Norman L. Hicks

Model of Trade and Growth for the Developing World

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(continued on inside back cover)
A MODEL OF TRADE AND GROWTH FOR THE DEVELOPING WORLD

Norman L. HICKS*

World Bank, Washington, D.C., U.S.A.

Assisted by
Peter POLLAK, Frank PINTO, Jan GUNNING, Ross WILLIAMS, Hazel ELKINGTON, Ezriel BROOK, Jos DE VRIES

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This paper describes structure, assumptions and projection results of the SIMLINK model. The purpose of this model is to simulate the trade linkages between the developed and developing world. By taking the growth expectations of the OECD countries and the price of petroleum as a starting point, the model estimates the price and volume of a series of commodities important in LDC exports. The export earnings for seven LDC regions are estimated from the commodity projections, and combined with a predetermined estimate of capital inflows to calculate import capacity. A simple growth model for each region then determines the import constrained growth rate for that region.

1. Introduction and background

The recent economic events of the past two years have made even more obvious the linkages between the world's economies. Rapid changes in commodity prices, inflation and real growth rates in the developed world have had both favorable and unfavorable impacts on the developing countries. In order to estimate the full range of all these events simultaneously, a model has been developed in the World Bank for analyzing trade linkages and growth prospects for the less developed countries (LDCs) under alternative scenarios of development and inflation in the developed world. This model, called SIMLINK [SIMulated trade LINKages], is not a new theoretical breakthrough, but a combination of existing modeling techniques into a comprehensive system which can furnish inputs for policy decisions on a timely basis. While comprehensive in nature, the model remains simple enough to be calculated quickly.

In recent years modeling work involving developing countries consisted of parallel, but often unconnected, work along three broad lines: country models,

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which concentrate on one country and assume the rest of the world as exogenously given; commodity models, which examine the market equilibrium conditions for a single commodity; and world trade models, which use a static share relationship to balance world exports and imports. An effort has been made to combine large econometric models and world trade relationships (Project LINK). This has not proven useful for studies of the developing world, since most of the models are short-term forecasting models of the developed world without the dynamics of the commodity markets and without adequate LDC models. In addition, the LINK system is too unwieldy to provide rapid solutions to policy alternatives. For a fuller discussion of the LINK system, see Ball (1973).

2. The SIMLINK approach

The approach adopted for SIMLINK is to borrow something from all three of the preceding methodologies, while keeping the level of disaggregation both meaningful and computable. The model might be thought of as being block recursive in the following steps:

1. The rates of growth of output and prices in the developed world (largely the OECD countries) are taken to be exogenously determined and outside the scope of the model. Since the LDC world has little feedback effect on the developed world, this was felt to be a reasonable assumption.

2. Commodity models are developed or adapted for the major primary exports of the developing world to project prices and volumes for these products. While varying in complexity, the emphasis has been to develop models for those commodities of greatest importance to the LDCs.

3. Exports of LDC manufactures and services are projected on the basis of historically estimated elasticities with respect to OECD growth. Prices for these items are projected on the basis of the exogenously forecasted inflation rates in the OECD.

4. The commodity trade volumes and prices so calculated are then translated into export volumes and both import and export prices, for seven LDC groups built up from data for the 40 largest LDCs (excluding OPEC members).

5. A simple growth model is developed for each LDC group which relates growth of imports to growth of output and investment. These models are then solved for the level of growth which equates total imports to total exports and an exogenously specified level of capital inflow.

At the present stage, the model contains 14 commodity models having a total of 79 structural equations, 11 equations for estimating exports of manufactures and services, and seven LDC models having eight equations each. Ignoring
detinitional equations and identities, the model has a total of 146 structural equations. This makes it easily computable and capable of producing alternative growth scenarios of the developing world on a rapid basis.

The model is estimated from past data generally using ordinary least-squares techniques. The span of data used depends largely on its availability, and the estimated coefficients tend to be based on data ranging from the past six to the past twenty years. The model is largely recursive in nature, although there is some simultaneity in certain parts, mainly related to the individual commodity models.

Section 3 contains a more detailed discussion of the structure of the model, followed by a description of some results obtained from running the model using alternative assumptions.¹

3. The model in detail

3.1. Commodity models

The model starts with a data base for 40 major LDCs who are not members of the Organization of Petroleum Exporting Countries (OPEC), and who account for approximately 85 percent of World Bank lending. These countries are aggregated together into seven groups: Mineral Producers, South Asia, East Africa (including the low-income areas of Central Africa), Mediterranean, West Africa, East Asia and Latin America. A matrix of export shares in 1972 for 35 primary products, manufactures and services was constructed for these regions. Of the 35 commodities, however, only about 15 account for a substantial share of exports of any one region.²

Consequently, commodity models were developed first for the most important commodities. In addition, some exogenous price and volume estimates have been used for a few commodities that are important to the LDCs but for which it proved difficult to construct useful models. These include commodities that in the past have been influenced by U.S. surplus policies (wheat, cotton, tobacco).

