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Global Modeling in The World Bank, 1973-76

Wouter Tims
Jean Waelbroeck

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First printing December 1982

Library of Congress Cataloging in Publication Data

Tims, Wouter.
Global modelling in the World Bank.

(World Bank staff working papers ; no. 544)

Bibliography: p.

1. Economic history--1971- --Mathematical models.
2. Economic forecasting--Mathematical models. 3. World
Bank. I. Waelbroeck, Jean. II. Title. III. Series.
HC59.T5168 1982 330.9'00724 82-17587
ISBN 0-8213-0109-8

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Abstract

This paper reviews the first stage of global modeling in the World Bank. It summarizes the models and analytical methods which were developed for that purpose between 1973 and 1976. These were in turn based on a large body of research and modeling which had taken place before 1973, and the work has progressed since. However, the first phase of development remains fairly distinct, and is of interest in relation to the impact of the sharp rise in petroleum prices on global economic trends in the mid-1970s.

The system was used to generate projections for the world economy to compare alternative policies, mainly in international trade and capital flows. The policy conclusions were discussed within the Bank and with other international agencies, and it is worth looking back to evaluate both the analysis and the conclusions which followed. This evaluation is of particular interest because of the large disturbances which occurred in the world economy during these years and because of the wide differences which existed with regard to the international policies that ought to have been pursued.

The lessons from this review have already been taken into account in the formulation of new tools of analysis. The system described in the chapters which follow was designed in particular to trace the international transmission of economic change in the world economy; the system therefore did not sufficiently address issues of economic and social policy within country groups and countries, particularly those related to employment and the distribution of income, and sectoral growth and policies. The current stage of the World Bank's global modeling efforts (second phase) treats these issues more explicitly, within the framework of a coherent global analysis.

Notwithstanding its shortcomings, the global analytical system has demonstrated its value throughout the years and has become an essential feature of the Bank's economic work. It will be needed as long as the international economic outlook remains characterized by a high degree of uncertainty, and as long as the Bank is called on to give its views on current international negotiations on future trade and capital flow regimes.

Table of Contents

	<u>Page Nos.</u>
Chapter I: INTRODUCTION	1
Introduction	1
Bank Economic Work: Some Basic Features	3
Chapter II: COUNTRY AND COMMODITY MARKET MODELS	10
Commodity Price and Quantity Forecasts	20
Chapter III: THE ANALYSIS OF CAPITAL FLOWS AND DEBT	26
The General Framework	26
Balance-of-Payments Data	27
The World Bank Debtor Reporting System (DRS)	30
Capital Flow Components	32
Links to Other Data Systems	33
The Sources of Capital Flows	35
Types of Flows	35
Developing Countries as Groups of Recipients	38
Adjustment to Donor Data	39
Comparison of Estimates	43
The Method for Projecting Flows of Capital	45
Official Development Assistance	48
Allocating ODA Flows	51
Other Official Flows	53
Total Official Flows	54
Private Direct Investment	54
Borrowing and Debt	55
Creditworthiness	58
Capital Markets	62
Chapter IV: AN OVERVIEW OF THE GLOBAL MODELING SYSTEM	65
Forecasting and Bank Operations: The Need for Consistency and Sensitivity Analysis of Projections	65
Alternative Modeling Strategies	68
An Overview of the Model System	71

Table of Contents (Cont'd)

	<u>Page Nos.</u>
Chapter V: THE SIMLINK MODEL AND THE DEVELOPING COUNTRIES	80
Background	80
The SIMLINK Approach	82
The Model in Detail	84
Properties of the Model	103
Dynamic Multipliers of SIMLINK	112
Chapter VI: EXOGENOUS INPUTS FOR THE SIMLINK FRAMEWORK	116
Projections of Real Growth	117
Projections of Price Development	122
Chapter VII: THE SIMRICH MODEL: ESTIMATION OF THE IMPACT OF HIGHER OIL PRICES ON THE GROWTH OF THE DEVELOPED COUNTRIES	128
Background	128
The SIMRICH Global Framework	129
Description of the Model	132
Results	154
Conclusions	164
Chapter VIII: ALTERNATIVE POLICIES AND THE GLOBAL ANALYSIS	166
International Policies	167
Policy of OECD Countries	169
Policy of OPEC Countries	170
Policy in Oil-Importing Developing Countries	172
Objectives	173
Sensitivity	173
OECD Growth	175
Export Growth	177
Aid Flows	178
Reliability	181
Appendices	
References	

Chapter I

INTRODUCTION

Introduction

The year 1973 was a turning point in the pattern of world economic expansion: since then, structural changes in the relations between groups of countries and also within each of these have taken place, continuing to the present day and casting long shadows into the future. It is not by coincidence that this occurred after a long period of sustained and unprecedented economic expansion which started in the late 1950s. The period ended when the expansion had generated its own manageable consequences of inflation, exchange rate disequilibrium and excess demand.

Simultaneously, suppliers of scarce commodities essential for the expansion of the world economy had become increasingly aware of their market strength, particularly in the early 1970s; the oil price increase of 1973 reflected a new concentration of international market power. These shocks might have been absorbed more readily, had the long expansion been less pronounced and not ended in a multitude of internal problems. To what extent those problems - which were not altogether unforeseen - could have been solved through timely international action is now a mute question; there is not much relevance in wondering whether the prospects for the world economy could have been better or less uncertain.

The occurrence of the disturbances around 1973 coincided with an increased awareness that some of the world's essential resources for development were finite. The long-term prospects for economic expansion were more and more seen to be influenced by resource scarcities, whether those be raw materials and energy, land, or clean air and water. These new notions, together made clear

that the issues were not just temporary phenomena, but had a bearing on the long-run outlook for the world economy. Suitable policies therefore could only be those which helped the necessary restructuring through long-term adjustment, or would sustain countries temporarily in order to permit an orderly adjustment process. The efforts to establish a New International Economic Order reflect the former; the measures to set up emergency funds or special financial facilities are examples of the latter.

The analysis of the new situation was difficult at the time. There were no precedents for these developments and the issues were many, complex and intertwined. Existing tools or analysis were inadequate to describe adequately what had happened or was still taking place with sufficient regard for the role of each group of countries or commodity markets. As the capability to trace through the events was gradually established, it also became clear that a longer-term perspective than had been customary in the past was essential. This posed questions and requirements to the analysts of the international economy which greatly exceeded their earlier responsibilities. But the characteristics of the crisis could not be understood otherwise, and a new focus on long-term policies of restructuring and adjustment was clearly called for.

The World Bank tried under those circumstances to adapt existing analytic capabilities for global economic studies focused on issues of long-term development. Existing analytic tools had earlier been developed within the organization to enhance the quality of country and project work. In the following chapters an account is given of the Bank's analytical instruments and of the way in which those were molded and expanded over time to shed light on the possible course of global economic events. The emphasis on the developing countries stems logically from the Bank's primary concern with those countries, but in this respect the value of its analysis was, to a certain extent, unique.

The important role which the developing countries played in the global economic developments of those years made it feasible to link the Bank's analysis readily to the work done by others for different parts of the world or for particular markets. How this was done, and what resulted from this work, is the subject of this paper.

Bank Economic Work: Some Basic Features

The basic decisions which concern the Bank in determining its operations relate to the allocation of lending among member countries, the terms to be applied, and the size of the intended operations. Within that framework, further decisions are required to select priority sectors and projects. In the present context, the focus is on that part of the work which is directed towards the macro-economic issues, although from time to time, the linkages with the more detailed operational decisions will be indicated. The main entity which is addressed in the decision process regarding the broad outlines of lending operations is the assessment of country economic positions and prospects.

The Bank relies for its information about member countries eligible for lending on regular economic reports, prepared through field missions by its own staff. These economic reports have a long tradition and are widely used outside the Bank. Many of these are short and mainly concerned with updating of the information base and with short- to medium-term developments. More important are the Basic Reports, which once about every five years provide a more structural analysis with a larger historical and prospective time horizon. These reports are preferably linked to the country's own schedule of medium-term plans, sometimes to assist with those efforts, or to assess their quality and relevance. From time to time, sector surveys are also undertaken separately, particularly in those countries in which the Bank expects to support a particular sector investment program with regular lending operations.

These reports do not suggest any particular level or composition of the Bank's own operations in a country; they are limited to a description and evaluation of the economic and social environment expected to surround and determine those operations. A separate, confidential document, the Country Program Paper (CPP), is the vehicle for management consideration and decision of planned Bank operations. Rigorously standardized in its format, it summarizes the latest economic information on the country, supplemented by standard tables presenting economic projections of growth, the balance of payments, and external indebtedness. It also summarizes past lending experience in the country and recommends levels and terms of future lending with a five-year time horizon; finally it identifies priority sectors and projects and their timing in the program.

The Bank has to stratify its lending program within the confines of its financial and staff resources. The lending decisions for individual countries must reflect these constraints, and the criteria applied must permit inter-country and inter-project comparisons. A substantial part of the statistical and analytical work program is therefore directed towards the compilation of comparable basic information and of standard analytical tools for all borrowing countries. The minimal information required for each country has been steadily raised over the years as data and the staff's ability to handle them improved. The minimum requirements have come to represent a fairly advanced data and modeling capability. For some of the major developing countries more elaborate models continue to be made, particularly to bring into better focus the determinants and effects of income distribution and employment. These models are capable of assessing policy alternatives more meaningfully than the minimum standard approach, but they are as yet too costly to expand their application beyond a few selected countries.

Countries are classified by groups according to their per capita incomes in order to determine their eligibility for particular lending terms. Thus, the highly concessional International Development Aid (IDA) resources are allocated entirely to countries at the lower end of the income scale. At the beginning of 1978 a ceiling of \$550 per capita (in 1976 prices) was applied. Similarly, different terms apply for different per capita income ranges for the Bank loans. The comparison of countries requires that a uniform methodology be applied to the estimation and conversion of each country's income data. The annually published World Bank Atlas provides such estimates for virtually all countries in the world, and the source material for the Atlas is an intrinsic part of the Bank's economic data system.

The assessment of creditworthiness, another of the criteria applied in country analyses, requires at a minimum a standard data set on balance of payments and on debt. The Bank relies for balance-of-payments information on the International Monetary Fund (IMF), with some other sources added in case of incomplete coverage. Information on debt has been collected throughout the years from all countries borrowing from the Bank, and been inserted in the files of the Debtor Reporting System (DRS). The increasing variety of forms of lending and the increase in the number of sources of capital have required almost continuous improvement and expansion of the system, and more recently the addition of new independent systems as well, to maintain an adequate coverage of capital flows and debt.

The analysis of the balance of payments and the projection of its main constituent parts over future years pose the question of reliable estimates for market and price developments for the products which developing countries export. As many of these countries depend on the exports of a few primary commodities, their market prospects require separate study. In that context, the need

is for projections of absolute prices, which can be transformed into relative, or "real," prices by deflation with an index representing the general price level development in the world economy. Further, projections are required of the growth of markets and of expected market shares reflecting changes in relative competitiveness and possible supply constraints in producing countries. The commodity analysis done in the Bank, and the modeling efforts which are described below, reflect these objectives.

These inputs are, as said before, essential elements of an analysis of creditworthiness. However, the issues to be studied go well beyond the confines of balance-of-payments and debt analysis. The capability of a country to manage its debt and its external accounts is of course closely linked to its capabilities to manage the domestic economy and, in particular, its fiscal and monetary affairs. Thus, the issues concerning creditworthiness cannot be isolated from those which pertain to general economic performance.

The data requirements for these broader purposes of analysis are very substantial, embracing not only national accounts, public sector finance and monetary and price statistics, but also a variety of social indicators which are suggestive of the level of development and the degree to which various population groups benefit from economic progress. Part of these data are incorporated in the standard country analysis. Standardization is achieved by the centralized management and maintenance of core data on the basis of country reporting used for greater depth of country analysis by economists assigned to particular countries. The World Tables, 1976 reproduced a major part of the Bank's central economic data files, while country economic reports indicate the depth and breadth of the country analytical model.

A set of models is also maintained centrally, and linked directly to the standard data. This enables the efficient production of the various reports and

tables for which fixed formats exist, and permits the operation of the system at low cost but with quality control. The minimum standard which applies to the country data base also applies to the country models: the Bank has been using for that purpose a (Revised) Minimum Standard Model (RMSM) which will be discussed in more detail later. The economic situation and prospects of individual developing countries has always required an assessment of the international conditions expected to prevail and to influence these countries from the outside. Country analysis in the World Bank therefore takes account of the most relevant external factors, particularly those related to external trade and capital flows. The increasing complexity of international economic relations necessitated over time an increasingly sophisticated approach to the analysis, in order to maintain the quality and reliability of the work done on individual developing countries.

It has been felt for some time that country economic work required a better and more embracing analysis of the world economy. In other words, the projections of commodity markets and of probable capital flows to the developing countries had to be rooted in an assessment of prospects in the industrial countries, which traditionally are the main markets for the exports of developing countries and also the main source of international capital flows. As existing organizations - IMF and OECD - do not in the main concern themselves with the long-term growth prospects of the industrial countries, the Bank created a small unit to work on such projections in coordination with other international organizations.

These were the main elements of the general projections work for the Bank's country analysis through 1973. Although linked to each other in informal ways, and gradually evolving towards more integrated analysis, the process was far from completed at the time of the oil price increase in 1973. The events of that year provided the necessary stimulus for the establishment of an integrated

analytical system and also affected its structure. For example, developing countries were affected differently; for that reason they needed to be shown separately.

The integration of the various elements into one global projection system was decided in late 1973. The sheer magnitude of the task of integration made it difficult to create a full-fledged world economy model out of the various elements. Problems arose partly because it was not possible to include all the elements fully, as this would have made the system far too large to be manageable. This is most easily seen when considering the large number of developing country models which would need to be integrated and linked to a smaller but still substantial number of commodity market models. Also, the international trade and payments segments would become overly tedious and not meaningfully related to some of the broader questions to be posed. For another part, there was a lack of analytical models describing essential parts of a global system; the industrial economies and trade in manufactured products in particular were missing.

The system that was built initially and was modified and extended in each subsequent year cannot be described in terms of a global modeling system. There remain significant gaps in its structure, and there are also significant overlaps among the constituent parts. Many of the components are modifications of existing models or otherwise derived from those, whereas some others were constructed ad hoc to permit the analysis of issues which were of crucial importance for the assessment, but not adequately covered by existing models.

The system had to assist in the analysis of the consequences of the international economic events after 1973 on the prospects of the developing countries. Was it possible for those countries to adjust to the new situation, and to return to their original growth path? And if so, what policies would be

conducive to that purpose, both by the developing countries themselves and by actions of others to help them through the adjustment process? These were the broad questions posed; it was essential to provide the country economists with a coherent picture of the effects which could be expected from the outside on their countries, in order to obtain their assessment of the problem arising in the developing countries themselves, and of the probable policy actions by their governments.

In turn, the summation of the country assessments provided a global view, on the basis of which international policies could be tested for their degree of effectiveness in assisting the adjustment process. These international policies, particularly concerning trade and capital flows, were the main focus of the work in the early exercises. But over time, with the adjustment process proceeding, emphasis gradually shifted to take more account of the developing countries' own policies. The flow of information about their adjustment policies, and the resulting developments, made this increasingly possible.

The description of the analytical system and its components is a snapshot of its shape and operation at one point in time and suffers therefore from a lack of perspective over time. The system grew between 1973 and 1976, and it had continued to evolve. An instant photo of its state at one specific date nevertheless sheds light on its scope and structure. Also, the years which have passed since the onset of the recession in industrialized countries permit us to look back at the assessments and projections made during those years.

Chapter II

COUNTRY AND COMMODITY MARKET MODELS

The focus of the Bank on operational issues and related institutional structures leads almost naturally to skepticism about the usefulness of quantitative models. It is no doubt more important to understand the decision-making processes of a borrowing government and to have a good perception of alternative policy options than to worry about the standard errors of some parameters of a macro-economic model. The challenges to the model builders in the Bank were thus twofold: in addition to the difficulties of manipulating scarce and sometimes unreliable statistics, there was a constant need to build models which were relevant to the issues raised from an operational angle. This challenge has been very important in shaping the approach taken by those who attempted to construct models and has no doubt been instrumental in improving the quality and perceptiveness of their analysis.

Country and commodity market models constructed over the course of the years have been of widely divergent kinds and degrees of sophistication. This variety was encouraged to develop models that were relevant to the issues which they were to analyze. Over time, minimum standard requirements were, however, introduced to ensure that each model would have certain minimum capabilities for making long-term projections. At the same time, increasing attention was given to the creation of a standardized set of historical data and their linkage to the projections.

The country models often go beyond the minimum standard requirements; in recent years a family of models has been developed and tested which emphasized the processes of employment generation and income distribution and which contained considerable details of production, trade, and investment. But even

those remain capable of providing a prescribed minimum standard output. At the same time, the need for standard projections in countries for which no elaborate models were available at the time caused the formulation of a minimum standard model (MSM) and later on a more expanded version, R(evised) MSM. These models were rather simple, almost of an accounting character, but have proved a convenient tool of country analysis. They provide consistency and the flexibility to analyze alternative policy options within a limited framework of variables.

No such standardization has been attempted for the commodity market models. First, they are more recent, and therefore still at early stages of development. The striking differences in the structure of individual commodity markets also make standardization difficult. The desirability of standardization is therefore less than for the country models, although some standardization of the projection outputs was needed for the linkage in the global framework.

We will describe only the revised minimum standard model. This is to be taken as representing minimum modeling requirements, assuring a standard and consistent approach between countries. Much more elaborate country models have been built in some instances for operational purposes, and there have been many extensions and elaborations of the RMSM model; such projection results have always been included in the standard outputs in preference to the simple RMSM outputs.

The RMSM simulation model distinguishes three production sectors: industry, agriculture, and other sectors. For each of these, exogenous growth rates are provided for the initial model run; as will be shown further, there is an option for obtaining alternative growth patterns which take the balance of payments as the starting point. Usually, the initial values are calibrated to the countries' planned targets or to historical rates, or to other judgments by

country economists. The country economist who builds the model uses historical series for additional guidance. It is of course also possible to develop functional relationships between sector growth rates, as long as either the growth rate of GDP or of one of the sectors is provided as an exogenous value. A computer program handles the required simultaneous solution.

The sectoral decomposition has the advantage that the implications of specific GDP growth assumptions are brought out more clearly, and may be easily compared with the past performance of the country. It also permits a more diversified analysis of trade flows and of compatibility of growth with investment activity. The RMSM specifies several of such relations, but allows numerous variations and extensions if these seem practicable and useful.

