economic Outlook.</th>
</tr>
</thead>
</table>

\[
y = \text{real GDP} \quad (\text{Source B}).
\]

\[
dk/y = \text{investment-output ratio} \quad (\text{Source B}).
\]

\[
L = \text{population} \quad (\text{Source B}).
\]

\[
s = \text{average private savings rate constructed by subtracting government savings from gross savings} \quad (\text{Sources A and B}).
\]
References


---, *World Economic Outlook* (Washington: International Monetary Fund, April 1988).