It is difficult to summarize in a small space the work done by different researchers on these commodity models. On the supply side, the models assume a distributed lag response to past prices by producers based on biological and information type lags. Other variables introduced often included prices of substitutes, dummy variables for exogenous factors affecting output, and time trends. The general form of the supply equation can be expressed as

\[ Q_j = f(P_{jt-1}, P_{jt-2}, \ldots, P_{jt-n}, Y, O_1, O_2, \ldots, O_n), \]  

1 A fuller discussion of the model is available in World Bank Staff Working Paper by Hicks (1975).

where $Q$ is the supply of the $j$th commodity, $P_j$ is its real prices lagged by an appropriate number of time periods, $Y$ is real OECD GNP in 1963 dollars, and the $O's$ are other variables. In most cases, total supply $Q_j$ is the sum of two or more supply equations estimated on a regional or country basis in order to capture the intrinsically different time lags apparent in various areas of the world. The lagged prices, $P_{j,t-2}, \ldots, P_{j,t-n}$, were often dropped in favor of simply lagged supply, $Q_{j,t-1}$, thus introducing the assumption of a distributed lag having geometrically declining weights. In some cases, such as rice, where world prices are affected mostly by exports and where a large part of production is not exported, the model deals only with exports rather than total world production. The prices of substitutes were important in only a few commodity models: rice (wheat), tin (aluminum) and fats and oils (other fats and oils).

The price formation or demand side of the models was, generally speaking, estimated in two different ways. In some models, prices were estimated to be a direct function of world supply and demand, giving an equation of the following form:

$$P_j = f(Y, Q, O_1, O_2, \ldots, O_n),$$

where $Y$ is the OECD GNP in constant 1963 U.S. dollars, $Q$ is the total of either world production or world exports, and the other variables ($O_j$) often include the prices of substitutes, dummy variables, and the rate of world inflation. An alternative to the simple direct price formation equation (2) above is the slightly more complex stock-adjustment approach. In this approach, the demand vector determines consumption of the commodity in question. Inventories or stocks are defined as current production less current consumption plus stocks from the previous year, and real prices are determined by the level of stocks (which may be expressed as an inverse relationship and/or as a ratio to total production). This three-equation method of determining prices can be summarized as

$$C_j = f(Y),$$

$$S_j = S_{j,t-1} + Q_j - C_j,$$  \hspace{1cm} (4)

$$P_j = f(S_j),$$  \hspace{1cm} (5)

where $C_j$ stands for consumption and $S_j$ for end year stocks, with only the lagged variables subscripted for time. As before, other variables may be included in the consumption and price equations, although these are not included in the notation above. It can also be readily seen that eqs. (3) to (5) can be

3For a discussion on the use of the lagged endogenous variable as a transform of the distributed lag equation, see Griliches (1967, p. 16).
reduced to eq. (2) by substitution, so that by using eq. (2) one is merely estimating directly a reduced form of the stock-adjustment model.

The $P_j$ are estimated in terms of real commodity prices, that is, nominal prices deflated by an index of world inflation. Since the supply equations are also related to real, rather than nominal prices, most of the commodity models are found to be neutral in their response to changes in world inflation. In the estimation of certain models, however, the index of world inflation was found to be an important independent variable. This occurred in the models for coffee, sugar and rice. In general, the higher the rate of world inflation, the lower the real prices of these commodities. This appears to confirm an often stated hypothesis that LDCs suffer during periods of world inflation because the prices of some of their exports fail to keep up with other prices, although it fails to explain why. It should also be pointed out that the lag is somewhat temporary, and that eventually real prices tend to adjust. This suggests that perhaps sellers lack perfect vision and fail to effectively note other world prices, or that sales are made in advance of production and delivery, and that an acceleration of inflation rates is generally unexpected.\footnote{For a more detailed description of the actual commodity models, see Hicks (1975).}

<table>
<thead>
<tr>
<th>Group</th>
<th>$E_y$</th>
<th>$E_d$</th>
<th>$s'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric - Food</td>
<td>0.5</td>
<td>-0.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Agric - Non-food</td>
<td>0.3</td>
<td>-0.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Minerals and metals</td>
<td>1.1</td>
<td>-0.4</td>
<td>6.0</td>
</tr>
</tbody>
</table>