Changes of stocks - a small but volatile element - are shown separately to permit the estimation of the investment equations in terms of fixed investment only. Stock changes are related in RMSM to the growth of GDP; although past fluctuations make it rather unlikely that a good relationship can be established, a simple average for several years of the past may suffice. Sometimes large stock changes may be expected for specific reasons and in those cases the country economist can put in specific values for the first projection years before reverting back to the standard equation. This is of considerable importance if these stock changes relate to internationally traded goods.

Investment in fixed assets is related to the growth of sectoral output through incremental capital-output ratios (ICOR's). A constant term is added to the equation, representing investment expenditures which cannot be related to the growth of output, particularly in some social sectors but also in those cases where gestation periods extend very far in the future (erosion control, reforestation). The investment equation is quite unsophisticated and cannot claim to represent advanced methods for dealing with the process of economic

accumulation. It hardly needs saying that, with very few exceptions, the available data for developing countries do not permit anything beyond this simple form. Frequently, data do not even provide the basis for estimating capital coefficients by sectors for historical years. In that case, the RMSM framework suggests an even simpler approach which relates total fixed investment to both the level and the growth of the GDP, plus a constant term as above. The link to the GDP-level serves the purpose of separating out replacement and infrastructure investments.

Probably the least satisfactory element is the absence of realistic gestation lags in the investment equation. The standard time lag between investment (during a year) and the growth of output (from this year to the next) is half a year, implying an average investment period from inception to completion of only one year. This may not be too far off the mark for some traditional on-farm investment, the acquisition of agricultural machinery or transport equipment, but it is clearly inadequate as a description of industrial investment and even more so for most infrastructure. Some of the more elaborate models for countries with a more advanced statistical system do include a variety of gestation periods, related to each sector. It would appear desirable that in the future such lags should be used more widely.

Imports of goods and non-factor services are divided into six classes according to typical end-uses, and related to the most appropriate demand category. Capital goods imports are linked to fixed investment; intermediate goods to value added in industry; food and other consumer goods imports to consumption; fuels and non-factor services are related to the total GDP. Again, these relations are not required for the RMSM; other equations or systems can replace the ones suggested if deemed necessary, and more detailed import demand systems can be accommodated. The import elasticities are usually obtained from

the historical series, but can be modified if specific reasons are given. A deviation from the standard system which is used regularly pertains to food imports: if domestic agricultural production is subject to considerable year-to-year fluctuations, it may be desirable to include the latter as a variable which influences food imports.

Exports of goods and non-factor services are also specified by commodity groups and classes. The main primary export products are shown separately, and linked with the commodity market projections made elsewhere in the Bank. If these commodities are a significant part of the country's total agricultural output, the RMSM sometimes specifies the export-oriented sector separately in the breakdown of the GDP.

Trade prices follow partly from commodity market analysis, trade analysis, and the inflation projection made in the global system. Price guidelines provided to the country economists pertain to projections of prices that are quotations for standard grades in international markets. The country analysis uses border prices (exports f.o.b. and imports c.i.f.) applicable for the goods actually shipped. Their relationships differ between countries and commodities and are characterized by irregular lags and leads, and thus require careful interpretation by the country economist.

The model described above estimates the imports required to achieve a given rate of growth but treats export earnings as exogenous. The resource gap (the difference between imports and exports of goods and non-factor services) reflects the excess of these imports over foreign exchange earned from exports. It represents the amount of external resources required to meet the growth target set, and the model with exogenous growth rates is therefore called the "requirements version" of the RMSM.

But other options are available. For example, the version described above estimates savings as the difference between investment expenditures and external resources, an amount which may exceed some preconceived notion of the feasible level and rate of savings. In that case the RMSM permits the introduction of an upper or lower constraint on savings. Ex ante savings are corrected through adjustment of the import level, i.e., investment and exports are assumed to be unresponsive to shortfalls. A choice must be made concerning the category of imports that must bear the adjustment. Commonly, the non-food consumer goods are selected for that purpose, as this is thought to have the best impact on sectoral production and also corresponds to the experience in many countries where these consumer imports constitute the most volatile element of imports. These goods are also most likely to be the subject of policy action in case of balance-of-payments constraints.

It is also possible to start the operation of the RMSM from a predetermined amount of available external resources. This "availabilities version," like the version with constrained savings, requires backward iteration to arrive at an estimate of possible growth of the GDP and/or some arbitrary allocation decisions. The important feature, however, is that the structure of the RMSM provides a flexibility which permits the country economist to work from several sets of assumptions and exogenous values and to use the model in a variety of directions. Judicious use of the model provides not only the required set of projections, but also a better perception of the main interrelationships within the economy.

To ease the testing of model runs, the RMSM program calculates and prints a number of ratios and other economic indicators from the basic data, both for the historical and the projected years. These permit, through quick scanning, an overview of the main changes which occur over the past and

projection years, and this permits discontinuities or other unexplained phenomena which either need justification or revision to be spotted.

The RMSM also contains a number of mainly derived variables like government consumption, tax receipts, indirect taxes net of subsidies, and some minor balance-of-payments items. A large fraction of the equations concerns the capital account of the balance of payments. The projected capital flows detailed by sources and by terms of borrowing permit the calculation of debt service liabilities. These are then added to the known obligations which stem from debt contracted in the past. This elaborate detail of the capital account is the basic source for creditworthiness analysis and is also used in the formulation of the Bank's own lending activities.

A summary of the RMSM equations is given at the end of this chapter, in Annex II.1.

This approach has several advantages, especially if an increasing part of the data and the models can be stored and accessed on the computer files. Direct links between the various data files and the models permit quick and regular updating of estimates and projections so that the country files are kept current. A number of standard tables for use in reports and for management information can be produced with little effort and a minimum of manual interference.

The system provides comparability between countries. This is important for comparative country analysis and for a systematic approach to international policy issues. The possibility of aggregating past and projected data by groups of countries was found to be of great value in the initial formulation of the global framework.

Over the years, a large number of minimum standard models was produced, in addition to a series of more complex country models. In total, some 75

developing country models have been built at one time or another. Many of these are no longer operational, often because they were replaced by improved versions, so that the number of countries for which models exist at any time is about 45. The larger models particularly have proved hard to maintain. They are often based on specially constructed data sets which deviate from standard concepts, so that their maintenance demands large amounts of staff time, and sometimes even travel to the country concerned. Because the RMSM models are based on standardized and regularly updated data available in computer readable form, they can be updated regularly. A set of 45 country models for so called "sample panel" countries was thus updated annually as a basis for the global analysis. It constituted the link between the projections for the developing countries which are made regularly for internal use, and the global projections which are the subject of this discussion. The selection of these countries and the resulting composition of the sample of countries will be discussed in Chapter V.

Because of the key role of the country projections in the 1973-76 global system, their critical parameters for countries or country groups have been compared for historical and projected periods. For example, optimism in projecting the balance of payments tended to be reflected in relatively high projected rates of growth of exports and relatively low - as compared to the past - import elasticities in relation to the national product. In the table below such comparisons are made for broad groups of countries between the periods 1967-73 and 1975-85, on the basis of the materials used in the 1976 global analyses.

**Table 1: COMPARISON OF HISTORICAL AND PROJECTED BALANCE-OF-PAYMENTS
PARAMETERS FOR COUNTRY GROUPS/1**

	Export Growth, % P/A		Import Elasticity	
	1967-73	1975-85	1967-73	1975-85
<u>Low-Income Countries</u>				
India	3.4	4.9	-.44	.73
Other South Asia	-2.3	7.0	-2.46	.84
In Africa	5.0	5.6	1.27	1.00
<u>Total</u>	<u>2.6</u>	<u>5.6</u>	<u>-.31</u>	<u>.91</u>
<u>Middle-Income Countries</u>				
In Africa	5.2	4.1	.95	1.04
East Asia, fast growing	17.8	8.3	1.37	.93
East Asia, slower growing	6.7	8.7	.28	1.02
Latin America, fast growing	8.6	8.6	1.37	.72
Latin America, slower growing	2.9	6.6	.83	.96
Middle East	5.4	7.5	1.06	1.08
Southern Europe	8.2	8.5	1.24	.91
<u>Total</u>	<u>7.9</u>	<u>7.8</u>	<u>1.04</u>	<u>.92</u>

/1 For country composition, see Annex II.2.

A similar set of comparisons can be made for parameters indicative of domestic resource mobilization efforts, and of the efficiency of their use, notably marginal savings rates and incremental capital/output ratios. On the basis of the 1976 global exercise, these indicators are presented for the same set of country groups in Table 2 below.

**Table 2: COMPARISON OF HISTORICAL AND PROJECTED DOMESTIC PERFORMANCE
INDICATORS FOR COUNTRY GROUPS**

	Capital/Output Ratio		Marginal Savings Rate	
	1967-73	1975-85	1967-73	1975-85
<u>Low-Income Countries</u>				
India	5.46	3.81	.09	.22
Other South Asia	3.58	2.47	.19	.13
In Africa	3.45	3.48	.19	.26
<u>Total</u>	<u>4.83</u>	<u>3.32</u>	<u>.13</u>	<u>.20</u>
<u>Middle-Income Countries</u>				
In Africa	4.31	3.96	.30	.24
East Asia, fast growing	2.17	2.85	.33	.32
East Asia, slower growing	3.17	3.59	.22	.25
Latin America, fast growing	2.12	3.21	.26	.28
Latin America, slower growing	3.14	2.80	.12	.22
Middle East	2.84	3.09	.21	.15
Southern Europe	3.66	4.03	.40	.26
<u>Total</u>	<u>2.60</u>	<u>3.28</u>	<u>.27</u>	<u>.26</u>

The table suggests that care was taken not to overstate the expected performance of the countries which did well in the past, whereas for countries with a rather weak historical performance, the assumption made implied significant policy improvements. The latter characteristic is demonstrated for all of the lower-income countries, but also for the slower growing countries of Latin America. An element of optimism could be read in the substantial decline of the import elasticities in the fast growing countries of East Asia and of Latin America; it should be observed, however, that these countries were able to expand their imports very rapidly until 1973 with their rapid export growth. Some decline of import elasticities was therefore to be expected in the future. And similar arguments applied to a somewhat lesser extent to the countries of the Middle East and in Southern Europe.

Again it appears that the presumption of improved performance is implicit in the projections for the lower-income countries and also in those for the slower growing Latin American countries. Other wise, it seems that the projections are not out of line with historical experience; in some cases where a very good performance was observed for the past, the projections do imply somewhat less favorable capital output and marginal savings ratios. This may partly be the result of some conservatism on the part of the country experts, but for another part it does, of course, reflect the more difficult circumstances under which many of these countries must implement their policies. Particularly the slower growth of the industrial countries as compared to the past and the heavier debt service burden to be carried in the years ahead may have an impact on their future performance. Such issues are presented in the last three chapters of this book.

Commodity Price and Quantity Forecasts

The Bank's interest in the market developments of primary commodities dates from the 1950s and 1960s, when they accounted for the bulk of developing country exports. Prices and levels of demand for primary commodities still affect the growth prospects and creditworthiness of developing countries, particularly of the small and least developed ones. Thus analysis of these market development prospects has been an essential ingredient of the Bank's country-economic work.

A second dimension to this work was provided by the requirements of projects analysis, particularly for loans for primary commodity production, processing, and trade. Projected commodity price developments were an element in the assessment of the costs and benefits of these projects. Finally, the Bank's commodity market analysis was found to be useful for the appraisal of such broad issues of international economic policies as the stabilization of commodity prices and export earnings, the effects of trade restrictions or their liberalization, and the proposals for supply control.

Market analysis is accordingly undertaken for the medium- to long-term projection horizon, extending from five to ten years. Short-term fluctuations - however important those may be - are accounted for in the analysis but not projected. The projections attempt to estimate relative long-run equilibrium prices that take into account long-run marginal costs. This requires a good deal of information on the determinants of supply in the various producing countries, sometimes including similar information on synthetic substitutes. It hardly needs saying that knowledge in this area is limited, not very reliable if available, and subject to continuous change. Thus notwithstanding considerable efforts, there is still a long way to go before this type of analysis can be considered firmly based on fact and on adequate understanding of market behavior.

The projections also need to be related to a set of broader projections concerning growth of the world economy. Before the Bank began its global analysis, in the years before 1973, that framework did not exist and most projections of commodity markets were based on trend extrapolations of economic growth and industrial production in the industrial countries.

Inflation in those countries was sometimes ignored and in others extrapolated from past trends. Clearly, by 1973 it was no longer realistic to abstract from the possibility of major deviations from those trends. Nor could the analysis ignore the role commodity prices themselves could play in generating general price developments in the world economy. Thus, the global framework became essential for a credible continuation of commodity market analysis.

As described below, the SIMLINK model included a number of simple commodity market models which permitted the full integration of commodity analysis into the broader framework. But this should not be interpreted as an indication that the Bank's commodity analysis was entirely integrated with the global analysis. The system used for the global projections was not always seen by the commodity economists as an adequate instrument for their projections, and the SIMLINK commodity models were as only one ingredient in a rather eclectic approach to projections. The commodity analysts' detailed knowledge of the factors which influence commodity markets and their - factual or intuitive - assessments of supply conditions in the major producing countries led them from time to time to modify or even reject the SIMLINK results.

Part of the problem was of course that most of the SIMLINK commodity models were by their nature suitable only for short-run forecasts, whereas the need was for forecasts extending 5-10 years in the future and describing long-run equilibrium. The latter required, among other things, an understanding of the mechanisms behind investment decisions concerning primary commodities. That

segment is absent in most of the models presently being used. Also, the issue of commodity price sensitivity to general inflation in the world economy has remained thorny, although it strongly affected the analysis./2

/2 For details, see Shamsher Singh and Wouter Tims, 1976 paper.

Annex: Revised Minimum Standard Model, RMSM

I. Production

1. YAG	=	$YAG_{t-1}(1+g_1)$	Value added, agriculture
2. YIND	=	$YIND_{t-1}(1+g_2)$	Value added, industry
3. YSER	=	$YSER_{t-1}(1+g_3)$	Value added, services
4. GDPFC	=	$YAG + YIND + YSER$	Gross domestic product, factor cost
5. INDTX	=	$a_5 \text{ GDPFC}$	Indirect taxes, net of subsidies
6. Y	=	$\text{GDPFC} + \text{INDTX}$	GDP at market prices
7. ΔY	=	$Y_t - Y_{t-1}$	Increment
8. NFY	=	endogenous from BoP deflated by IPf	Net factor income from abroad
9. GNP	=	$Y + \text{NFY}$	Gross national product, market prices
10. GDY	=	$Y + \text{TTADJ}$	Gross domestic income
11. GNY	=	$\text{GNP} + \text{TTADJ}$	Gross national income

II. Expenditures

12. ΔSTK	=	$a_4 \Delta Y$	Stock changes
13 ^a . IF	=	$a_1 Y + a_2 \Delta Y + K$	Fixed investment
or 13 ^b . IF	=	$a_1 \Delta YAG + a_2 \Delta YIND + a_3 \Delta YSER + k$	
14. I	=	$\text{IF} + \Delta \text{STK}$	Total investment
15. C	=	$\text{GDY} - \text{I} + \text{M} - \text{XADJ}$	Total consumption
16. GC	=	$\text{GC}_{t-1}(1+g_4)$	Government consumption
17. PC	=	$C - \text{GC}$	Private consumption

III. External Trade

18. MCAP	=	$\{1+a_6 \cdot (IF_t - IF_{t-1}) / IF_{t-1}\} MCAP_{t-1}$	Imports, capital goods
19. MINT	=	$\{1+a_7 (YIND_t - YIND_{t-1}) / YIND_{t-1}\} MINT_{t-1}$	Imports, intermediate goods
20. MFUEL	=	$\{1+a_8 (Y_t - Y_{t-1}) / Y_{t-1}\} MFUEL_{t-1}$	Imports, fuels
21. MFOOD	=	$\{1+a_9 (PC_t - PC_{t-1}) / PC_{t-1}\} MFOOD_{t-1}$	Imports, food
22. MOCGP	=	$\{1+a_{10} (PC_t - PC_{t-1}) / PC_{t-1}\} MOCGP_{t-1}$	Import potential, other consumer goods
23. MNFS	=	$\{1+a_{11} (Y_t - Y_{t-1}) / Y_{t-1}\} MNFS_{t-1}$	Imports, non-factor services
24. MG	=	MCAP+MINT+MFUEL+MFOOD+MOCGP	Imports, all goods
25. M	=	MG+MNFS	Imports, goods and non-factor services
26. X	=	$X_1 + X_2 + \dots + X_n$	Exports, goods and non-factor services, volume
27. X^Σ	=	$X_1^\Sigma + X_2^\Sigma + \dots + X_n^\Sigma$	Exports, goods and non-factor services, value
28. MPI_i	=	exogenous	Import prices index for commodity i
29. XPI_i	=	exogenous	Export prices index for commodity i
30. X_i^Σ	=	$X_i \cdot XPI_i$	Export, values, commodity i
31. M_i^Σ	=	$M_i \cdot MPI_i$	Import values, commodity i
32. MG^Σ	=	$MCAP^\Sigma + MINT^\Sigma + MFUEL^\Sigma + MFOOD^\Sigma + MOCGP^\Sigma$	Imports of goods, value
33. M^Σ	=	$MG^\Sigma + MNFS^\Sigma$	Imports, total value
34. RG^Σ	=	$M^\Sigma - X^\Sigma$	Resource gap, current prices
35. TTADJ	=	$\frac{X^\Sigma}{MPI} - \frac{X^\Sigma}{XPI}$	Income adjustment from terms of trade
36. XADJ	=	$X + TTADJ$	Exports, capacity to import
37. NT	=	endogenous from BoP deflated by IPI	Net transfers from abroad

IV. Savings, Government, Prices

38. GDS	=	GDY - C	Gross domestic savings
39. GNS	=	GDS + NFY + NT	Gross national savings
40. MAXMSR	=	exogenous	Maximum marginal savings rate
41. $GNSP_t$	=	$MAXMSR(GNY_t - GNY_{t-1}) + GNS_{t-1}$	Potential gross nat. savings
42. GR^*	=	$\{1 + a_{12} \cdot (Y_t^* - Y_{t-1}^*) / Y_{t-1}^*\} GR_{t-1}$	Government revenue
43. GE^*	=	$(1 + g_6) GC_t / GC_{t-1} \cdot GE_{t-1}$	Government current expenditures
44. IPD	=	$(1 + g_6) IPD_{t-1}$	GDP price deflator
45. Y^*	=	IPD.Y	GDP, current prices

V. Capital Flows

46. COM	=	exogenous	New commitments, 23 possible categories by terms, sources
47. DBN	=	exogenous routine	New disbursements, 7 patterns
48. DBT	=	exogenous routine	Total disbursements, by year
49. AMT	=	exogenous routine	Amortization
50. INT	=	exogenous routine	Interest charges
51. NET	=	DBT - AMT	Net lending
52. NTR	=	NET - INT	Net transfer
53. DOD_t	=	$DOD_{t-1} + NET$	Debt outstanding disbursed
54. EXCHR	=	exogenous	Exchange rate, \$ per unit
55. PIINT	=	exogenous	International price index

Chapter III

THE ANALYSIS OF CAPITAL FLOWS AND DEBT

The transmission of economic impulses between countries takes place through the movement of goods and services and flows of capital. The particular significance of capital flows for the developing countries arises from the fact that the transfer of resources from the richer to the poorer countries is part of them. The World Bank, as an intermediary for part of these flows, has a special interest in their level and composition.

The General Framework

Information on the flows of capital was obtained from each country's balance of payments. Their standardization by the IMF increasingly permitted the use of these data for analytical purposes. However, balance-of-payments data provided information only on flows taking place within a particular period, usually a year. It did not say on what conditions of interest and repayment these capital flows were contracted, and to what extent the flow in any given year resulted from commitments in earlier years. Nor did it provide information on the sources of capital, both by countries of origin and by types of institutions in these countries. Information on terms is essential for determining the future liabilities of interest and amortization; a classification by sources is needed for the analysis of the supply of capital and its future development.

Several more detailed information sources were available, but could not easily be used in conjunction with the IMF balance of payments (or with each other) as country coverages differed, definitions and classifications of capital

flows were not the same, and significant capital movements to developing countries were not or were inadequately covered for their joint use.

The linkage of the various available data sources gradually progressed over time. The earlier attempts to cover and classify all capital flows were crude and consistent only at a rather high level of aggregation. Additional and new data collection systems had to be devised and implemented to permit capital flow presentations of reasonable quality and reliability. It became possible to estimate with some reliability the debt implications of current borrowing by the developing countries, and thus to improve the analysis and projections of creditworthiness of these countries.

Projections of capital flows require a concise presentation of the sources of capital, by types, as well as a comprehensive description of the inflows for each recipient country. Flows need to be consistent between origins and destinations, in order to translate constrained supplies - for example, of concessional capital - into constrained receipts of the developing countries affected by such limitation. Similarly, the demand for capital which developing countries can exercise reasonably and within the limits of their creditworthiness must be translated towards their potential sources and compared with the availability of capital in relevant markets. These requirements make heavy demands on available statistics and cannot yet be met fully. In what follows, the main sources and their uses and linkages will be discussed, together with the remaining weaknesses and shortcomings of the methods and the resulting estimates.

Balance-of-Payments Data

Standardized balances of payments were available for 88 developing countries and constituted the basic source of information on capital flows to these countries. These data are regularly published by the IMF in its Balance of

Payments Yearbook. They had to be expanded to full geographic coverage of all developing countries to link capital receipts to capital supply by sources. Such additional estimates for countries not covered in the IMF Balances of Payments were, by necessity, less reliable. Fortunately, these additional estimates concerned countries with relatively minor trade and capital flows. Thus, the totals for all developing countries together remained rather close to the IMF data on the 88 countries.

The sources and methods used for these estimates are summarized in Table 3. The first column contains the 88 countries in the IMF balance of payments data file; the reason for changes under the item "net long-term borrowing" of the standardized balance of payments will be discussed separately.

The main sources of data for countries outside the IMF's standardized system of balances of payments are:

- (a) Data from the IMF publication International Financial Statistics (IFS) concerning imports and exports, changes in reserves, and the use of IMF credit;
- (b) Data from the IMF/IBRD publication Direction of International Trade concerning imports and exports, where these are not available from the IFS;
- (c) Data from the OECD/DAC publication The Geographic Distribution of Financial Flows to Developing Countries concerning flows of grants and loans, as well as direct foreign investment;
- (d) Data from the World Bank's Debtor Reporting System (DRS).

Obviously, the easiest part to estimate in the balance-of-payments format was the trade balance: IFS data were preferred, with those from the Direction of Trade (DOT) as a second substitute. No estimate could be made of non-factor services, which were therefore assumed to be zero (net). IFS

Table 3: FORMAT AND SOURCES FOR CONSOLIDATED BALANCE-OF-PAYMENTS STATEMENTS
(In million of U.S. dollars)

	Countries for which IMF Balance-of- Payments Data are Available (1)	Countries for which Balance-of-Payments Data are not Available	
		IFS Data Available (2)	Only DAC and DOT Data Available (3)
1. Exports (goods + NFS)	BOP	IFS FOB	DOT FOB
2. Imports (goods + NFS)	BOP	IFS CIF	DOT CIF
3. Resource balance	BOP	Lines 1-2	Lines 1-2
4. Net factor services	BOP	Estimate (4)	Estimate (4)
5. Net transfers (a)	BOP	Residual	Residual
6. Current account balance (before official transfer receipts)	BOP	= Line 16	= Line 16
7. Official grants & grant-like flows	BOP	DAC	DAC
8. Direct private investment (net)	BOP	DAC	DAC
9. Net public loan disbursements	DRS (1)	DRS (1)	n.a.
a. multilateral agencies	DRS (1)	DRS (1)	n.a.
b. official bilateral	DRS (1)	DRS (1)	n.a.
c. private lenders	DRS (1)	DRS (1)	n.a.
10. Use of IMF credit	BOP	IFS	n.a.
11. Other M & LT loans (net)	BOP - DRS (1)	DAC - DRS (1)	DAC
12. Sub-total M & LT capital inflow	BOP	Lines 7+8+10+11	Lines 7+8+11
13. Short-term capital (net)	BOP	n.a.	n.a.
14. Capital flows n.e.i. (b)	BOP	n.a.	n.a.
15. Change in reserves (c)	BOP (2)	IFS (3)	n.a.
16. Capital account balance	BOP	Lines 12+15	= Line 12

Notes to balance-of-payments lines:

- (a) Excludes net official unrequited transfers
- (b) Includes errors and omissions
- (c) Excludes use of IMF credit; minus sign indicates increase.

Notes to data sources

- (1) DRS where available; otherwise zero.
- (2) Gross reserves and related items except for "use of IMF credit."
- (3) Gross reserves only are available.
- (4) Estimated on basis of external liabilities (from DAC data).

information concerning changes in reserves and the use of IMF credit, together with Development Assistance Committee (DAC) data on capital flows, permitted the construction of a fairly complete capital and reserves account. In some cases, there were capital flow data from the World Bank's own Debtor Reporting System (DRS) which were then used in preference over DAC data. Net factor services were assumed to consist mainly of interest payments and were therefore estimated on the basis of total liabilities as reported in the DAC statistics. Any difference between the estimated current account balance on the one hand, and the capital and reserve account on the other, was treated as a residual and shown as net transfers.

Table 4 presents the aggregate balance of payments for all non-oil-exporting developing countries obtained in this way. A similar table is available for the oil-exporting developing countries./³ For easy reference, the table shows some detail of the capital flows.

The World Bank Debtor Reporting System (DRS)

The DRS is considered to be the best available source of data on public and publicly guaranteed medium- and long-term borrowing by developing countries. It contains loan-specific information and its integration in the balance-of-payments framework is therefore most desirable. Compatibility between the IMF and IBRD records of foreign borrowing by developing countries is, however, only true by assumption. That assumption is (as should be in principle) that each flow reported by the DRS has its counterpart in the IMF balance of payments. Flows reported by the IMF in excess of DRS data should thus be non-guaranteed capital. When a detailed comparison was possible, it appeared that

³ See Table 3 for lists of non-oil and oil-exporting countries.

Table 4: OFFICIAL GRANTS AND NET MEDIUM- AND LONG-TERM LOANS
TO ALL NON-OIL DEVELOPING COUNTRIES IN A
BALANCE-OF-PAYMENTS CONTEXT, 1970-74
(In millions of U.S. dollars)

	1970	1974
<u>Consolidated Balance of Payments</u>		
Current account lines		
Balance of goods, services and private transfers	-9,325	-30,372
Official grants and capital		
1. Official grants and net M & LT loans received	6,967	22,301
2. Other		
a. Direct investment	1,449	4,323
b. Short-term capital (net)	1,737	4,889
c. Changes in reserves (increase = -)	-2,036	-2,443
d. Net errors and omissions and other	1,208	1,302
	<hr/>	<hr/>
Total	2,358	8,071
Total financing	9,325	30,372
	=====	=====
<u>Details of Official Grants and Net M & LT Loans/a</u>		
1. Grants received by the public sector (net)	2,320	5,018
2. Net M & LT loans received by the public sector	4,527	12,852
3. Use of IMF credit (net)	-482	1,424
4. Other M & LT loans (residual)	602	3,007
	<hr/>	<hr/>
Total	6,967	22,301

/a According to recipient country data.

the compatibility assumption was plausible. But in some cases problems do arise, as the residual difference which should reflect non-guaranteed private borrowing does not always give estimates which are corroborated by other and independent estimates of such flows. Therefore, the line "other medium- and long-term loans" in the table (which represents the non-guaranteed private capital) needs to be handled with care and to be compared to other available information before being relied upon. As this line was obtained as a residual, it absorbed whatever inconsistencies existed between DRS and balance-of-payments data.

Capital Flow Components

The first distinction made, along the lines of the IMF's balance-of-payments concepts, was among direct foreign investments, grants, medium- and long-term borrowing, and short-term capital. The numbers used for each of these main categories were those from the consolidated balance-of-payments described above. Some observations on each of these components may be made here.

Grants were not reported adequately by recipient countries, largely for administrative reasons. Much higher totals reported by the DAC-donors were not useful for a number of conceptual reasons. Short-term borrowing largely represents trade credits and has therefore been growing with the increase in developing country trade. Links between this type of credit and borrowing with longer maturities were established sometimes, when countries rolled over short-term credit as a substitute for longer-term borrowing. Other countries increased their medium- and long-term debt through the consolidation of short-term liabilities. For such reasons short-term debt needs to be taken into account from time to time in the case of particular countries.

Direct foreign investment is not always recorded well in balances-of-payments of developing countries; the different modes of financing private

enterprise by foreign companies are not always known to the recording authority and can give rise to significant errors. The data available from the DAC, collected from the countries of origin, are not very useful in this context as they contain a large flow which has no specified destination.

The medium- and long-term borrowings as shown in the balance-of-payments were accepted in total, but were broken down further, using the more detailed data from the World Bank DRS which contains full information on sources, terms, and purposes. As the DRS contains only lending to the public sector in the reporting countries, or to their agencies, or lending for which the recipient country government has provided a guarantee, there was a residual of medium- and long-term borrowing which was assumed to go to the recipient country's private sector without a guarantee from that country's government. It was also assumed that those flows (if not all) originated in the private sector of the creditor countries (through all or part of these may carry a guarantee from the creditor country government). The borderline between such private-to-private lending and private foreign direct investment was not always clear and accounts for some of the estimation problems for the latter.

As already indicated, the procedure followed in breaking down medium- and long-term capital flows assumed compatibility of IMF and World Bank data. Inconsistencies which may in fact exist were absorbed in the item "Other Medium- and Long-Term Loans (net)" which therefore was not always regarded as a reliable estimate of non-guaranteed private capital flows.

Links to Other Data Systems

The preceding paragraphs described the method used to obtain a presentation of the capital account of the balance-of-payments for all developing countries together and for groups of those countries. The results, presented in

Table 4, were comprehensive in a geographic sense, but specified capital flows only by very broad categories. The reliability of each component differed. Above all, these data by themselves could provide answers to the main questions raised in the context of the global analysis:

- (a) The sources of these flows needed to be identified, in sufficient detail, to permit the analysis of the criteria and conditions which governed their size and composition;
- (b) The flows needed to be linked to components of commitment, disbursement and terms (amortization and interest mainly) to permit the analysis of external debt and debt service.

The balance-of-payments should constitute the framework for these more detailed studies, but cannot by itself provide the necessary information. The additional information needed does not exist in a format which is suitable for both purposes. Data with a useful specification of capital flows by sources are available for the major sources in a classification made by (and for the use of) the DAC of the OECD. But data which relate capital flows to individual loan transactions and their terms are available mainly from recipient country sources and follow a quite different classification.

The problem is not limited to incompatible sets of data from different sources, as neither of the two issues to be analyzed can be approached exclusively on the basis of one data source. Each of the sources is incomplete, both in terms of geographic coverage and with respect to the flows covered. Therefore, each one of the issues requires the fullest possible use of all sources together, notwithstanding the incompatibility of the classifications. A discussion of the methods used and the resulting estimates is therefore unavoidably tedious and sometimes confusing. The discussion will proceed by taking the two issues seriatim but with a forewarning to the reader concerning the necessity to cross-reference between the two.

The Sources of Capital Flows

The concepts of financial flows presented below were first introduced by the OECD's Development Assistance Committee/4 for its own members' capital transactions with developing countries. These concepts were currently applied to other donors as well: members of the Organization of Petroleum Exporting Countries (OPEC), the centrally planned economies (CPE), and multilateral agencies. Financial flows from developing countries other than OPEC and CPE to other developing countries were usually excluded from the statistics.

Types of Flows

Three major types of flows are defined by the DAC as follows:

- (a) Official Development Assistance (ODA), defined as those flows to developing countries provided by official agencies; to the extent that these transactions meet the following tests: (i) they are administered with the objective to promote the economic development and welfare of developing countries; (ii) they are concessional with a grant element/5 of at least 25 percent.

ODA consists of grants and official development lending. Official flows to multilateral agencies in the form of capital subscriptions, contributions, and concessional lending are also classified as ODA.

/4 Members of the OECD Development Assistance Committee are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, the United States, and the Commission of the European Economic Communities (EEC). The statistics exclude EEC as a donor.

/5 The grant element is the grant equivalent as a percentage of the face value of a financial commitment; the grant equivalent is defined as the difference between the face value of a financial commitment and the discounted present value of the required amortization and interest payments using a 10 percent discount rate.

Flows from multilateral agencies to developing countries are also subjected to the above tests.^{/6}

- (b) Other Official Flows (OOF) are those transactions which are not concessional or which, even though they are concessional, are primarily trade-facilitating in character. OOF includes official export credits, other long-term capital such as equity investments, and a small amount of grants which is not for development purposes. The net acquisition by governments and central monetary institutions of securities issued by multilateral agencies at market terms is also classified by the DAC as OOF; however, such transactions were excluded as the acquisition itself did not constitute a flow to developing countries.
- (c) Private Flows cover changes in private long-term assets, both bilateral and multilateral, of non-monetary and monetary sectors. Private flows include direct investments, other net private capital flows, guaranteed private export credits to the developing countries, and portfolio investment in developing countries and in multilateral agencies. The DAC countries are the primary source of private flows to developing countries. Another type of private flow is international bank lending, in the form of Eurocurrency credits. These are not part of the DAC reports and are treated separately here.

^{/6} The DAC treated all flows from multilateral agencies for development purposes as ODA before 1974. Starting with 1974, most multilateral loans made with ordinary funds ("hard" or conventional loans) were classified as OOF. Only grants and loans made with special funds ("soft" loans) have since then been classified as ODA.

Major Donors

The following are the major donors or sources of financial flows to developing countries and to multilateral agencies.

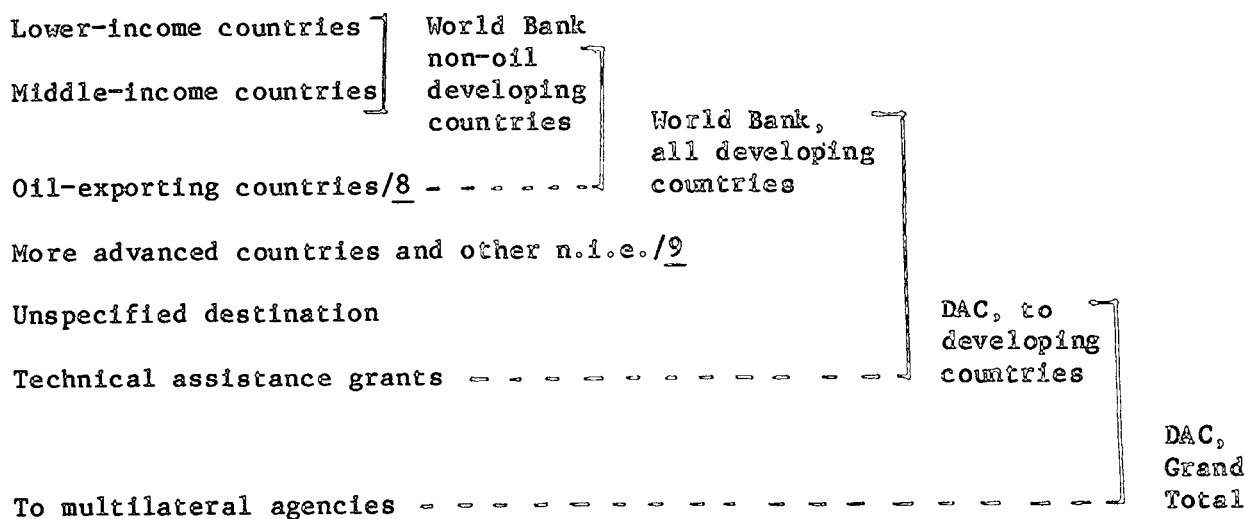
- (a) DAC: includes the 17 member countries listed in footnote 4 on page 27. Before 1974, Portugal was a member. Up to 1974, Portugal's data were included in the statistics.
- (b) OPEC: refers primarily to 10 countries within OPEC, of which Saudi Arabia, Kuwait, the United Arab Emirates, and Qatar are major donors. Others are Algeria, Iran, Iraq, Libya, Nigeria, and Venezuela./7
- (c) CPE: the USSR, Eastern European countries (i.e., Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania), and the People's Republic of China. Although about 90 percent of CPE flows are known to be grants or concessional loans, they were treated as OOF because of lack of comprehensive and reliable data. Allocation of CPE flows was at best crude.
- (d) Multilateral Agencies: the traditional multilateral agencies include the World Bank Group, the Inter-American Development Bank, the Asian Development Bank, the African Development Bank, the European Development Fund, the European Investment Bank, the Caribbean Development Bank, and several UN agencies; the new OPEC multilateral agencies, established between 1974 and 1976, include the Arab Fund for Economic and Social Development (AFESD), the Special Account of the Organization of Arab Petroleum Exporting Countries (OAPEC), and the Special Arab Fund for Africa (SAFA).

/7 Other OPEC members are Ecuador, Gabon, and Indonesia.

Developing Countries as Groups of Recipients

Since the coverage of developing countries in the global framework "universe" was more restricted than in the DAC data, for analytical purposes, more groupings were included than the original four income groups and oil-exporting countries.

The following definitions indicate the data coverage and allocation:



All flows presented, unless specified otherwise, were net flows, i.e., gross disbursements minus amortization. The net flow concept was generally used because the gross flow and amortization data were less complete than net flow data. The net flow data also corresponded to the balance-of-payments information about capital flows.