For primary products not covered by the existing commodity models, a more general formulation has been used to project volumes and prices. First, the remaining commodities are aggregated into three broad classes; food, non-food agriculture and minerals and metals. The percentage increase in the prices of these 'residual' commodity groups is estimated using

$$p' = \frac{y' E_y - s'}{E_d},$$

where $p'$ is the percentage increase in price for the $i$th residual commodity class, $y'$ is the growth rate of OECD real GNP, $s'$ is an exogenous estimate of the growth rate of supply, and $E_y$ and $E_d$ are the respective income and price elasticities. The values of the parameters used in the model for this equation are given in table 1, and are based on estimates provided by the Commodities and Export Projections Division of the World Bank.
3.2. Manufactured exports

For manufactured exports from the LDCs, a slightly different approach is utilized compared to the primary product models. First of all, since the LDCs have a relatively small share of total manufactured export trade, we assume that reconciliation of supply and demand does not occur via the price mechanism. Instead, total demand for LDC manufactured exports by the OECD and Socialist countries is allocated among the LDC groups according to shares based on exogenous initial estimates of the growth of supply. To estimate demand elasticities, log-log regressions were run between constant price OECD and Socialist groups GDP and imports by these groups of manufactures from all LDCs, regardless of source. (The data for these regressions is based on the U.N. trade data, and covers the years 1965–72.) As summarized in table 2, these regressions reveal a fairly high elasticity for import demand by the developed countries, ranging from 2.2 to 5.4.

<table>
<thead>
<tr>
<th>Region</th>
<th>$E_y$</th>
<th>$t$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan/Oceania</td>
<td>2.24</td>
<td>7.4</td>
<td>0.885</td>
</tr>
<tr>
<td>Western Europe</td>
<td>2.62</td>
<td>9.9</td>
<td>0.933</td>
</tr>
<tr>
<td>North America</td>
<td>5.36</td>
<td>10.9</td>
<td>0.943</td>
</tr>
<tr>
<td>Socialist</td>
<td>2.27</td>
<td>6.3</td>
<td>0.849</td>
</tr>
</tbody>
</table>

The elasticities estimated in table 2 have to be adjusted for two factors: first, they are for 68 LDCs including Hong Kong, Taiwan and Singapore, and not for the 40 LDCs used in our sample. Secondly, the exports of manufactures of the LDCs include some exports to other LDCs, while the demand elasticities refer to only imports of the developed world. In order to adjust these elasticities so as to avoid overstating export demand, the export growth for the 40 LDCs was calculated for the 1965–72 period (12.2 percent per annum) and compared with the OECD import demand growth from all LDCs for the same period (15.7 percent per annum) both in constant prices. The ratio of the two growth rates (0.777) was used to adjust the original elasticities downward.

An estimate of the supply of manufactured exports from the LDCs is used to arrive at the market shares of the exporting regions. These estimates are based on historical growth rates in constant prices for the period 1965–72. For two regions, South Asia and East Africa, political events in the 1970-72 period cause the growth rates of manufactured exports to be very low, so the growth rate for the period 1965–70 is used in its place.

5Manufactured exports are here defined as SITC 5-8 less SITC 68.
3.3. Service exports

Exports of services are another very important part of export earnings in LDCs, but often ignored in trade models due to the lack of data on an origin-destination basis. Data for non-factor service exports was obtained from the World Bank’s Socio-Economic Data Bank, in current prices for each region for the period 1964–72. It was assumed, once again, that the OECD is the principal source of demand for these services, which includes tourism, travel and shipping services. The results are shown in table 3.6

<table>
<thead>
<tr>
<th>LDC group</th>
<th>Service exports to total exports</th>
<th>GNP</th>
<th>E</th>
<th>t</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral producers</td>
<td>18.2</td>
<td>W. Europe</td>
<td>1.006</td>
<td>16.09</td>
<td>0.974</td>
</tr>
<tr>
<td>South Asia</td>
<td>7.2</td>
<td>Total OECD</td>
<td>0.448</td>
<td>8.54</td>
<td>0.947</td>
</tr>
<tr>
<td>East/Central Africa</td>
<td>26.9</td>
<td>Total OECD</td>
<td>1.311</td>
<td>8.55</td>
<td>0.911</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>35.9</td>
<td>W. Europe</td>
<td>1.244</td>
<td>15.10</td>
<td>0.970</td>
</tr>
<tr>
<td>West Africa</td>
<td>27.2</td>
<td>Total OECD</td>
<td>1.920</td>
<td>15.45</td>
<td>0.971</td>
</tr>
<tr>
<td>East Asia</td>
<td>17.8</td>
<td>Japan and</td>
<td>0.959</td>
<td>4.59</td>
<td>0.742</td>
</tr>
<tr>
<td>Latin America</td>
<td>23.6</td>
<td>Japan and</td>
<td>1.288</td>
<td>28.89</td>
<td>0.992</td>
</tr>
</tbody>
</table>