The structure of financial flows has changed drastically during the past decade, and especially since 1973. The members of OPEC became major sources of capital, through bilateral and multilateral channels. Flows originating in the private sector increased considerably; official flows from the DAC and CPE

/8 OPEC members plus Bahrain, Brunei, Oman, Trinidad and Tobago.

/9 More advanced countries: Cyprus, Gibraltar, Greece, Malta, Portugal, Spain, and Israel. Others n.i.e.: all others not included elsewhere, mostly dependencies.

countries increased at a slower pace than the other components. Table 5 presents the flows and the changes during 1970-75 as reflected in the records of the donors and their institutions.

It should be noted that the total (net) flows presented exceed the totals from recipient country data as recorded in Table 4 by a significant margin. These differences are the subject of much that follows.

The table attempts to take account of the flows to and from multilateral agencies, in order to build a bridge between the statistics on capital flows by origin and the amounts which pass through to the developing countries. It should be noted that the amounts do not differ greatly, but their composition changes in the process of passing through the multilateral agencies.

Adjustment to Donor Data

Differences which are observed between the capital flows from donor sources (Table 5) and received by developing countries (Table 4) arise for a number of reasons, quite apart from statistical discrepancies. Some of the differences can be attributed to specific factors such as geographical coverage, or classification of flows, but not all of the differences can be given exact statistical quantification. The adjustments presented below, which intend to bring the donor data in closer harmony with the flows recorded by the developing countries, are therefore not based in all instances on exact measurement and in some cases are even rather crude. Table 6 summarizes the adjustments. It presents only the summary of the adjustments. They were made, for each donor country or agency separately, and by detailed categories of capital flows.

The largest adjustment is for technical assistance grants. This flow generally constitutes a much smaller amount in the balance-of-payments accounts of the recipient countries than in the values shown in DAC statistics. The

destination of technical assistance flows was often not known, but even when the recipient country was clearly identified, it was seldom possible for the recipient country's balance-of-payments statistician to record the value of the technical assistance received. To do so would have involved difficult problems in the valuation of services, of costs which recipient countries often bore, whether domestic (housing and subsistence) or foreign exchange (automotive transport). Furthermore, many of the transactions involved, such as salary payments to donor country nationals paid in the donor country, were entirely outside the recipients' borders. For that reason this component was omitted, without prejudicing the real value of those flows, but in order to achieve consistency which was essential for the projections.

Three other types of adjustments were made to donor records of official flows to developing countries. First, some flows were not allocated to individual countries in donor country records but reported in regional or global summary figures. Since all flows in the global summary had to be related to the overall financing of current deficits of individual countries, these unidentified flows were excluded. This adjustment was rather small. Secondly, the DAC figures included flows to a few developing countries that were not included in the global framework such as Cuba and North Vietnam.

The third adjustment was related to the composition of the universe of developing countries. In 1976, several countries on the DAC list of recipient developing countries were excluded because of their relatively advanced economic status. These were: Greece, Iceland, Israel, Malta, Portugal, and Spain.

The adjustments to private source flows applied mainly to direct investment. A considerable portion of investment by transnational petroleum companies based in the developed countries could not be allocated to individual recipient countries and was therefore omitted.

Table 5: COMPOSITION OF TOTAL FINANCIAL FLOWS TO DEVELOPING COUNTRIES
 ACCORDING TO DONOR RECORDS
 (In billion of U.S. dollars, net disbursements)

Type of Flows	Bilateral Sources				Destination			Total to Developing Countries	% of Total	
	DAC	OPEC	CPE	Total	To Multi-lateral Agencies	To Developing Countries	From Multi-lateral Agencies			
1970	ODA	6.84	-	-	6.84	1.12	5.72	1.06	6.78	43
	OOF	1.14	-	1.10	2.24	0.28	1.97	0.72	2.69	17
	Private	6.95	-	-	6.95	0.47	6.47	-	6.47	40
	Total	<u>14.93</u>	<u>-</u>	<u>1.10</u>	<u>16.03</u>	<u>1.87</u>	<u>14.16</u>	<u>1.78</u>	<u>15.94</u>	<u>100</u>
1974	ODA	11.30	3.40	-	14.70	3.41	11.29	2.83	14.22	42
	OOF	2.18	2.41	1.18	5.77	1.48	4.29	1.93	6.12	18
	Private	13.17	-	-	13.17	-0.07	13.24	-	13.24	39
	Total	<u>26.65</u>	<u>5.81</u>	<u>1.18</u>	<u>33.64</u>	<u>4.82</u>	<u>28.82</u>	<u>4.76</u>	<u>33.58</u>	<u>100</u>
1975	ODA	13.57	5.43	-	19.01	4.33	14.68	3.66	18.49	40
	OOF	3.02	2.42	0.88	6.32	1.09	5.22	2.66	7.72	17
	Private	21.88	-	-	21.88	2.28	19.61	-	19.61	43
	Total	<u>38.48</u>	<u>7.85</u>	<u>0.88</u>	<u>47.20</u>	<u>7.70</u>	<u>39.50</u>	<u>6.32</u>	<u>45.82</u>	<u>100</u>

Sources: DAC and World Bank staff estimates.

Table 6: ADJUSTMENTS TO DONOR DATA ON FINANCIAL FLOWS
(In \$ billions, net disbursements)

		Reductions for				
		Total to Developing Countries*	Technical Assistance Grants	Flows Not Specified by Destination	Flows to More Advanced Countries	Total to IBRD Developing Countries
1970	Official	9.24	2.08	0.30	0.27	6.59
	Private	6.47	-	2.42	-	4.05
	Total	15.71	2.08	2.72	0.27	10.64
1974	Official	20.34	3.58	0.60	0.50	15.66
	Private	13.24	-	6.57	-	6.67
	Total	33.58	3.58	7.17	0.50	22.33
1975	Official	26.21	4.63	-	-	-
	Private	19.61	-	-	-	-
	Total	45.82	4.63	.	.	.

* As in the last column of Table 5.

Comparison of Estimates

Before a comparison of estimates could be made between the records of donors and recipients, a last step had to be taken to adjust for differences in geography. Donor records, as adjusted above in Tables 5 and 6, pertain to all developing countries; a comparison with the consolidated balance of payments of the recipient countries in Table 4 requires a distinction to be drawn between oil-exporting and non-oil-exporting developing countries. For example, in 1974 out of \$15.66 billion official net capital flows to specified developing countries, (\$1.35) billion was received by oil-exporting countries, leaving a total of \$12.56 for non-oil developing countries.

This estimate from donors' records is compared in Table 7 below, with the flows recorded by recipients. The latter is taken as firm information, and the data from donors' records are adjusted to those, as represented by the residual, or adjustment, item in line 6 of Table 7. It should be noted that, in line 4, part of the flows recorded by recipients as public loans from private sources are recorded by the donors as private flows. The same will be the case for the "other" loans (line 5, the difference between IMF balance-of-payments data and the public capital flows recorded by the DRS), as those are flows without public guarantee by the recipient and therefore are most likely to be from private sources.

The efforts to develop comprehensive figures on capital flows to developing countries highlight the need to expand and to relate the various overlapping data systems. It would be most helpful, for example, if the classifications of the IMF's balance-of-payments statistics and the DRS could be reconciled. Another area where further reconciliation would be desirable is between the DAC's distinction of official versus private sources of lending and the balance of payments' distinction among general government, financial, and

other residents sectors (the latter being mainly the non-financial enterprise sector).

Table 7: COMPARISON OF DONORS' AND RECIPIENTS' DATA ON MEDIUM- AND LONG-TERM CAPITAL FLOWS TO ALL NON-OIL DEVELOPING COUNTRIES IN 1974
(Millions of U.S. dollars)

	Recipients' data	Donors' Data
1. Official grants	5,018	4,233
2. Public medium- and long-term loans from official sources	5,829	n.a.
3. Official bilateral and multilateral loans	n.a.	8,238
4. Public medium- and long-term loans from private sources	7,023	n.a.
Subtotal	17,870	12,561
5. Other medium- and long-term loans	3,007	n.a.
6. Residual/ <u>a</u>	-	8,316/ <u>a</u>
Total	20,877/ <u>b</u>	20,877/ <u>b</u>

/a Includes lending from private (national) sources, flows from international capital markets, and statistical discrepancies.

/b Equals the total of official grants and net medium- and long-term loans received according to the balance-of-payments presentation of Table 2, but excluding the net use of IMF credit shown in the lower half of Table 2.

It is understandable that statistical systems developed by different agencies for quite separate purposes at different points in time, each being dependent on different statistical offices in member countries, would inevitably have incompatible elements. But if improvements in the understanding of interna-

tional capital flows are to come about, harmonization of different data systems will be essential.

The Method for Projecting Flows of Capital

Linking data on the donor and recipient ends of the flows of capital, however unsatisfactory from a statistical point of view, permitted the design of a system of projections which took account of aid policies that determined capital flows to developing countries, and of the needs of the developing countries associated with alternative development objectives. It further permitted the introduction of capital availability as a constraint on the balance-of-payments of the developing countries or, conversely, the translation of their capital requirements into desirable levels of development assistance from major donors.

This projections system was, however, somewhat less straightforward than the statement above suggests. Starting from the donor side, the main restriction was on the availability of capital on terms more lenient than the market provided. These funds, which were almost identical with ODA as defined by the DAC, were provided through appropriations in national budgets and subjected to the scrutiny of parliaments in the donor countries. Apart from the usual time lags between their commitment and disbursement, their level was thus determined by the political process in the donor countries and, implicitly, by the priority attached to development assistance in each of these countries. Projections of these flows either had to reflect those political realities as well as possible, or they could be made in a normative sense, on the basis of estimated needs of the developing countries.

Political decisions concerning the level of official development assistance are linked with decisions allocating these amounts by countries. The

various donors have their own sets of country preferences, with criteria ranging over such factors as previous colonial relationships, the degree of poverty of developing countries, their political regimes, or the kinds of development programs which their governments pursue. The decision to allocate a part of resources to multilateral institutions affects the country allocations. In order to take properly into account the various policy options, both positive and normative projections were made and presented. A positive projection takes account of these political realities and assesses the amounts which developing countries can expect to receive on the basis of the past or stated policies; a normative projection, however, suggests allocation changes based on the analysis of the prospects of developing countries individually and as groups.

As developing countries were only modest users in relatively large markets, it would not have served any purpose to estimate the flows of other capital (largely on market terms) in the same way. A more appropriate method was to incorporate in the projections system the criteria and considerations which guided the suppliers of capital in these markets when deciding to lend to developing countries. Most or all of those considerations were concerned with creditworthiness (that is, the assessment of the likelihood that loans would be serviced as contracted).

After the allocation of official development assistance was made, the sequence of the analysis therefore turned to the economic situation and the prospects of the developing countries themselves. Projections for each developing country provided estimates of the future current account gap that would require external financing. This gap could be reduced by the amounts of official concessional capital expected to be received. The remainder constituted the need for lending at market terms and for direct private investment. For the latter, independent estimates were made largely reflecting historical trends at

both the origin and destination ends. Short-term capital was entered on the basis of the growth of a country's international trade. This left as a residual external finance gap the amounts which would need to be obtained at market terms and with a maturity over one year.

The question whether this residual financing could in fact be assumed to be available depended on the debt service burden which was associated with that level of borrowing, and on the amount and terms of the already outstanding debt. Debt service burdens from previous and new borrowing together could be compared to indicators of a country's carrying capacity, usually related to exports, the national income, the fiscal position, or combinations of those. In addition to objective indicators of this kind, subjective ones, such as judgments about political and economic stability, are also likely to be relevant. These are usually based on past experience, particularly regarding the debt servicing record and past recourse to debt renegotiations.

Once the amounts needed to be borrowed at market terms were considered to be reasonably within the limits of proper financial management, these were adopted and used as firm projections. If they exceeded such limits, either of two possibilities had to be considered: a larger part of total capital flows had to be provided at concessional terms, or the total projected flows had to be reduced to manageable levels. The first alternative arose only for countries with low per capita incomes, where donors preferred in the main to concentrate their concessional capital. The more advanced developing countries - which were also the largest borrowers at market terms - depended for their capital flows almost exclusively on what was considered to be prudent financial management.

Thus, total capital flow projections, particularly official flows and borrowing from other sources, consisted of a donor-determined flow of concessional capital and an element of other lending which was determined by the

balance-of-payments prospects of the recipient country and the judgments concerning these prospects by the major capital suppliers to the markets.

Official Development Assistance (ODA)

Until 1973 the DAC countries were virtually the only source of concessional capital to developing countries meeting the standards set for ODA: (i) administered with the promotion of the economic development and welfare of developing countries as its main objective and (ii) concessional with a grant element/¹⁰ of at least 25 percent. ODA consists of grants and official development lending. Its level has often been measured against a yardstick of 0.7 percent of DAC members' GNP, but it has in practice been considerably less. In 1970 it amounted (in terms of net disbursements) to 0.34 percent; and in 1975, to 0.36 percent.

Earliest projections, in 1974 and 1975, were pessimistic. The ODA flows had declined considerably between the 1970 and 1973, and the latter year constituted a low point (0.30 percent) compared to the DAC countries aggregate GNP. This decline resulted not only from the slow rise of new commitments, but also from the eroding effect of inflation, which raised the nominal GNP of most countries by unprecedented annual percentages. Currency revaluations gave increasing weights to countries with below-average performance, thus reducing the average even further.

¹⁰ Grant element is grant equivalent as a percentage of the face value of a financial commitment; grant equivalent is defined as the face value of a financial commitment less the discounted present value of the required amortization and interest payments using a 10 percent discount rate.

Table 8: ODA FROM DAC MEMBER COUNTRIES, 1974-85/a
(As % of GNP)

	1973	1974	1975	1980	1985
Projections mid-1974	<u>.30</u>	.30.30	.25	n.a.	
mid-1975	<u>.30</u>	<u>.33.32</u>	.24	n.a.	
mid-1976	<u>.30</u>	<u>.33.36</u>	.31	.35	

/a Underlined are (provisional) actuals at the time of the projection.

Early pessimism was not only based on the declines noted in previous years: it also reflected the assumption of a rapid recovery from the recession and the restoration of growth in the industrial countries, combined, however, with high rates of inflation. It was doubted whether allocations for ODA would be made sufficiently large to keep up with those GNP projections. Finally, the better than expected performance in 1974 was thought to be incidental because of large food aid shipments which could not be considered representative for longer-term trends. In the projections made in mid-1976, the conservative assumption for 1980 was dropped, given the provisionally available data concerning the 1975 performance, which was considerably above earlier expectations. As detail was lacking at the time, it was felt that stated policies of donor countries still did not justify the maintenance of the 1975 percentage of 0.36. A decline between 1974 and 1980 was expected, with a subsequent rise towards that level by 1985. A decline in 1976 to 0.33 percent seemed to substantiate this view./11

/11 Note, however, that Robert S. McNamara, Address to the Board of Governors, September 26, 1977, Annex III, page 39, assumed a rising ODA percentage from 1975 to 1980.

From 1973 the group of capital-surplus OPEC countries became an important new source of ODA. As these countries did not report to the DAC secretariat on their capital transactions with developing countries, their contribution to actual flows was difficult to establish. To project these flows in the absence of clear statements of policy and under rather uncertain balance-of-payments prospects of policy was even harder. In the first projections exercise (in mid-1974) no attempt to estimate the contribution of the OPEC group was made; instead, the additional capital requirements under alternative development strategies were simply listed, without apportionment between OPEC and DAC countries.

Subsequent projections, in 1975 and 1976, benefited from the gradual improvements in data on actual commitments by the OPEC countries, and attempted to establish links between these commitments and the current account surplus of these countries' balances-of-payments. But information on the terms of these commitments remained scarce, whereas it was also not easy to derive disbursement estimates from the data on commitments. The reporting by recipient countries under the DRS gradually provided more insight, but the overall flow estimates remained subject to considerable error and doubt.

The 1976 estimates are presented in Table 9, which also contains the estimates of flows to multilateral agencies and the flows from those agencies to developing countries. Flows of ODA to multilateral agencies include the contribution (as grants) of member countries to the capitalization of those agencies. These amounts are never passed on to developing countries but are the basis for borrowing in the capital markets by these agencies which are subsequently passed to developing countries at near-market terms. This is one of the main reasons why ODA flows to multilateral agencies almost always exceed the ODA flows from these agencies. Conversely, OOF to developing countries always

significantly exceed receipts of such capital from member countries. The last line of Table 9 contains the previously discussed adjustments which were considered appropriate to bringing donor records more closely in line with reporting by recipient countries.

Table 9: ODA SOURCES AND DESTINATIONS
(In billions of U.S. dollars, net disbursements)

	Actual			Estimated Projections		
	1970	1974	1975	1976	1980	1985
DAC	6.84	11.30	13.57	13.74	24.40	41.90
(As % of GNP)	(0.34)	(0.33)	(0.36)	(0.33)	(0.37)	(0.37)
OPEC	-	3.40	5.43	5.07	5.46	6.36
Total from bilateral sources	<u><u>6.84</u></u>	<u><u>14.70</u></u>	<u><u>19.01</u></u>	<u><u>18.81</u></u>	<u><u>29.86</u></u>	<u><u>48.26</u></u>
To multilateral agencies	1.12	3.41	4.33	4.77	7.58	12.33
(As % of total from bilateral sources)	(16.4)	(23.2)	(22.8)	(25.4)	(25.4)	(25.5)
To developing countries	5.72	11.29	14.68	14.05	22.28	35.93
From multilateral agencies	<u>1.06</u>	<u>2.93</u>	<u>3.81</u>	<u>4.00</u>	<u>6.61</u>	<u>10.58</u>
Total ODA for developing countries	<u><u>6.78</u></u>	<u><u>14.22</u></u>	<u><u>18.49</u></u>	<u><u>18.05</u></u>	<u><u>28.89</u></u>	<u><u>26.51</u></u>
Of which developing countries/ <u>a</u>	4.37	9.92	12.70	12.49	19.93	32.10

/a After deleting technical assistance, flows to more advanced countries and flows without specified destination (see Table 4).

Allocating ODA Flows

The distribution of ODA to recipient countries is governed by a variety of criteria and donor preferences (which have changed over the years) and by the

types of assistance offered. The latter factor is, for example, demonstrated by the role which food aid has played in the past. The amounts have fluctuated strongly from year to year, depending on the food situation in major food-deficit countries, and have through those fluctuations affected the overall allocation by countries. To a lesser extent, this applied to the ODA amounts used for debt reorganization.

The share of the lower-income countries (those with per capita incomes of \$200 or less in 1975) never rose to that of their share in the total population of the developing countries, notwithstanding efforts to allocate a larger part of ODA to them between 1970 and 1975. The oil-exporting countries did, however, see their share reduced by about one-half between 1970 and 1975, and this shift did entirely benefit the middle-income countries, particularly those with per capita incomes of about \$200 and \$520 in 1975. In Table 10 the data for 1970 and 1975 are brought together in a summary presentation. As the data combine bilateral and multilateral flows, it may be noted in addition that, whereas bilateral flows contain a relatively larger share for the middle-income countries, multilateral ODA is more favorably distributed towards the lower-income countries.

Table 10: ALLOCATION OF TOTAL ODA BETWEEN DEVELOPING COUNTRIES
IN 1970 AND 1975

	1970			1975		
	Lower- Income Country	Middle- Income Country	Oil- Exporting Country	Lower- Income Country	Middle- Income Country	Oil- Exporting Country
ODA (\$ bln)	1.96	1.76	0.64	5.55	6.21	0.95
(% of total)	(45)	(40)	(15)	(44)	(49)	(7)
Population (mln)	930	660	270	1,040	730	310
(%)	(50)	(35)	(15)	(50)	(35)	(15)
Per capita ODA (\$)	2.12	2.67	2.41	5.34	8.51	3.09

The projections assumed, in accordance with stated policy, that there would be some increase in the share of the lower-income countries over time, reaching proportionality to population shares in 1985. In alternative (normative) projections this assumption was changed, suggesting that the share of the lower-income countries should increase faster over time. It was noted that in 1974 about \$2.0 billion went either to countries with per capita incomes above \$1,000 or to countries receiving \$20 or more in per capita terms per year. It was suggested that this amount was available for reallocation to the lower-income countries. It could have added about 40 percent to the ODA - flows directed towards those countries. This was equivalent to about 10 percent of their total foreign exchange receipts.

Other Official Flows

OOF are largely in the form of official credits to finance the exports of the donor countries, or other transactions on nonconcessional terms. Projections of these flows are based on the best evidence available of transactions in the recent past and, at least for DAC countries, on what is known about the operations of such institutions as the U.S. Export-Import Bank. Of necessity, the aggregates were based on scattered information of uneven quality. The information for the OPEC countries was even less firm and the projections weaker. In the case of the CPEs, the information was derived from the press or from agencies of other (DAC) governments and from the records of recipients. Much of this information was particularly difficult to interpret, because many purchases from CPEs by recipient countries were valued at unknown prices, and were often repaid by exports to the CPEs with prices and commodity composition left to be agreed upon at some future date.

Total Official Flows

The analysis of official flows "received" by groups of developing countries was based on the historical record of flows to them, on estimates, and on projections, with an underlying assumption that present policies, and the resulting patterns of flows by type and destination, would generally be more or less static. Because all of these flows were recorded and projected net of amortization, and because the projections were made in light of what was known of commitments in the recent past, this general assumption was probably sound enough for a large proportion of flows for the near-term projected years, though weaker after that time. In the near-term, it was nonetheless at the mercy of major noneconomic changes, hostilities, natural disasters, and so on, which lay outside the system of projections. The identity of each of the main types of flow was preserved. Grants were distinguished from loans because the former did not, and the latter did, affect the external debt position and prospects of the recipient countries. Bilateral and multilateral flows were shown separately because the assumptions underlying the projections were somewhat different.

Private Direct Investment

As was noted before, the information contained in the balances of payments of the recipient countries was taken as the preferred source of past data on private foreign direct investment. In a few cases this needed to be supplemented from information collected by the DAC secretariat from sources in countries of origin. There were wide differences between DAC data and the IMF balance-of-payments reports. The balance-of-payments reports investments from all origins, whereas DAC data cover only member countries, and different treatment of reinvested earnings also causes a discrepancy. The latter are usually not recorded in the balance of payments. The preferred data source may thus have

underestimated the contribution to total capital flows. There would, however, not have been any difference in balance-of-payments totals, as, obviously, investment income payments were understated by the same offsetting amount.

Private foreign direct investment is characterized by fluctuations from year to year. In current prices the rate of growth between 1969 and 1975 was close to 20 percent per year, and even more if a trend is fitted to the estimates. In constant prices the rate was probably closer to 6-7 percent per year. The projections assumed even lower rates for the future, around 4-5 percent per year in real terms, to take account that less interest in investment in minerals and oil production in developing countries was not entirely offset by growing flows for manufacturing industry.

Borrowing and Debt

A variety of sources exists for meeting the residual requirements of external finance, after account is taken of inflows from official sources and private foreign direct investment. The developing countries' creditworthiness ratings determine the availability of such sources. They can be tapped in various ways: by governments or public authorities, in which case there will be a public guarantee of the recipient government; or by other agencies in the recipient countries either with or without a public guarantee. Therefore, the accounts (drawn from recipient data) distinguish between public loans from private sources, including loans publicly guaranteed, and other (non-guaranteed) borrowing which usually constitutes a transaction between a private lender and a private borrower. As the latter category of lending was not initially recorded in the DRS, it was estimated as a residual flow from a comparison between the balance-of-payments and the DRS.

The DRS distinguished further, within public loans from private sources, between suppliers' credit, financial markets (including private banks), and other private sources. This information was cross-checked and sometimes supplemented with data provided by the DAC countries, particularly on guaranteed (by the donor) export credits through the Expanded Reporting System (ERS). The World Bank also maintains a separate information base, the Capital Markets System (CMS), on foreign and international bond issues and Eurocurrency credits. As transactions are in the main individually recorded in these systems, details of borrowers, lenders, terms, and amounts are usually available. On that basis it was possible to obtain a reasonably complete account of all debts which had been incurred in the past by the public sector or with a public guarantee; the information also permitted projections of future debt service arising from these liabilities.

Such information was not available for non-guaranteed debt and capital flows. Some reporting took place through the DRS under a program started in 1970; by 1976, 16 countries provided various degrees of information. Such borrowing was important only in a relatively few countries which had a private sector sufficiently creditworthy to borrow. Several of those countries were among the most advanced, and some published their own statistical reports on private external debt.

A survey of these reports suggested that a total of about \$22-23 billion of outstanding debt without developing country guarantee by the end of 1975 was a reasonable estimate for non-oil developing countries. This rough estimate was corroborated by aggregating the net capital flows labeled "other medium- and long-term loans" over the period 1967-75 for all countries with positive numbers for this item in the balance of payments.^{/12} This estimate compared with a total

^{/12} It will be recalled that this item was the residual from comparing total medium- and long-term capital (net) in the IMF balance-of-payments with public borrowing (net) as recorded in the DRS.

public or publicly guaranteed debt outstanding by the end of 1975 of \$95 billion, again for the non-oil countries only. Both numbers exclude undisbursed balances. Table 11 summarizes the estimates.

Table 11: DEBT OUTSTANDING AND DEBT SERVICE BY COUNTRY GROUPS, 1975
(In billions of U.S. dollars)

	Public Debt		Private Debt
	Official Sources	Private Sources	Private Sources
DEBT OUTSTANDING AND DISBURSED:			
Low-income countries (24)	22.5	2.8	1.0
Middle-income countries (49) ^{/a}	34.9	34.5	22.0
Oil-exporting countries (8) ^{/b}	12.1	10.1	n.a.
Total	69.5	47.4	23.0 ^{/c}
DEBT SERVICE LIABILITIES:			
Low-income countries	1.3	0.4	0.2
Middle-income countries ^{/a}	3.6	8.1	5.2
Oil-exporting countries ^{/b}	1.3	1.6	n.a.
Total	6.2	10.1	5.4 ^{/c}

^{/a} Excluding more advanced Mediterranean countries.

^{/b} Partly estimated.

^{/c} Excluding oil-exporting countries.

Inflows of private source capital, subsequent debt accumulations, and debt service liabilities were estimated for each recipient country separately on the basis of the balance-of-payments prospects and an assessment of prudent borrowing levels and debt management. The creditworthiness assessment was not purely objective as it did involve risk assessment which could not be quantified, although the use of comparatively objective indicators became more sophisticated

over time. The heavy borrowing by developing countries, particularly in the years 1974-76, gave rise to fears that several of these countries would, in due course, find themselves unable to meet their debt service liabilities. The World Bank, though directly concerned, tended to take a relatively sanguine view which gradually was accepted in financial quarters. The analysis which led to this attitude is presented below, as it provides interesting insights into a number of interactions and relationships of relevant economic variables.

Creditworthiness

The most common approach to assessments of creditworthiness compares future debt service liabilities to export earnings. For a number of years, it was thought that debt service exceeding a particular percentage of export earnings constituted a warning signal of reduced creditworthiness and increased risks associated with new loans to the country. But such a simple measure cannot convey a proper assessment for all countries at all times.

Obviously, the growth record of a country and, in particular, the export performance in past years have a bearing on the assessment. Linked to this factor is the composition of exports and the stability or instability of foreign exchange earnings. Thus, the calculation of a debt service ratio for a single year is a very inadequate indicator of debt servicing capacity; the direction and magnitude of changes over time are crucial in any examination of debt burden indicators. And in cases characterized by instability of export earnings, one is clearly led to the question whether a country had adequate foreign exchange receipts and has preserved its access to IMF resources to meet unanticipated declines in export earnings without endangering the timely payment of debt service liabilities. Behind all of this, there is the quality of balance-of-payments management by the government concerned.

Similarly, there is a significant element of management associated with the debt itself. Problems can arise if a government permits external borrowing without some form of control - direct or indirect - or registration requirements as to amounts, terms, and purpose. In the majority of cases, governments are at least aware of the debt service burdens which are assumed for the future, or take a firm hand in preserving manageable future payments by setting ceilings on amounts and terms. The quality and continuity of debt management plays a major role in maintaining access to foreign capital markets.

It is therefore not possible to rely on one or just a few objective indicators of creditworthiness; those are only a starting point, not a substitute, for country-specific knowledge and analysis. In much of the public debate concerning the rapid growth of indebtedness of the developing countries and the international measures to be taken, a lack of such in-depth analysis and excessive reliance on aggregated data for country groups have led to unwarranted conclusions and to policy recommendations of doubtful quality and usefulness.

Between 1968 and 1973, the debt of the non-oil developing countries rose on average by over 16 percent per year. As the share of borrowing from private sources increased somewhat over that period, average terms hardened somewhat, with debt service payments increasing slightly faster, by a little over 17 percent per year. However, export earnings of these countries increased about equally rapidly, by an average of almost 17 percent per year, resulting in a stable ratio of average debt service to exports. But movements of the ratio over time were quite different between individual countries.

As shown in Table 12, the growth of indebtedness accelerated (in current terms) between 1973 and 1976, to more than 21 percent per year. It should be noted, however, that export earnings almost maintained their growth in nominal terms, so that on average the indebtedness compared to exports did not rise very much.

Table 12: THE GROWTH OF DEBT AND EXPORTS, 1967-76
(In % per annum)

	1967-73		1973-76	
	Exports	Debt ^{/a}	Exports	Debt ^{/a}
Lower-income countries (24)	10.6	11.8	12.5	14.3
Middle-income countries (49)	17.8	18.4	16.8	23.5
Total non-oil countries	16.7	16.5	16.3	21.3
Oil-exporting countries (8)	21.1	25.6	38.3	19.3
Total developing countries	17.7	17.8	22.6	21.0

^{/a} Outstanding and disbursed, end of period.

Borrowing from private sources, which is the major part of capital flows for which creditworthiness is important, is concentrated largely in the group of middle-income countries. Debt to private creditors amounted to only 12 percent of total debt of the lower-income countries' by the end of 1975; a large part was concentrated in only a few countries, particularly Zaire, Sudan, and Pakistan. This was at the same time less than 5 percent of total developing countries' debt to private creditors. Oil-exporting countries, which were mostly in a favorable balance-of-payments position, accounted for another 17 percent; the remaining 78 percent was owned by middle-income countries. And within that group there was again a very strong concentration in a few countries: five accounted for almost 70 percent of private source debt of middle-income countries, and nine countries together for about 80 percent. In order of importance these were Brazil, Mexico, Yugoslavia, Argentina, and Korea, followed by Chile, Philippines, Peru, and Colombia.

Whereas rapid growth of debt through 1973 was almost fully offset by the growth of exports, between 1973 and 1976 this was no longer so. In addition,

while the earlier period was characterized by an even more rapid increase of foreign exchange reserves, after 1973 reserves remained stable through 1974 and 1975, and increased significantly again only in 1976. There was also an important change in the growth rate of debt service payments, which, until 1973, equaled more or less the growth of exports and of debt; since 1973, debt service grew much faster than debt because of harder average terms. The development for the middle-income countries are summarized below:

	<u>1967</u>	<u>1973</u>	<u>1976</u>
Debt service as % of debt	15.5	16.2	18.7
Debt as % of exports	86.2	89.2	105.3
Debt service as % of exports	13.4	14.5	17.8

The continued heavy borrowing through 1976 and the difficulties of reducing balance-of-payments deficits rapidly in sluggish international conditions suggested further increases of debt service burdens in the years ahead. During 1976 particularly there was considerable doubt about the capability of the major borrowing countries to manage their external financial matters properly; these feelings were expressed in a number of publications which influence opinion in financial markets.

The World Bank's analysis took account of the changed character of the borrowing by these countries: loans from private sources (particularly from banks and from the international capital market) were not tied to the execution of projects. Instead, their proceeds were available fully from the day of issue of loan. It was therefore also possible to refinance these loans when they fell due, and this kind of financial arrangement was applied rather widely. The willingness of lenders to engage in refinancing depended to a significant degree on the prompt payment of the other part of debt service: the interest on the outstanding amount. Under conditions of sound financial management, the part of debt service

which in fact had to be paid consisted of all interest charges plus amortization of official loans. The element of amortization on loans from private sources constituted almost half of debt service payments, and was therefore of profound importance in the assessment of creditworthiness.

The level of interest payments thus became an essential part of the analysis. If a country had good overall prospects, then refinancing and changes in the maturity of previous loans would be expected to be available. Interest payments depended on rates charged on loans. These were affected by the adoption of variable interest rates, which were reduced after 1974 as inflation rates fell and the capital market softened. The average rates of interest charged by private lenders to developing countries were, moreover, at or below the annual rates of inflation prevailing in the world economy. They nevertheless provided needed investment opportunities for the capital market. The developing countries' strategy of borrowing at commercial rates of interest made good sense as long as amortization requirements did not place excessive strains on the flow of foreign exchange.

Capital Markets

The considerations about creditworthiness and debt management described above led to estimates of amounts that would be borrowed by each of the developing countries on commercial terms. Some effort was made to specify most likely sources of these flows, to permit their aggregation. Those totals could then be analyzed further, assessing not only the totals from each source and the probability that their growth could be justified, but also the relation of these totals to possible overall trends in the major markets in which developing countries were expected to borrow. For example, developing (non-oil) countries appear to have used, through the end of 1976, some 10 percent of total available

resources of the Eurocurrency market; adding flows to them through so-called offshore centers, this share might be somewhat larger. They also contributed significantly to the total funds available in that market and were therefore not likely to find the size of the market to be a constraint on their borrowing.

This type of analysis could, however, not be carried very far, as the relations between private lenders and (public or private) borrowers were quite complex and interwoven. Some banks which lent to developing countries were themselves engaged in banking operations within those countries; some were the holders of those countries' assets abroad. Loans by banks were frequently only a part of a much larger financial operation which included equity investment by a foreign private corporation, combined with a Eurocurrency loan for working capital and an officially guaranteed export credit for imported equipment. At the same time the government may have borrowed in the Eurobond market and possibly from a multilateral financial agency to finance the necessary infrastructure.

Profitability has been an important consideration in decisions of private lenders to extend credits to developing countries. So far, only few mishaps have occurred, and even those have not been too costly for the banks involved, as interest payments have been preserved in debt reorganizations involving private lending. This accounted for a good deal of the staying power of the new borrowers in these markets. One should nevertheless take account of the fact that capital markets are sensitive to expressed opinion, even if only based on casual judgment. Excessive pessimism can destroy a balanced investment climate and create severe liquidity problems which, in turn, would have consequences seemingly justifying the expressed pessimism. Sound analysis of the debt situation and economic management which takes account of its results can perpetuate that situation. In this context, the impartial analysis by multilateral financial institutions can serve the interests of lenders and of borrowers alike. The

manageability of the situation can be further improved if international resources are available to meet the needs of these countries in case of export shortfalls, for which many are less well-equipped now as compared to the early 1970s.

Chapter IV

AN OVERVIEW OF THE GLOBAL MODELLING SYSTEM

Forecasting and Bank Operations: The Need for Consistency and Sensitivity Analysis of Projections

The Bank needs projections both for general planning purposes and to ensure that individual lending operations are based on coherent assumptions about the future. The projections presented here were also developed to complement other international organizations' analyses of prospects of the world economy.

The broad sweep of the Bank's economic intelligence system of the early 1970s was surveyed in the first part of this book. It covered the growth of individual developing countries, trends in commodity markets, and capital flows from developed to developing countries. The system integrated data collecting, forecasting, and decisionmaking. This second part describes how global modeling was used to complement the detailed data-collecting and forecasting work.

The high degree of decentralization of this intelligence system was both its strength and its weakness. It was a source of strength because it made it possible to draw on the detailed firsthand knowledge of the operational staff. It was a source of weakness because it made it difficult to build up a consistent picture of economic trends.

Routing of this information through the Economic Projections Department of the Bank solved the consistency problem only partly. Centralization of the data processing ensured that definitions were consistent, and made it easier to spot and to eliminate obvious errors in the basic data. The statistical staff were gradually able to acquire an understanding of the biases which affected the data, making it possible to improve the consistency of the data produced in spite of its diverse origin.

Consistency of forecasts was no less important than consistency of data. The Bank's activity required correct judgments about the appropriate allocation of funds between borrowers, and about the selection of economically justifiable projects. It was clear that these judgments had to be based on a consistent view of the future. It would not do, for example, to compare the creditworthiness of two countries on the basis of export projections which reflected different views of the future rate of growth of the world economy, to base cost-benefit calculations for different sugar production projects on different sugar prices, or to undertake simultaneous lending projects for a commodity which would lead to production increases so large that they could disrupt its market.

Producing consistent forecasts raises problems of a different order than those involved in producing consistent statistical data. Forecasts involve personal judgments about the future, and reconciling different views about the future is a more delicate task than reconciling numbers.

It has been argued that consistency of forecasts can be achieved readily through "horsetrading sessions" in which participants argue out their differences, without any need for a formal model. Such sessions are indeed necessary, and in fact they provide a vital channel for the exchange of information which conditions the forecasting process. But this approach has limitations.

It is easy to achieve agreement about facts: about the policy measures recently adopted by a government, or the date at which new production facilities will begin to produce. But reconciling divergent views of the future also requires agreement about the repercussions of those events -- about their impact on prices, incomes, and other variables.