The estimated equations all show good fits with respect to their demand vectors, and all of the income elasticities are significant at the 95 percent confidence level or higher. It is interesting to note the wide differences in elasticities, from 0.45 for South Asia to 1.9 for West Africa. Areas with a highly developed tourism sector seem to have higher elasticities than those without, and this is probably the major factor explaining these regional differences. The 1.9 elasticity for West Africa appears to be unusually high and was probably influenced by the very rapid development of tourism in this region during the past few years. Consequently, this coefficient was lowered to 1.4 for projection purposes in the model.

3.4. Prices and inflation

An exogenous estimate of the rate of world inflation is given to the model in terms of a general index of international prices.7 This index is used as a current price index for the exports and imports of manufactures and services. The con-

6Unlike the manufactured export regressions, the non-factor service regressions are done in current prices. In the model, the projected current price service exports are deflated by the implicit GNP deflator of the OECD countries to convert to constant prices.

7Basically the International Price Index (IPI) constructed by the staff of the World Bank.
stant price estimates of the commodity models are converted to current price indices using the same general index. By using 1972 weights for exports by commodity type and imports by end-use, a weighted import and export price index is calculated for each of the seven regions. It should be noted that the primary commodity prices enter into both the export and import price indices, since LDC imports include basic foods and intermediate products.

3.5. Regional growth models

At this point SIMLINK has produced for each of its seven regional groups a weighted price index for both exports and imports, and a volume index for exports. Capital inflows are given to the model based on exogenous estimates from country analysis of creditworthiness and capital availabilities. The term 'capital' used here is defined as the net transfer of resources from foreign savings, or the so-called 'gap' between imports and exports of goods and non-factor services. This equals, by definition, the gap between investment and domestic savings.

The indices for prices and volumes are used to project export prices, import prices and exports in constant 1967-69 U.S. dollars for each of the regions. The constant dollar exports are adjusted for changes in the terms of trade to produce 'exports-adjusted'. This is necessary so that they reflect true import purchasing power. The adjusted exports \( X_{ADJ} \) for each region are defined as

\[
X_{ADJ} = \frac{XPI}{MPI} X, \quad (7)
\]

(all variables are for period \( t \) and region \( i \)) where \( X \) represents exports in constant prices, and \( MPI \) and \( XPI \) are the relevant regional import and export price indices, respectively. Total import supply or capacity \( (M_s) \) is then defined as the sum of \( X_{ADJ} \) and the available capital inflow or resource gap \( (RG_a) \),

\[
M_s = X_{ADJ} + RG_a. \quad (8)
\]

Much discussion has taken place concerning the relationship between imports and growth, and the role of foreign exchange versus other constraints in the developing world. Some authors have contended that there is no relationship, or that increases in imports (particularly those derived from increases in capital inflows) result in lower savings, higher consumption and no appreciable increase in growth [Griffin and Enos (1970)]. Such analyses have tended to examine imports in the aggregate, and their relationship to total GNP. In fact, LDC imports are a very non-homogenous mixture of capital goods, intermediate products and raw materials necessary for the production process, and foodstuffs and other consumer goods that are not related to capital formation and pro-

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8Chenery and Strout (1966), Fei and Ranis (1968), Bruton (1969).
duction. The imports of foodstuffs are often inversely correlated with growth, since they often supplement declines in domestic agricultural production. In most of the better country models, imports are disaggregated in some fashion, usually by end-use classes, and related either to sector outputs or some part of GNP expenditure. Following the same approach, a general model of growth and imports was formulated along the following lines. First, industrial production is assumed to be a linear function of total GDP, \( Y_{IND} = a_1 + b_1 GDP \) \( [\text{value added, industry}] \). (9)

Investment is a function of the increment to GDP and lagged investment, on the style of the flexible accelerator where the desired capital stock adjusts with a distributed lag. In this case the implied lag is of the Koyck type, or one having geometrically declining weights,

\[ I = a_1 + b_2 (GDP - GDP_{t-1}) + b_2 I_{t-1} \]  

[gross investment]. (10)

Imports of capital goods are then related linearly to investment, intermediate goods to value added in industry, and imports of fuels and non-factor services to total GDP, or

\[ MCAP = a_3 + b_3 I \]  

[imports, capital goods], (11)

\[ MINT = a_4 + b_4 Y_{IND} \]  

[imports, intermediate products], (12)

\[ MFUEL = a_5 + b_5 GDP \]  