One of the important functions of a model is therefore to provide an agreed view of the economic mechanisms involved in formulating a forecast, so as to make it easier to reconcile differences of opinion in the future. Experience suggests that no model is detailed or accurate enough to cover all aspects of the situation. A country economist may, for example, feel that the price of the coffee exported by his country will move differently from the price of the type of coffee predicted by the model. It may be argued that a new disease will reduce yields and depress output below the level predicted by the supply equation. The model eases the task of reconciling divergent views, but the forecasts which are finally used as a basis for decisions usually do not coincide precisely with those predicted by its equations.

A perhaps even more important function of a global model is to produce a consistent set of basic forecasts for use in generating the detailed forecasts required for decisionmaking. Any detailed forecast involves, in addition to a knowledge of facts and mechanisms which are specific to a market or a country, assumptions about future changes of global variables such as the rate of inflation in the world, the growth of world trade, of GNP in developed countries, etc. The use of a global model assures that such forecasts are compatible with a coherent view of developments in the world economy.

What must be emphasized above all is that the global model is but one element of a broad attempt at comprehending the future. Bank operations are inseparable from attempts to comprehend the future, and this implies that a wide diversity of forecasts tends to be made throughout the Bank. The model is an essential component of this forecasting effort, but it is only one of the pieces. It can help to reduce inconsistencies among projections, but there are too many divergences of opinions to preclude their complete elimination among forecasters.

Alternative Modelling Strategies

Three approaches are conceivable in modeling the world economy. The first is to specify and estimate a comprehensive model to answer a wide range of questions. This approach was used as early as 1953 in the model of the world economy designed by Neisser and Modigliani./¹³ Many models of that type have been built since that time. Recent well-known examples are those of the Club of Rome and that built for the United Nations by Leontief, Carter, and Petri./¹⁴

A problem with this approach is that it takes a centralized team of specialists to build a coherent and comprehensive global model. This may be the best organization in academic research, but in a policy-oriented organization there is some risk in splitting model specialists from those involved in analyzing current developments. A specialized group of model builders is probably able to build and to operate sophisticated models, but there is a risk that they might lose the grass roots knowledge of current facts, and produce work which seems irrelevant and out of touch with reality to those whom the model is meant to serve.

The single-model approach may also not be flexible enough to satisfy all needs. Answering a given question usually requires a detailed representation of only part of the economy: other parts can be represented in an aggregated way. Multipurpose models therefore tend to be quite large, with all the problems of errors and difficulties in analyzing output which characterizes very large

¹³ H. Neisser and F. M. Modigliani, National Incomes and International Trade (Urbana: University of Illinois Press, 1953).

¹⁴ Meadows, Donella et. al., The Limits to Growth (New York: N. Y. University Books, 1972); Mesarovic, M. and E. Pestel, Mankind at the Turning Point (New York: E. P. Dutton, 1974); Leontief, W. et. al., The Future of the World Economy (New York: Oxford University Press, 1977).

models./¹⁵ A multipurpose model is of course richer than a system designed to answer a narrowly defined set of questions. But in operational use, when speed is at a premium, this gain may be more than offset by the loss of time involved in manipulating large systems of equations.

One of the most promising trends in model building in recent years has been the development of methods of linking models built by different teams into a broad and comprehensive system. The pioneering effort in this field has been Project LINK. This approach avoids the tendency of the builders of the global model to become separated from reality. Their main function becomes that of fitting into a coherent system component models built by persons who have detailed knowledge of the various parts of the world economy. This makes it possible to draw on a far greater pool of knowledge than would be available to any centralized model-building team, while retaining the consistency and the ability to represent global interactions which characterize global models.

Linkage is, however, a less elegant approach than the design of a single global model. Because their design is not coordinated, the individual models may be difficult to fit together convincingly. Individual models tend to contain large groups of equations predicting variables which are of interest to the country itself, but could be dispensed with from the point of view of analyzing interactions among countries. The resulting linked model may therefore be much larger than necessary. On the other hand, individual model builders very naturally attempt to pay greater attention to interactions among domestic variables than to the mechanism through which countries interact. There is therefore a bias towards underestimation of the interdependence of countries.

¹⁵ The increase in size is often multiplicative rather than additive. For example, if there are "n" products and "m" regions in a country, an input/output system which seeks to describe production regionally, will have an (nm x nm) coefficient matrix.

For these reasons, linkage of the minimum standard models was not an attractive solution. The 40-odd RMSMs are quite large, principally because of their detailed representation of the foreign debt of borrowing countries to a much greater degree of detail than would be needed for global analysis. At the same time, the mechanisms which determine growth are described quite crudely; the growth of particular sectors is in fact frequently treated as exogenous. Linkage of these models would not have been an effective way of studying the impact of the outside world on the growth of developing countries.

Linkage, finally, requires a major effort in specifying and estimating the linking equations, and running the system as a whole through the computer. The specification of the linkage equations has to take account of any inconsistencies in the choice and definition of the variables involved in linkage. Variables which at first sight seem similar may, for example, differ because different model builders have used different sources. The adjustments are conceptually not difficult, but may in practice absorb a substantial amount of time and effort.

The approach which was eventually used - parallel simulation of overlapping models - is by far the simplest to operate, and is undoubtedly the one most widely used by policy-making organizations. The basic elements are models built by different persons or groups of persons, describing different parts of the economy, having overlapping variables which are common to two or more of the models. The overlapping variables could be used to link the models together formally, provided that appropriate equations were used to convert each model's variables into those of the others. It is simpler to operate the models in what has sometimes been termed as a "conversational mode," in which the output of simulation of each model suggests alternative runs of the others.

This approach, of course, does not make it possible to reflect, except in a rough way, feedbacks of one model to the others. This is a serious problem only if these feedbacks are strong. If not, a "conversational" use of models can be made to yield as much of a feel for the workings of the world economy as would result from the operation of a fully linked model system.

An Overview of the Model System

The model system was designed to study the interaction among the economies of the non-oil-exporting developing countries, the developed countries, and the oil-exporting developing countries. These were grouped into regions linked by trade and capital flows, the definition of which varied from year to year. A special attempt was made to represent the relation between commodity prices and the level of aggregate output in the world economy by a system of commodity models.

(i) The determinants of growth of developing countries: the SIMLINK model

The dominant problem confronted by developing countries at the time when the global modeling system was first built was a severe balance-of-payments crisis resulting from a sudden drop of the purchasing power of their exports. The non-oil-exporting developing countries were hard hit by the near quadrupling of oil prices. The boom in grains prices, which continued into the year 1974, added to their difficulties; the recession in developed countries was beginning to affect the exports of developing countries.

It was obviously necessary to focus the initial modeling effort on these problems. The SIMLINK model, the first version of which was built in 1974, was designed to assess the impact of these balance-of-payments pressures, and to suggest ways of reducing them by appropriate aid policies./16 An important

/16 See Chapter V for a complete description of SIMLINK.

objective was to illustrate how changes in the level and allocation of aid might avoid cutbacks of the growth of developing countries and, in particular, of the poorest among them.

It was felt that until 1980, the terminal year of the projections, the shortage of foreign exchange would be the main constraint on the growth of developing countries: in the phraseology of the two-gap model of developing countries' growth, the "dominant gap" would be the balance-of-payments constraint. This implied a model structure of the type described by the heavy arrows in the diagram below.

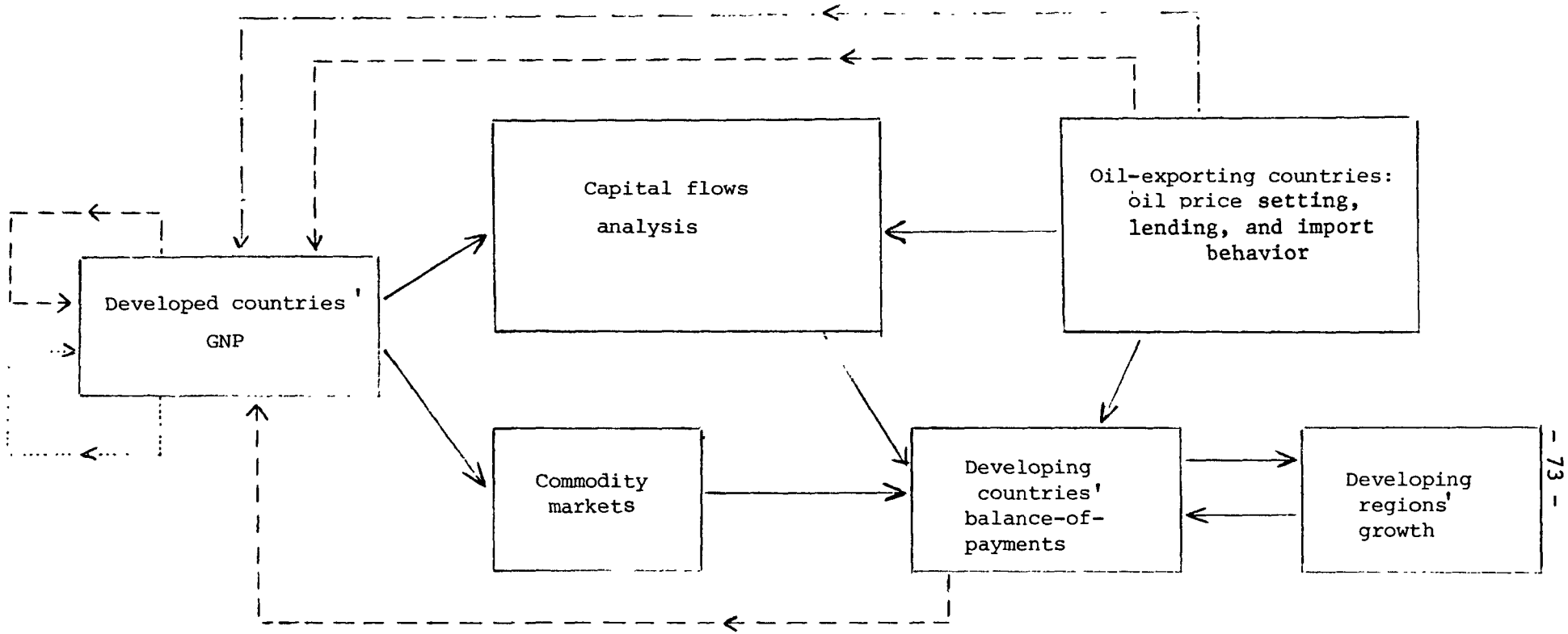
The model describes a recursive mechanism, in which developing countries respond to changes in the purchasing power of their exports and receipts of aid by adjusting the level of their GNP to a level at which imports are equal to foreign exchange receipts. The prices of their oil exports are exogenous, while - this is the most original feature of the model - commodity prices are determined endogenously by a system of commodity market models. Capital flows to developing countries are treated implicitly as endogenous. In alternative simulations, the amount of official development assistance extended by the developed countries is related to their GNP, while the amount of aid from members of OPEC is related to the surplus of their balance of payments.

(ii) Tracking the recession using the MULTILINK system of dynamic multipliers: an analysis of the short-run impact of events affecting the world economy.

According to the SIMLINK model, GNP changes in developed countries are the strongest of the forces which affect the growth of developing countries. It was clearly necessary to improve the understanding of how these changes are determined.

Fig. 1

GLOBAL FRAMEWORK OF THE MODELS SYSTEM



In the short-run, the relevant mechanisms are Keynesian. It is necessary to account for the forces which are responsible for short-run changes in the level of aggregate demand. Examples are (see dashed arrows in Figure 1):

- (a) The increase of oil prices was to a certain extent comparable to an excise duty imposed on oil-importing countries by the members of OPEC. To the extent that this drain on purchasing power was not offset by a corresponding increase of imports by members of OPEC, it should be counted as one of the factors contributing to the recession.
- (b) It was widely expected initially that the increase in oil prices would lead to a sharp upsurge of investment in the production of oil, coal, and nuclear power.^{/17} This investment did not materialize, because of the opposition of environmentalists to nuclear power, offshore oil exploration, and strip mining of coal, and because energy prices in the U.S. were kept at low levels. But it seemed at the time that it would become a significant force in pulling developed countries out of the recession.
- (c) Developing countries resorted heavily to foreign borrowing in 1974 and 1975 to maintain growth in spite of the pressure on their balances-of-payments. The imports financed by this borrowing helped to sustain employment in the early years of the recession.

^{/17} See, for example, the forecasts of OECD in Energy Prospects to 1985: An Assessment of Long-Term Energy Developments and Related Policy, (Paris, 1974).

(d) Finally, it was desirable to have a means of assessing the impact on the world economy of the fiscal policy measures - both expansionary and deflationary - which were adopted by governments of developed countries from the beginning of the recession./18

The analysis of the impact of events such as these requires a large model. This model should be able to represent adequately the short-run dynamic interactions involved; it must also indicate how short-run changes in demand are transmitted from country to country. It would have to describe the economies of developed countries, which play a dominant role in business-cycle fluctuations.

No such model was available in the Bank, nor would it have been sensible to build one for the purpose; a substantial amount of work on linked short-run models of developed economies already existed. It would have been pointless to duplicate it.

It would have been possible to run simulations on one of those models to assess the impact of the events mentioned. Even this would have been a complex task, because of the size of the models. As only rough estimates of the magnitude of these impacts were needed, it was decided to adopt a simpler approach involving the models' dynamic multipliers.

Dynamic multipliers measure the impact on the variables of a model of specified changes of their exogenous variables. They are calculated as the difference between a "perturbed solution," in which one exogenous variable is changed with respect to a "base case solution." Each perturbed solution makes it possible to calculate how a given change in one exogenous variable modifies each

/18 A number of countries - the U.S. in particular - have sought to expand demand by tax cuts. Many others have, however, increased taxes and cut back spending in an attempt to reduce budget deficits.

of the model's "M" endogenous variables: the multipliers thus defined form a vector for each year. If "N" exogenous variables are perturbed successively, then the dynamic multipliers form an (M x N) matrix.

The dynamic multipliers are constants only for linear models; in the non-linear case, the matrices depend on the chosen base case solution. Present day business cycle models are nonlinear. However, experience suggests that they behave almost like linear systems, so that assuming constancy of the dynamic multiplier matrix is a reasonable simplification if all that is desired is to evaluate the order of magnitude of the impact of specific events./19

(iii) The lasting impact of the recession on potential growth of developed countries: the simple developed countries growth models: the OECD potential growth evaluation.

A prolonged recession may affect the future production potential of the economy by changing the rate of technical progress, and by reducing the rate of growth of the labor force and of the capital stock. There is little that can be said on the size or magnitude of the first of these impacts: a recession may slow down technical progress by stimulating Malthusian reactions which reduce productivity, or accelerate the latter as producers are driven to maximize efficiency to stay in business. The impact of the recession on the growth of factor supply can, on the other hand, be quantified in rough terms.

The impact which the recession might have on growth via changes in the supply of factors/20 was therefore calculated on the following lines. The first step was to use Cobb Douglas functions to estimate the rate of technical progress

/19 The construction of the system used is described in the appendix to this chapter.

/20 Various versions of the procedure were used at different times. We describe only the basic idea.

in the 1960-73 period by means of the regression

$$(\log Y - 0.33 \log K - 0.67 \log L) = \log a + ct$$

where Y = GNP, k = capital stock/21, L = labor force, c = rate of technical progress, a = scale factor of the Cobb Douglas function

$$Y = AK^{0.33} L^{0.67} e^{ct}$$

in which capital and labor exponent values of 0.33 and 0.67 are imposed a priori.

The next step was to set down a range of possible recovery scenarios of the economies of developed countries, based on the observation of rates of recovery from earlier postwar recessions. This made it possible to assess the rate of growth of the capital stock in the post-recession period, using observed data for past years and estimates based on projected savings for later years. The savings projections were obtained by applying savings functions from models of developed countries to GNP projections from the alternative recovery paths described above.

The recession was likely to have a lasting impact on the growth of the labor force in European countries as a result of foregone migration from the Mediterranean developing countries during the recession years. It would probably also affect immigration into North America, Australia, and New Zealand. But as most of the latter flow involved migrants from other developed countries, they involved no change in the labor force available in developed countries and, accordingly, changes in this type of migration flow were neglected./22

The potential labor force figures were built up from projections for the population by age and sex, allowing for trends of the participation rates and

/21 The capital stock figures were built up by the permanent inventory method, using assumed initial capital stock figures suggested by available studies and an average amortization rate of 5 percent.

/22 The U.S. receives a substantial number of workers from Mexico including many illegal migrants. No allowance was made for the impact of the recession on this inflow.

sharply reduced immigration flows into Europe. It was assumed that unemployment rates in future periods of full employment would be kept at a level exceeding by 1 percent the low levels of the 1960s and early 1970s, to prevent inflation forces from building up once again. As a result of the lesser tension on the labor market, immigration into Europe would stay at the low levels reached during the recession.

Inserting these capital stock and labor force projections then made it possible to calculate the paths of potential output in developed countries. Because of the impact of the recession on factor supply, the rate of growth along this path lay appreciably below the rate of growth achieved in 1960-73.

(iv) Energy prices and potential growth of developed countries: the SIMRICH model.

Many observers have stressed that the rise in oil prices was likely to reduce potential growth of developed countries. A careful examination of the mechanisms through which oil prices affect growth suggests that these were substantially more complex than appeared at first sight - too complex in fact to be readily grasped without the aid of a model.

These mechanisms include:

- A welfare loss, reflecting the terms-of trade loss in the oil importing countries at the high oil price, plus the welfare cost involved in the substitution of high-cost domestic energy for part of the cheap oil initially imported, and in energy conservation.
- This loss was offset to a certain extent by the gain derived by developed countries at very low rates of interest.
- It has been argued, on the other hand, that the increase in oil prices inflicted a capital stock loss on developed countries, as

a result of the accelerated obsolescence of energy-intensive capital goods bought before the rise in oil prices.

These issues ought to be studied in a dynamic context. For this reason, the SIMRICH model designed to study them is a dynamic neo-classical growth model. This is described in Chapter VII.

Chapter V

THE SIMLINK MODEL AND THE DEVELOPING COUNTRIES

A. Background

The Bank's SIMLINK/23 model was designed to study the impact of higher oil prices, of changes in business conditions in OECD countries, and of changes in the flow of foreign aid in developing countries./24 The model was not a theoretical breakthrough, but combined existing modeling techniques into a comprehensive system which provided inputs for policy decisions relatively quickly.

In recent years modeling work involving developing countries has largely been along three broad lines: country models, international trade models, and commodity models. While each approach can yield useful insights, none can be used alone to make definitive statements about the linkage effects of world events.

Developing Country Models generally take exports to be either largely exogenous, or sold under perfectly competitive conditions. In either case, export prices do not depend on the model solution. Aggregation of models of course provided no assurance that the results would be consistent: the sum of the

/23 For Simulated Trade Linkages. This chapter was written by N. Hicks, F. Pinto, and J. Shilling. The authors wish to thank Hollis Chenery, Wouter Tims, Jean Waelbroeck, and Nicholas Carter for their advice and guidance, and B. Dow, F. F. Jen, and K. Malik for their computational assistance.

/24 As elsewhere in this monograph, "developing countries" or "LDCs" refer to all developing countries except for members of OPEC and centrally planned Economies (CPEs). "OECD countries" refer to the more industrialized members of the Organisation for Economic Cooperation and Development, excluding Greece, Portugal, Spain, Turkey, Iceland, and Yugoslavia.

import and export price and volume estimates for a group of models would only fortuitously be in line with world demand and supply.

International Trade Models. Constructing a matrix of international trade flows, and distributing world imports and exports among countries according to past trade relationships, ensures that total world imports will equal total world exports, and that the estimated trade balances of a group of countries will be consistent with each other. Such models usually include only sketchy analysis of the domestic economies of the different countries. A more comprehensive approach has been attempted in Project LINK, starting with large econometric models of developed countries, and linking them through an entirely consistent set of world trade equations. LINK has up to now lacked detailed models of the developing world countries, and its main thrust has been toward short-term estimates of trade and growth rather than longer-range projections. Though the model contains submodels for developing regions, estimated by UNCTAD, and has of late been used for three-year forecasts, it remains a model focused on developed countries and emphasizing short-term fluctuations. This made it unsuitable as a basic tool of analysis for the World Bank.

Commodity Models. Examining world trade on a commodity-by-commodity basis was thought to be very useful from the developing countries' point of view, as most of their exports were primary products which were traded on world markets with little differentiation as to source and destination. However, commodity models, like country models, were generally solved in isolation. This could be misleading for certain commodities which can be substituted for each other. A combination of commodity models would ensure that country price and volume projections for the commodities in question were consistent with the world market, but fitting these models together would pose major problems, because of

the diversity of existing models - using different dates and time periods - and the diversity of levels of aggregation and choice of variables./27

B. The SIMLINK Approach

SIMLINK combined elements of all three of these approaches./28 Exports of the developing countries were related to the level of economic activity in the industrialized countries through individual commodity models. Growth in the developing countries was linked to investment levels and imports; the latter, in turn, were tied to export earnings and the inflow of external capital (as indicated by the real resource transfer, or balance on merchandise and non-factor services). The model would be run to determine the import and GDP growth levels of developing countries which were permitted by a particular capital inflow and set of GDP growth rates in the OECD countries, or to determine the real resource transfer needed to support a specified target growth rate of GDP in developing countries, given expected developments in the OECD countries. SIMLINK may be thought of as being block recursive in the following steps:

- (a) The rates of growth of output and prices in the developed world (largely the OECD countries) were taken as exogenously determined. Since the developing countries had little feedback effect on the developed world, this was felt to be a reasonable assumption;

/27 For a survey of some commodity models and commodity modeling techniques, see W. Labys, Dynamic Commodity Models: Specification, Estimation and Speculation (Lexington, Mass., 1973).

/28 SIMLINK went through successive stages of updating and improvement; the version discussed here is the one in existence and used in mid-1975.

- (b) Some commodity models were used to calculate the world prices and the world demand for primary commodities exported by developing countries. The price of petroleum was taken as exogenous, and so were the prices of commodities for which no models were developed.
- (c) Exports of manufactures and services from developing countries were projected on the basis of historically estimated elasticities with respect to OECD growth, modified to take account of an expected fall of these elasticities. Prices for these items were projected on the basis of exogenously forecasted rates of inflation in the OECD;
- (d) The commodity trade volumes and prices so calculated were translated into export volumes, import prices, and export prices for seven groups of developing countries;
- (e) A simple growth model was used to relate the growth of each of the seven groups of developing countries to the growth of their imports and to investment. These models were then solved to calculate the level of GDP growth which equated total imports with the capacity to import, defined as the sum of the value of exports and an exogenously specified level of capital inflow. They were also solved imposing exogenous target GDP growth rates; the resulting balance-of-payments gap was an estimate of the foreign capital inflow required to meet those targets.

The version of SIMLINK presented here contained 14 commodity models with a total of about 79 structural equations, 11 equations for estimated exports of

manufactures and services, and 7 regional models with 7 behavioral equations each. Ignoring definitional equations and identities, the model had a total of 146 structural equations. While comprehensive in nature, it thus remained simple enough to be calculated quickly. It was estimated by least squares and was block recursive. Figure 2 gives a rough idea of the structure of the model. The period covered by estimation varied from equation to equation according to the availability of data: the shortest sample was 6 years; the longest, 20.

C. The Model in Detail

The model started with a data base for a sample panel of 40 developing countries which accounted for about 85 percent of the population of the developing market economies (excluding OPEC members). Based on 1973 data, the panel received over 80 percent of the net disbursements on public loans and accounted for over 80 percent of the external public debt (outstanding and disbursed). Its share in the aggregate GNP of developing countries was slightly smaller - 76 percent in 1973. It accounted for 70 percent of the exports of developing countries in all regions except East Asia and the Mediterranean - in these two regions the trading role of a few non-sample panel countries (notably Singapore, Hong Kong, and Spain) lowered the panel's coverage to about 61 percent (based on 1973 data). For the purposes of the model, the sample panel countries were aggregated into seven "regions" or groups, which are shown in Table 13.

1. Commodity Models

A matrix of export shares in 1972 for 35 primary products and for manufactures and services was constructed for these seven groups from data compiled by the Commodities and Export Projections Division of the Bank and from U.N. Trade Yearbooks. Of the 35 primary products, about 15 accounted for a

Figure 2 SIMLINK FLOW DIAGRAM

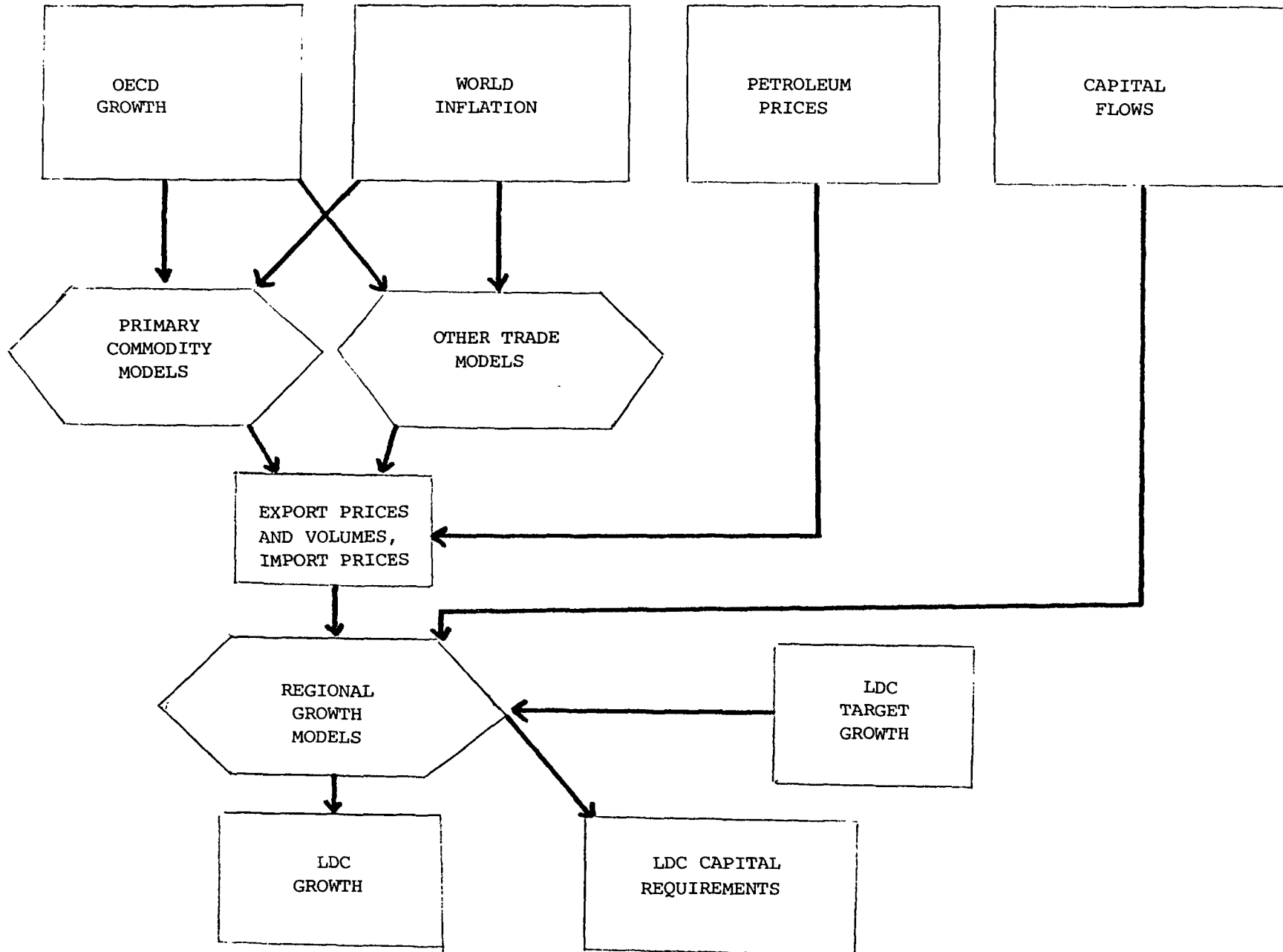


Table 13: SAMPLE PANEL COUNTRY GROUPINGS

1. Low Income/ <u>a</u>		
a. South Asia (4)		
India		Sri Lanka
Bangladesh		Pakistan
b. East/Central Africa (6)		
Kenya		Ethiopia
Tanzania		Mali
Uganda		Sudan
2. Middle Income		
a. Mediterranean (6)		
Egypt		Greece
Syria		Turkey
Tunisia		Yugoslavia
b. West Africa (5)		
Cameroon		Senegal
Ghana		Sierra Leone
Ivory Coast		
c. East Asia (4)		
Korea		Thailand
Philippines		Malaysia
d. Latin America (8)		
Argentina		Guatemala
Brazil		Mexico
Colombia		Peru
Dominican Republic		Uruguay
e. Mineral Producers (7)/ <u>b</u>		
Chile		Morocco
Bolivia		Zaire
Jamaica		Zambia
Liberia		

/a 1971 per capita income less than \$200.

/b All mineral producers were in the middle income group except Zaire. Results for this "region" were divided among the two income groups according to Zaire's proportion of total GDP, imports, etc.

substantial share of the exports of any one regional group. Models were developed for the most important commodities (excluding petroleum). They are summarized in Table 14. Exogenous price and volume estimates were used for a few important commodities for which it proved difficult to develop useful models. Some of these, like wheat, cotton, and tobacco, had been influenced in the past by US surplus policies.

Supply. On the supply side, the models assumed a distributed lag response by producers to past prices, based on biological and information lags. The general form of the supply equation can be expressed as

$$Q_j = (P_{j_{t-1}}, P_{j_{t-2}}, \dots, P_{j_{t-m}}, 0_1, 0_2, \dots, 0_n) \quad (1)$$

where Q is the supply of the J^{th} commodity, P_j is its real price lagged by an appropriate number of time periods, and the 0 's are other variables. In most cases, total supply Q_j was the sum of two or more supply equations estimated on a regional or country basis in order to capture the differences in supply response patterns apparent in different arenas of the world. The lagged prices $P_{j_{t-2}} \dots P_{j_{t-m}}$ were often dropped in favor of simple lagged supply, $Q_{j_{t-1}}$, thus introducing the assumption of a distributed lag with geometrically declining weights./²⁹ In some cases, such as rice, where world prices were largely determined by fluctuations in exports and a large part of the production was not exported, the model dealt 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). Summary

²⁹ For a discussion of the use of the lagged endogenous variable as a transform of the distributed lag equation, see Zvi Grilliches, "Distributed Lags: A Survey," Econometrica, Vol. 35 (January 1967).

variables were inserted to reflect unusual conditions present in certain years, many of which could be traced to weather fluctuations. Most of the models were estimated econometrically with annual time series data from the 1955-72 period, although the time period differed slightly in each model. In certain regions where no econometric relationship could be uncovered, an exogenous supply estimate was used (see Table 14).

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

$$P_j = f(Y, Q, O_1, O_2, \dots O_n) \quad (2)$$

where Y was total OECD GNP, Q was the total of world exports or production, and the O_i are other variables important in price determination (for example, the prices of substitutes, dummy variables, and the rate of world inflation). An alternative to the simple direct price formation equation (2) above was the slightly more complex stock adjustment approach. Here, the demand vector determined consumption of the commodity in question. Inventories or stocks were defined as current production less current consumption plus stocks from the previous year, and real prices were determined by the level of stocks (which may be expressed as an inverse relationship or as a ratio to total production). This three-equation method of determining prices can be summarized as follows:

$$C_j = f(Y, P, O) \quad (3)$$

$$S_j = S_{j,t-1} + Q_j(P, O) - C_j \quad (4)$$

$$P_j = f(S_j) \quad (5)$$

where C_j stands for consumption and S_j for end-year stocks, with only the lagged variables subscripted for time. Other variables may be included in the consumption and price equations, although these are not included in the notation above.

Table 14: COMMODITY MODELS SUMMARY

Commodity	Author	No. of Equations		No. of Supply Equations/2	No. of Exog. Supply Est.	Prices Related to:
		Total	Structural			
Iron Ore	F. Pinto	6	3	1	0	Exogenous
Fats & Oils/ <u>1</u>	P. Pollak	25	24	0	12	OECD income, sugar exports, prices of substitutes.
Copper	F. Pinto	7	5	2	0	OECD income, lagged prices, mine production, lagged cons.
Rice	N. Hicks	8	6	2	2	OECD income, rice exports, wheat price, inflation.
Sugar	E. Brook/ P. Pollak	15	13	7	0	Excess consumption-production ratio, lagged prices, food price inflation.
Beef	N. Hicks	6	5	4	0	Income W. Europe, production.
Tin	F. Pinto	5	4	1	0	Stocks: consumption, lagged price of aluminum.
Cocoa	N. Hicks	9	7	5	1	OECD income, production, lagged stocks, lagged average prices.
Rubber	J. Gunning	7	6	4	1	Stock changes, lagged prices.
Tea	N. Hicks	3	3	1	0	Production, time trend.
Coffee	J. de Vries	13	10	6	0	Production, lagged prices, stocks, inflation, lagged consumption.

/1 Covers groundnuts, groundnut oil, copra, coconut oil, palm oil.

/2 Excludes exogenous supply estimates.

Sensitivity to Inflation. The P_j were estimated in real terms, by deflating current prices by the Bank's International Price Index (IPI).^{/30} The supply equations were also related to real rather than current prices, and most of the commodity models were neutral in their response to changes in the rate of world inflation. Certain models - coffee, sugar, and rice - were exceptional in that the index of world inflation was found to be an important variable. In general, the higher the rate of world inflation, the lower the real prices of these commodities.^{/31}

"Residual" Commodities. For primary products not covered by the existing commodity models, a more general formulation was used to project volumes and prices. First, they were aggregated into three broad classes: food, agriculture non-food, and minerals and metals. Increases in the prices of these "residual" commodity groups were estimated using the following equation:

$$p' = \frac{-Y' E_y - s'}{E_d} \quad (6)$$

where p' was the percentage increase in price for the commodity group in question; y' was the growth rate of OECD real GNP; s' was an exogenous estimate of the growth rate of supply; and E_y and E_d were the respective income and price demand elasticities. The values of the parameters used in the model for this equation are given in the table below, and were based on estimates provided by the Commodities and Projections Division of the Bank.

^{/30} An index of prices of developed countries' manufactured exports to all destinations. See Table 19 below.

^{/31} This appears to confirm the hypothesis that developing countries suffer during periods of sharp world inflation because the prices of most of their exports fail to keep up with other prices. But it should be pointed out that the lag is somewhat temporary, and that eventually real prices tend to adjust. This suggests that perhaps sellers - in particular the government trading agencies which play a major role in the coffee and sugar markets - fail to note other world prices effectively, or that sales are made in advance of production and delivery and that acceleration of inflation rates is generally unexpected.

Table 15: RESIDUAL COMMODITY MODEL COEFFICIENTS

<u>Group</u>	<u>E_y</u>	<u>E_d</u>	<u>s²</u>
Agric-Food	0.5	-0.5	4.0
Agric-Non Food	0.9	-0.7	5.0
Minerals and Metals	1.1	-0.5	6.0

2. Manufactured Exports/32

A slightly different approach was used for developing countries' manufactured exports. First, since these countries accounted for a relatively small share of total manufactured exports, it was assumed that supply and demand were not reconciled via the price mechanism. Total demand by the OECD and centrally planned countries for manufactured exports from developing countries was allocated among the seven groups of sample panel countries according to market shares based on initial exogenous estimates of the growth of supply. To estimate income elasticities of demand, log-log regressions were run, using constant prices, between the GDP and manufactured imports from developing countries (regardless of source), of groups of OECD countries, and of the centrally planned economies. The data for these regressions were based on UN trade data and covered the period 1965-72. The results are summarized in Table 16 below:

Table 16: INCOME ELASTICITIES FOR IMPORTS OF MANUFACTURED GOODS FROM DEVELOPING COUNTRIES

	<u>E_y</u>	<u>t</u>	<u>R²</u>
Japan/Oceania	2.24	7.4	.885
Western Europe	2.62	9.9	.933
North America	5.36	10.9	.943
Centrally Planned Economies	2.27	6.3	.849

/32 Here defined as SITC 5-8, excluding SITC 6-8 (non-ferrous metals).

These rather high elasticities had to be adjusted for two factors. First, they relate to 68 developing countries, including Hong Kong, Singapore, and Taiwan; and second, they did not obviously take account of manufactured exports to other developing, rather than to developed, countries. So as to avoid overstating export demand, the export growth rate calculated for the 40 sample panel developing countries between 1965 and 1972 - 12.2 percent per annum - was compared with the rate of growth of import demand in OECD countries (from all developing countries) for the same period - 15.7 percent per annum - both in constant prices. The ratio of these two growth rates (0.777) was used to adjust the original elasticities downward.