[imports, fuels], (13)

\[ MSER = a_6 + b_6 GDP \]  

[imports, non-factor services]. (14)

Initially, it was proposed that imports of food should be related to private consumption and to agricultural production, and imports of other consumer goods to private consumption expenditures. In almost all cases, however, the results tended to be statistically non-significant or have the 'wrong' signs, since in the case of food it should be expected that food imports vary inversely with food production, but directly with consumption. It appears that both of these import categories are heavily influenced by the level of foreign exchange available for imports. The proxy for foreign exchange availabilities was taken to be the actual level of imports of goods, so that the combination of imports of food plus consumer goods was simply related to this variable, \( MCF = a_7 + b_7 MG \). (15)

All \( a \)'s are constant terms, and all \( b \)'s are estimated coefficients.

In South Asia and East Africa exogenous estimates of \( MCF \) are used, based on a projected increase in foodgrain imports and constant imports of other foods and consumer goods. In the base case, a growth rate of 3.5 percent is used for foodgrain imports in both regions.
Total imports of goods are defined as

\[ MG = MCAP + MINT + MFUEL + MCF, \]  

(16)

and total imports as

\[ M_d = MG + MSER, \]  

(17)

where the \( d \) subscript indicates an estimate of import demand, as opposed to the initial import supply, \( M \).

In the *availabilities* version of the model an equilibrium condition is enforced such that import demand must equal import supply, or

\[ M_d = M_s. \]  

(18)

The model then solves for that level of GDP that satisfies this equilibrium condition. The predetermined capital flow availability then determines an endogenous level of GDP and GDP growth on an annual basis.

In the *requirements* version, target growth rates \( (g) \) of GDP are specified for each region, or

\[ GDP_t = GDP_{t-1}(1+g). \]  

(19)

The level of capital inflow necessary or required for this level of GDP is determined as the difference between import demand and import supply,

\[ RGr = M_d - XADJ. \]  

(20)

Hence the requirements model drops eqs. (8) and (18) from the model and uses (19) and (20) to determine an endogenous capital flow from a predetermined growth level. The *additional* capital requirements are defined as the difference between the capital available \( (RG_a) \) and that required to attain the growth targets \( (RGr) \).

Domestic saving \( (GDS) \) can be determined residually from the identity

\[ GDS = I - RG. \]  

(21)

This residual determination of savings is the necessary consequence of the structure of the model which considers foreign exchange, rather than savings, capital or labor, as the binding constraint limiting growth in the developing world. While this is a serious simplification, since the model is being used to project over a period when deteriorating terms of trade and low export volume growth will squeeze foreign exchange earnings, it is considered to be acceptable.
The *ex-post* calculation of the savings rate allows for the qualitative judgement that such rates are realistic, and that a savings constraint is not binding.

In general, these equations were estimated on the basis of pooled cross-section time series data for the period 1966 to 1971, although the exact time period differs slightly from region to region. The shortness of the time period used is a product of the shortage of data on imports by end-use. The data used here is derived from the United Nations Trade Year-book data, allocated to end-use classes on a two-digit SITC level. The data for individual countries in each region was pooled together for estimates of the region, using the technique of including an individual constant term of each country. This increases the degrees of freedom and offsets the shortness of the observation period. While the $R^2$ of the estimated equations are low, almost all of the estimated coefficients are significant at the 95 percent level. The low $R^2$ can be attributed in part to the fact that cross-sectional data is being used. Much higher correlation coefficients are found in the regressions for imports of services, since these are based on straight time series data.\footnote{Details of the estimated regressions are available from the author.}

4. Projection results

Results for the base case are shown in table 4, in terms of growth rates, 1974–80. The projections for the base case assume:

(1) OECD growth of about 4.1 percent per annum, 1974–80,\footnote{The projected OECD growth rates used in SIMLINK are derived from Celasun and Pinto (1975).}

(2) petroleum price level in constant prices at $9.40 (1974 $),

(3) net capital flows averaging $25 billion per year for the 40 sample countries.

The overall growth rate of export prices is projected at 6.1 percent per annum, somewhat less than the 7.1 percent projected for import prices. This general deterioration of the terms of trade reflects a movement from the historically very high commodity prices of 1974, which has a greater impact on LDC exports than on imports. This deterioration is relatively greater for those regions having a higher percentage of their exports in primary commodities. The overall growth of export volume is projected at 7.1 percent per annum, but this is somewhat unevenly divided between the low-income countries at 5.0 percent and the middle/high-income countries with 7.4 percent. The fall in the terms of trade, combined with a trend for capital flows to grow less rapidly than imports, causes the import growth rate to be substantially lower than the export-volume growth (4.4 versus 7.1). The overall rate of GDP growth consistent with the projected import growth is 4.4 percent for all LDCs, but this is broken down into 2.5 percent for the low-income countries and 4.9 percent for the middle/high.
This represents growth substantially below the United Nation Development Decade II (DD-II) targets of 6 percent for the developing world.

In the 'requirements' version of the model, the imports and capital flows necessary to sustain 5 percent growth in the low-income countries and about 6 percent for all LDCs for the 1974–80 period is examined. This implies a growth rate of only about 5.8 percent for the entire decade 1970–80, again somewhat short of the DD-II targets. The gap in terms of the additional capital required for this target growth rate represents an average inflow of $13.0 billion per year, of which $2.0 billion per year would be for the low income countries.¹³

Table 4

<table>
<thead>
<tr>
<th>Region</th>
<th>GDP</th>
<th>Imports</th>
<th>Export adjusted</th>
<th>Export volume</th>
<th>Export prices</th>
<th>Import prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>2.5</td>
<td>2.9</td>
<td>4.5</td>
<td>5.0</td>
<td>6.3</td>
<td>6.7</td>
</tr>
<tr>
<td>South Asia</td>
<td>2.5</td>
<td>3.0</td>
<td>4.7</td>
<td>4.9</td>
<td>6.3</td>
<td>6.5</td>
</tr>
<tr>
<td>East Africa</td>
<td>2.4</td>
<td>2.2</td>
<td>4.2</td>
<td>5.6</td>
<td>5.8</td>
<td>7.2</td>
</tr>
<tr>
<td>Middle/high income</td>
<td>4.9</td>
<td>4.6</td>
<td>6.4</td>
<td>7.4</td>
<td>6.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Mineral producers</td>
<td>4.5</td>
<td>4.2</td>
<td>4.4</td>
<td>4.6</td>
<td>7.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>5.4</td>
<td>6.3</td>
<td>7.9</td>
<td>7.2</td>
<td>7.8</td>
<td>7.1</td>
</tr>
<tr>
<td>West Africa</td>
<td>4.2</td>
<td>3.9</td>
<td>3.4</td>
<td>5.0</td>
<td>5.4</td>
<td>7.0</td>
</tr>
<tr>
<td>East Asia</td>
<td>5.3</td>
<td>5.0</td>
<td>6.2</td>
<td>9.0</td>
<td>4.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Latin America</td>
<td>4.8</td>
<td>3.3</td>
<td>6.4</td>
<td>7.6</td>
<td>6.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>4.4</td>
<td>4.4</td>
<td>6.2</td>
<td>7.1</td>
<td>6.1</td>
<td>7.1</td>
</tr>
</tbody>
</table>

¹³ All capital flow data is expressed in current dollars on an annual average basis for the period 1975–80. The term 'capital' used here means the net transfer of foreign resources or resource flow.
two growth rates is about 0.9.\textsuperscript{14} The reduction in growth appears to fall heavily on the low-income countries; their growth rates decline proportionally more between the high and low OECD cases. Since population growth in the low-income countries is about 2.4 percent per annum, the low OECD growth case implies negative per-capita income growth for these countries.

Another possible way in which our base projections may change is in the estimate of the oil price. In case D, a simulation of the model with $7.00 oil is shown.\textsuperscript{15} This low oil price results in an increased growth rate over the base case since it increases the purchasing power of export earnings. Lower OPEC demand for LDC exports, however, has a slight offsetting effect, as do the lower earnings of those LDCs in our sample who export small amounts of petroleum. The net result, however, is an increase in the growth of all LDCs from 4.4 percent in the base case to 4.8 percent but with the major impact falling on the low-income countries. Their growth rates increase from 2.5 to 3.2 percent as opposed to the middle/high-income group which only increase from 4.9 to 5.3 percent. This implies that a $1.00 change in the 1980 real price of oil would raise LDC growth by about 0.17 percentage points. Even if oil prices were to drop to $3.00 or below, the effect would be insufficient to restore 6 percent growth to the LDCs by itself. A simulation of the model with the price of oil dropping immediately to $3.00 in 1976, as opposed to a gradual decline

\begin{center}
Table 5
\end{center}

\begin{center}
\begin{tabular}{lccc}
\hline
Case & Low income & Middle/high income & Total \\
\hline
(A) Base case & 2.5 & 4.9 & 4.4 \\
(B) High OECD growth & 3.0 & 5.5 & 5.0 \\
(C) Low OECD growth & 2.0 & 4.4 & 3.8 \\
(D) Low oil price & 3.2 & 5.3 & 4.8 \\
(E) High manufactured exports & 2.8 & 5.5 & 4.9 \\
(F) High OPEC imports & 3.3 & 5.1 & 4.7 \\
\hline
\end{tabular}
\end{center}

\textsuperscript{*}Base case (A): OECD growth 4.1 percent, oil price $9.40 (in 1974$), LDC manufactured exports grow at 13 percent per year, LDCs' share of OPEC imports = 5.9 percent. Sensitivity cases: Identical to case A except with (B) 4.7 percent OECD growth, (D) oil price dropping to $7.00 by 1980, (E) manufactured exports growing 17 percent per year, (F) OPEC import share rising to 8.5 percent by 1980.

\textsuperscript{14}The absolute reduction is on the order of about one to one, but the higher initial growth rate in the LDCs causes the elasticity to be less than one. This result is also sensitive to the distribution of growth among OECD regions.

\textsuperscript{15}This assumes a gradual decline to $7.00 (1974 $) by 1980. The effect would be different if the price were to drop immediately to $7.00 in 1976.
to that level in 1980, produces only a 5.2 percent growth rate for the LDCs. The complete impact of such a decline is difficult to estimate with SIMLINK since the impact of this price decline on the OECD countries is not clear. In addition, the probability of such a price decline occurring is considered highly unlikely, unless it took the form of a price discount or rebate scheme applicable only to the LDCs.

The developing world could be substantially assisted by schemes which would result in a more rapid growth of their exports. As shown in table 5, SIMLINK has been run with two modifications along these lines: an assumption of higher manufactured exports to the OECD and an assumption of greater LDC exports to the OPEC countries.

The higher manufactured exports run (case E) assumes a 17 percent growth rate of manufactured exports versus the 13 percent used in the base case. This would be feasible provided the LDCs would select policies designed to promote exports and the OECD countries would make tariff and other concessions to LDC trade. The effect is to raise the export volume growth from 7.1 percent to 8.2 percent for all LDCs during the 1974–80 period, and the growth rate of GDP from 4.4 to 4.9 percent. The effect, however, is distributed rather unevenly, with the middle, high group receiving most of the benefits since they are already the predominant exporters of manufactures and have the greatest potential for expansion. Their growth of exports rises from 7.4 to 8.6 percent, and their GDP from 4.9 to 5.5 percent, while the low-income group shows a rise from 5.0 to only 5.3 percent for export volume, and 2.5 to 2.8 percent for GDP.

Another possible way for the developing world to expand its exports is through expanded trade with the OPEC countries. While the LDCs are assumed in the base case to have a fixed (5.9 percent) share of incremental OPEC import demand (excluding military goods), case F assumes that this will rise to 8.5 percent by 1980. The result is a substantial increase in export and GDP growth rates for both LDC income groups. The average growth rate for all LDCs rises from 4.4 percent in the base case to 4.7 percent in this case. This is almost as beneficial as the lower oil-price simulation, but has a greater impact on the low-income countries. The growth rate of this group rises to 3.3 percent, compared with 2.5 percent in the base case and 3.2 percent in the low oil-price case. Because of the proximity of the major OPEC countries to the low-income areas of South Asia and Africa, increases in OPEC trade have more impact in these areas than on the middle, high-income areas.

The impact of alternative assumptions on the need for additional capital to attain the DD-II target, as shown in table 6, tend to reflect a mirror image of the impact on growth rates shown in table 5. A movement which permits a higher growth rate naturally reduces the amount of capital necessary to raise that growth.

The capital requirements described here are additional to what is presently felt to be available, and is based on a sample of the 40 major LDCs. Conversion of these numbers to totals for the entire developing world can be approximated by multiplying by a factor of 1.4.
rate to the 6 percent target. The total required in the base case is $13 billion per year, an amount in excess of what could be reasonably expected to come from either official or private sources. This number is somewhat deceptive, since it involves $2.0 billion for the low-income countries and $11.0 billion for the middle/high-income countries. Since the middle/high-income countries achieve a 4.9 percent growth rate in the base case, the $2 billion annual requirement of the low-income countries is a more urgent requirement than the $11 billion requirement of the middle/high group.

The higher OECD growth rate saves the LDCs about $4 billion per year, and the lower OECD growth rate increases the capital requirement by about the same amount. The implied trade-off between capital and OECD growth works out to about a savings of $6.7 billion in capital requirements for every increase of one percentage point in the OECD growth rate. The lower oil price ($7.00 in 1980) saves about $3 billion per year, including $500 million annually in the low-income countries. The trade-off here indicates that a $1.00 drop in the real 1980 price of petroleum would save about $1.3 billion annually for all LDCs.

Table 6
Annual average of additional capital requirements, 1975–80 (millions current $). a

<table>
<thead>
<tr>
<th>Case</th>
<th>Low income</th>
<th>Middle/high income</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Base case</td>
<td>2.0</td>
<td>11.0</td>
<td>13.0</td>
</tr>
<tr>
<td>(B) High OECD growth</td>
<td>1.6</td>
<td>7.4</td>
<td>9.0</td>
</tr>
<tr>
<td>(C) Low OECD growth</td>
<td>2.4</td>
<td>14.3</td>
<td>16.7</td>
</tr>
<tr>
<td>(D) Low oil price</td>
<td>1.5</td>
<td>8.4</td>
<td>9.9</td>
</tr>
<tr>
<td>(E) High manufactured exports</td>
<td>1.9</td>
<td>8.1</td>
<td>10.0</td>
</tr>
<tr>
<td>(F) High OPEC imports</td>
<td>1.5</td>
<td>10.0</td>
<td>11.5</td>
</tr>
</tbody>
</table>

aCapital requirements shown here are additional to what is presently thought available and based on 40 sample LDCs.

A one percentage point increase in the growth rate of manufactures exports appears to save the LDCs about $750 million annually, mostly in the middle/high-income group.

Sensitivity tests undertaken with SIMLINK indicate that these trade-off effects are roughly linear when the variations are not extreme, and the combined effects are additive. Consequently, the combined effects of different ‘packages’ of policy measures can be deduced by adding together the incremental effects of each individual policy measure. For instance, the combined effect of higher manufactured goods exports, high OECD growth and low oil prices would have the cumulative effect of lowering capital requirements by $10.1 billion (4.0 + 3.1 + 3.0).

There are, of course, multiple combinations of policy changes that could
produce the same results, and the variations shown here are merely illustrative. Consequently, the sensitivity of the model to changes in OECD growth rates, capital flows and exports has been recast in terms of the amount necessary to raise the overall growth rate of the LDCs by one percentage point. This is summarized in Table 7.

An increase of one percentage point in the LDC overall growth rate can be had by either increasing the OECD growth rate by one percentage point, raising capital flows by $6.7 billion per year, reducing the price of petroleum by $6.00 in 1980, increasing the LDC export of manufactures growth rate by 8.0 percentage points, or increasing the LDC share of OPEC imports by 8.7 percentage points. (Capital flows are expressed in current dollars, oil prices in 1974 dollars.) Though these magnitudes are somewhat inexact since they do not consider the distribution of the effects between low- and middle/high-income groups, they nevertheless indicate the scope of trade-offs in policy instruments.

<table>
<thead>
<tr>
<th>Policy instrument</th>
<th>Measured in</th>
<th>Amount of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNP growth in</td>
<td>Average growth rate 1974-80</td>
<td>+1.10</td>
</tr>
<tr>
<td>OECD countries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital flows</td>
<td>Current $ billions/year</td>
<td>+6.7</td>
</tr>
<tr>
<td>to LDCs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price of petroleum</td>
<td>Real 1980 price in 1974 $</td>
<td>-6.00</td>
</tr>
<tr>
<td>LDC exports of</td>
<td>Annual average growth rate</td>
<td>+8.0</td>
</tr>
<tr>
<td>manufactures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDC share of</td>
<td>Percentage of total OPEC imports in</td>
<td>+8.7</td>
</tr>
<tr>
<td>OPEC imports</td>
<td>1980</td>
<td></td>
</tr>
</tbody>
</table>

5. Conclusions

The alternative simulations of the SIMLINK model illustrate the usefulness of the model in analyzing the prospects of the developing world and the impact of alternative policies of the OECD and OPEC countries. The sensitivity illustrations of the model are probably more useful than the actual absolute numbers projected, since the latter are undoubtedly subject to a certain range of error.

One main conclusion of the model appears to be that the slackening of growth in the OECD countries has proven to be more detrimental to the LDCs than the direct effects of the higher price of petroleum. Whether the indirect effects
of the higher price of petroleum have caused the lower growth rates in the OECD is, of course, outside the scope of this model. As a consequence, the LDCs are faced with the prospect of growth rates during the 1970s substantially below the level achieved in the previous decade, and below the targets suggested by the United Nations Development Decade II. The deterioration of the situation in the low-income countries is particularly critical, since the prospect for these countries is for little or no increase in per-capita output during the rest of the decade. Policies aimed at expanding LDC exports must be carefully chosen, since they are apt to benefit mostly the middle/high-income group, which has a less severe problem and has greater access to private capital markets. The low-income countries, in addition to having a more severe problem, have far fewer options, and are more dependent on positive policies in the OECD and OPEC countries for relief.

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