An estimate of the aggregate supply of manufactured exports from developing countries was used to arrive at the market shares of the seven regional groups, taking account of historical growth rates in constant prices for the period 1965-72. For two regions, South Asia and East/Central Africa, political events in 1970-72 meant that manufactured exports grew at lower than historical rates, so the growth rates for 1965-70 were used instead. These supply estimates, each region's share of total sample panel exports of manufactured goods, and the importance of manufactured goods in total exports from sample panel countries are shown in Table 17:

Using the 1972 percentage distribution (column 2), a weighted average growth rate of supply of manufactures was calculated, and compared to the average growth rate of demand, weighted according to the shares of OECD and centrally planned country groups in total demand. The initial estimates of the growth rate of supply were then adjusted so that the growth rates of aggregate rates of aggregate supply and demand were equal. Algebraically, if SM_i is the initial supply growth estimate for the i^{th} developing country region, and DM_j is the demand growth estimate for the j^{th} developed region, and w_d_j and w_{s_i} are the

appropriate weights, the final export growth rate for the i^{th} region (XM_i) is given as:

$$XM_i = SM_i \frac{(\sum_{j=1}^4 DM_j w_d_j)}{7} \frac{(\sum_{i=1} SM_i w_s_i)}{7} \quad (7)$$

Table 17: MANUFACTURED EXPORTS BY SAMPLE PANEL GROUPS

	(1) Growth Rate of Manufactured Exports (1965-72)	(2) Distribution of LDC Manufactured Exports (1972)	(3) Manufactured Exports Share of Total LDC Exports (1972)
	(% p.a.)	(%)	(%)
Mineral Producers	13.8	2.1	3.8
South Asia	5.4/ <u>a</u>	16.6	32.2
East Africa	6.0/ <u>a</u>	.8	3.5
Mediterranean	10.4	26.8	26.0
West Africa	7.2	2.1	8.9
East Asia	26.8	26.4	26.6
Latin America	19.8	25.2	14.9
Total: 40 LDCs	12.2	100.1	19.1

/a For period 1965-70.

3. Service Exports

Services are another very important source of export earnings in developing countries, but are often ignored in trade models due to the lack of data on an origin-destination basis. Data for non-factor service exports were obtained from the World Bank's socio-economic data in current prices for each region for the period 1964-72. It was assumed, once again, that the OECD was the

principal source of demand for these services, which included tourism, travel, and shipping services.

As with manufactures, the OECD was disaggregated into three regions: North America, Western Europe, and Japan/Oceania. Regressions were then run to estimate demand elasticities with respect to the GNP of each of the OECD regions, with the best estimate being used in the model. Since the observation period was relatively short, only single-variable regressions were attempted. While the income of the Japan/Oceania region did not prove significant for any sample panel region, a combination of Japan/Oceania and North America worked well for three regions, with Western Europe proving best for another two, and total OECD accounting for the remaining two. The results are shown in Table 18 below./33

Table 18: EXPORTS OF SERVICES

Developing Country Group	Service Exports to Total Exports	GNP	E	t	R ²
Mineral Producers	18.2	W. Europe	1.006	16.09	.974
South Asia	7.2	Total OECD	.448	8.54	.947
East/Central Africa	26.9	Total OECD	1.311	8.55	.911
Mediterranean	35.9	W. Europe	1.244	15.10	.970
West Africa	27.2	Total OECD	1.920	15.45	.971
East Asia	17.8	Japan and N. America	.959	4.59	.742
Latin America	23.6	Japan and N. America	1.288	28.89	.992

/33 Unlike the manufactured export regressions, the non-factor service regressions were done in current prices. In the model, the projected current price service exports were deflated by the implicit GNP deflator of the OECD countries to convert to constant prices.

The estimated equations all show good fits, 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 starting from a low base. This coefficient was lowered to 1.4 for projection purposes in the model.

4. Prices and Inflation

The consistency between current and constant price estimates was maintained by the use of a series of international price deflators. The four main indices of world inflation that were used in the model are shown in Table 19. IPI - the international price index - was used both to inflate projected real commodity prices to current prices and to serve as a price index for manufactured imports by developing countries. IPIXM - the price index of manufactures - was used to inflate the value of exports of manufactures from developed countries. IPI - the GNP price index - was used to convert the GNP growth of OECD countries from real to current terms, and to inflate the value of non-factor service imports and exports. IPICAP, the price index of capital goods from developed countries.

For each of the seven sample panel regions, SIMLINK constructed an index of export value and export volume using the 1972 weights shown in Appendix I, Tables 30 and 31. Regional export price indices (XPI) were determined by the export value and volume indices: real export prices of each region were converted to current prices by multiplication by XPI, and, using 1972 weights, the export price index was then calculated in current prices. Regional import price indices

Table 19: INFLATION ASSUMPTIONS

(1967-69 = 100)

	IPD/1		IPI/2		IPICAP/3		IPIKM/4	
	Index	% Change	Index	% Change	Index	% Change	Index	% Change
1960	76.5	-	90.9	-	91.3	-	92.6	-
1961	79.8	4.3	92.9	2.2	92.6	1.5	94.2	1.6
1962	82.9	3.9	92.9	0.0	93.5	1.0	93.9	-0.2
1963	86.4	4.2	93.6	0.7	95.1	1.7	94.5	0.5
1964	89.4	3.5	94.7	1.2	95.9	0.8	95.3	0.8
1965	92.6	3.6	96.4	1.8	96.8	0.9	97.0	1.8
1966	95.2	2.8	98.4	2.1	98.8	2.1	98.7	1.8
1967	97.8	2.7	99.4	1.1	99.7	1.0	99.5	0.8
1968	99.1	1.3	98.4	-1.0	98.4	-1.3	98.4	-1.1
1969	103.0	3.9	102.1	3.8	101.8	3.5	102.1	3.8
1970	110.2	7.0	109.4	7.1	109.0	7.1	108.9	6.1
1971	120.6	9.4	116.5	6.3	118.0	8.2	114.4	5.1
1972	135.4	12.3	126.6	8.8	129.1	9.4	121.2	5.9
1973	149.2	13.5	149.6	18.2	147.9	14.5	144.7	19.4
1974	164.0	9.9	182.2	21.8	171.8	16.1	178.2	23.2
1975	183.7	12.0	202.0	10.8	191.0	11.2	199.6	12.0
1976	201.7	9.8	219.9	8.8	208.5	9.2	219.1	9.8
1977	218.8	8.5	237.5	8.0	225.6	8.2	237.7	8.5
1978	236.4	8.0	255.4	7.5	242.9	7.7	256.7	8.0
1979	254.1	7.5	274.6	7.5	261.1	7.5	276.0	7.5
1980	271.9	7.0	293.8	7.0	279.4	7.0	295.3	7.0

/1 An index of the implicit GNP price deflators, converted to U.S. dollars, of USA, France, Germany, Italy, Japan, and U.K.

/2 An index of manufactured import prices for LDCs, based on SITC categories 5 through 8 (f.o.b. prices of manufactured exports of OECD countries to all destinations, adjusted for the freight component of c.i.f. costs).

/3 An index of capital goods (SITC 7 only) import prices for LDCs.

/4 An index of developed countries' manufactured export prices, basically the same as IPI but on an f.o.b. basis, and using LDC export weights.

Note: Based on UN trade indices for export prices from developed countries of SITC categories 5 through 8 (manufactures) and SITC 7 (capital goods). IBRD staff estimates of freight costs.

(MPI) were made up from series of five basic indices for each region, constructed on the basis of imports in 1972 divided by end-use class into food, intermediates, fuels, capital goods, and non-factor services. The price indices for capital goods and non-factor services were based on assumed international inflation rates. The price index for fuels was assumed to equal that for petroleum. For food imports, a weighted price index was constructed using the commodity prices generated by the model.^{/34} The weights used were based on an analysis of the composition of food imports of the larger developing countries.

5. Regional Growth Models

The regional indices of export value, export volume, and import prices were applied to 1972 base data in 1967-69 prices to derive estimates through 1980. Export values, expressed in constant dollars, were then adjusted for changes in the terms of trade to produce "adjusted exports" (XADJ), which reflected import-purchasing power. The adjusted exports for each region were defined as:^{/35}

$$XADJ = \frac{XPI}{MPI} X \quad (8)$$

where X represented exports in constant prices, and MPI and XPI were the relevant regional import and export price indices, respectively. Total import capacity (M_a) was then defined as the sum of XADJ and the capital inflow available, or resource gap (RG_a). Capital inflows were estimated exogenously, according to analyses of countries' creditworthiness and the availability of external capital.

$$M_a = XADJ + RG_a \quad (9)$$

^{/34} The commodities included and their weights were: wheat, 40 percent; rice, 15 percent; maize, 5 percent; sugar, 15 percent; tobacco, 5 percent; groundnut oil, 15 percent; and beef, 5 percent.

^{/35} All variables are for period "t" and region "i", unless subscripted differently.

Imports and Growth

Much discussion has taken place over the relationship between imports and growth, and the importance of foreign exchange versus other constraints in the developing world./36 Some authors have contended that there is no relationship, or that increases in imports (particularly those financed from increases in capital inflows) result in lower savings, higher consumption, and no appreciable increase in growth./37 Such analyses have tended to examine imports in the aggregate, and their relationship to total GNP. In fact, developing country imports are a very non-homogenous mixture of capital goods, intermediate products, raw materials, foodstuffs, and other consumer goods that are not related to capital formation and production. 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 to some parts of GNP expenditure.

Following the same approach, a general model of growth and imports was formulated along the following lines: First, industrial production was assumed to be a linear function of total GDP:/38

$$Y_{IND} = a_1 + b_1 \text{ GDP (value added, industry)} \quad (10)$$

/36 H. B. Chenery and Alan M. Strout, "Foreign Assistance and Economic Development," American Economic Review, LVI (Sept. 1966), pp. 680-733; J. C. H. Fei and Gustav Ranis, "Foreign Assistance and Economic Development: Comment," American Economic Review, LVII (Sept. 1968), pp. 897-912; and Henry J. Bruton, "The Two-Gap Approach to Aid and Development: Comment," American Economic Review, LIX (June 1969), pp. 439-46.

/37 K. G. Griffin and J. L. Enos, "Foreign Assistance: Objectives and Consequences," Economic Development and Cultural Change, XVII (April 1970), pp. 313-27.

/38 All a's are constant terms, and all b's are estimated coefficients.

Investment was a function of the increment to GDP and lagged investment, as implied by the flexible accelerator where the desired capital stock adjusted with a distributed lag. In this case, the implied lag was of the Koyck type, with geometrically declining weights:

$$I = a_2 + b_{21} (GDP - GDP_{t-1}) + b_{22} I_{t-1} \quad (\text{gross investment}) \quad (11)$$

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

$$MCAP = a_3 + b_3 I \quad (\text{imports, capital goods}) \quad (12)$$

$$MINT = a_4 + b_4 YIND \quad (\text{imports, intermediate products}) \quad (13)$$

$$MFUEL = a_5 + b_5 GDP \quad (\text{imports, fuels}) \quad (14)$$

$$MSER = a_6 + b_6 GDP \quad (\text{imports, non-factor services}) \quad (15)$$

It was initially proposed to relate imports of food to private consumption and to agricultural production, and imports of other consumer goods to private consumption expenditures. However, in almost all cases the results of so doing were nonsignificant or had the "wrong" signs. (In the case of food it can be expected that imports vary inversely with domestic production, and directly with consumption.) It appears that imports in both these categories were heavily influenced by the availability of foreign exchange. The proxy for foreign exchange availabilities was taken to be the actual level of imports of goods, so that the combination of food plus other consumer goods imports was simply related to this variable:^{/39}

$$MCF = a_7 + b_7 MG \quad (16)$$

^{/39} In South Asia and East/Central Africa, exogenous estimates of MCF were used, based on a projected increase in food grain imports and constant imports of other foods and consumer good. In the base case, a growth rate of 3.5 percent was used for food grain imports in both regions.

Total (actual) imports of goods is defined as:

$$MG = M_{CAP} + M_{INT} + M_{FUEL} + M_{CF} \quad (17)$$

and total import demand, at a given level of GDP, as:

$$M_d = MG + M_{SER} \quad (18)$$

where the "d" subscript denotes import demand, as opposed to the capacity to finance imports, M.

Two Versions of the Model

So far the discussion in this section has focused on the availabilities version of the model, in which the amount of foreign capital which was available was exogenous. In this version, an equilibrium condition was enforced such that import demand must equal the capacity to import, or

$$M_d = M \quad (19)$$

The model was then solved for that level of GDP and GDP growth which would satisfy this condition.

In the requirements version, target GDP growth rates (g) were specified exogenously for each region:

$$GDP_t = GDP_{t-1} (1 + g) \quad (20)$$

The capital inflow that was required to support such a growth rate (RG_r) was determined as the difference between import demand and the capacity to finance imports, based on export earnings:

$$RG_r = M_d - X_{ADJ} \quad (21)$$

Hence the requirements version dropped equations 9 and 19 from the model, and used 20 and 21 to determine a capital inflow endogenously from a pre-determined growth level. The additional capital requirement (ACR) was defined as the difference between the capital available and that required to attain the growth target:

$$ACR = RG_r - RG_a \quad (22)$$

Savings Rate

Domestic savings (GDS) can be determined residually from the identity:

$$GDS = I - RG$$

This residual determination of savings is the consequence of considering foreign exchange, rather than domestic resources (savings, capital, or labor), as the binding constraint on growth in the developing world. This is a serious simplification. However, since the model is being used to project over a period when deteriorating terms of trade and low export volume growth would squeeze foreign exchange earnings, the simplification appeared acceptable. The ex post calculation of the savings rate allows for a rough check that this rate is realistic, and that a savings constraint is not binding.

Regression Results

The estimated equations are given in Table 20. In general, these equations were estimated on the basis of pooled cross-section and time series data for the period 1966 to 1971, although the exact time period differed slightly from region to region. The time period used was short because of the shortage of data on imports by end-use. The data used here were derived from the United Nations Trade Yearbook, allocated to end-use classes on a two-digit SITC level. The data for individual countries in each region were pooled together for estimates of the region, using the technique of including an individual constant term for each country. This increases the degrees of freedom and offsets the shortness of the observation period. While the R^2 of the estimated equations is low, almost all of the estimated coefficients were significant at the 95 percent level.

Table 20: SUMMARY OF REGIONAL MODEL REGRESSIONS

	MCAP = a ₃ + b ₃ I			MINT = a ₄ + b ₄ YIND			MFUEL = a ₅ + b ₅ Y			MCF = a ₇ + b ₇ MG		
	a ₃	b ₃	R ²	a ₄	b ₄	R ²	a ₅	b ₅	R ²	a ₇	b ₇	R ²
		(t)			(t)			(t)			(t)	
Mineral Producers	307.5	.3120 (4.85)	.505	337.3	.2371 (3.6)	.301	-201.5	.0255 (4.2)	.429	75.8	.2462 (5.73)	.588
South Asia		.111/a			.218/a		-384.6	.0089 (4.04)	.539		exogenous	
East Africa	62.2	.2778 (8.0)	.646	84.6	.4322 (5.14)	.430	-3.2	.0077 (3.17)	.223		exogenous	
Mediterranean	-420.6	.2731 (10.2)	.746	160.7	.217 (7.84)	.637	-135.0	.0128 (6.69)	.561	156.9	.178 (10.0)	.741
West Africa	178.0	.2069 (4.12)	.414	285.4	.2449 (3.93)	.392	7.5	.0068 (1.46)	.082	22.3	.3088 (10.5)	.821
East Asia	-55.2	.3423 (7.11)	.727	684.5	.3275 (5.53)	.617	-432.6	.0376 (9.22)	.817	-185.1	.2615 (13.4)	.904
Latin America	-1377.3	.2365 (18.8)	.929	-282.2	.1179 (7.89)	.697	-262.0	.0071 (4.58)	.437	515.5	.1174 (5.85)	.559

	I = a ₂ + b ₂₁ (Y _t - Y _{t-1}) + b ₂₂ I _{t-1}				YIND = a ₁ + b ₁ Y			MSER = a ₆ + b ₆ Y/c		
	a ₂	b ₂₁	b ₂₂	R ²	a ₁	b ₁	R ²	a ₆	b ₆	R ²
		(t)	(t)			(t)			(t)	
Mineral Producers	504.3	.5129 (1.38)	.7335 (3.94)	.854	-1010.5	.2994 (7.80)	.726	-350.0	.078 (5.42)	.780
South Asia	-397.9	.1537/b (8.99)		.869	-7860.6	.3035 (8.69)	.844		.0083/a	
East Africa	-125.2	.1805/b (5.09)		.757	-5061.2	.3339 (30.9)	.972	-13.0	.040 (4.28)	.684
Mediterranean	-164.4	.4763 (2.34)	.9653 (8.03)	.971	-4664.0	.4049 (2.49)	.947	-452.0	.036 (47.59)	.997
West Africa	77.4	.8678 (2.97)	.6649 (2.46)	.608	-101.6	.1823 (6.71)	.652	-194.	.106 (8.74)	.915
East Asia	702.3	.6358 (4.10)	.7323 (7.77)	.943	-2099.7	.3058 (19.18)	.951	-154	.037 (4.72)	.727
Latin America	-391.2	.5473 (6.60)	.9193 (21.0)	.999	-5061.2	.3339 (30.9)	.972	-341	.026 (8.62)	.902

/a Based on average of 1969-71.

/b Investment function for South Asia and East Africa: I = + BY.

/c Equations for MSER are estimated in 1967-69 constant prices.

Major problems arose with the regression for South Asia: the past history of that region, with recurring natural disasters and wars, made almost all of the regressions nonsignificant. Data for the period 1968-71 were used to estimate coefficients based on simple averages. This implied that import elasticities were close to unity, although this may have been far from the truth for that region. In both South Asia and East/Central Africa, the apparent stability of investment in the face of unstable output made it necessary to substitute an investment function based on total income, rather than on incremental income and lagged investment.

D. Properties of the Model

1. Assumptions

The properties of SIMLINK may be illustrated by simulations undertaken in 1975 in studying the prospects of developing countries. These results give an idea of the model's response to a realistic set of alternative assumptions.

For OECD growth, the most important exogenous variable of the model, two alternative parts were judged equally likely. The "high" OECD growth case assumed swift recovery from the recession - full employment by 1977-78, followed by a period of growth at pre-1974 rates. The annual average growth rate between 1975 and 1980 was 6.1 percent, while that between 1974-80, including the major recession year of 1975, was 4.9 percent./40 The "low" growth case assumed a slow recovery, so that full employment was not reached until after 1980, and annual growth averaged 4.6 percent between 1975 and 1980 and 3.5 percent between 1974

/40 All growth rates quoted in this paper are compound rates of growth between the indicated end points (i.e., 3.5 percent for 1974-80 is the growth rate from end 1974 to end 1980 and does not include growth in 1974.

Capital flows were exogenous in the "availabilities" version of SIMLINK, which calculated the growth part which was compatible with given amounts of aid; they were endogenous in the "requirements" version, which measured the aid required to achieve given growth targets.

Table 22: SAMPLE PANEL COUNTRIES' EXPORTS TO OPEC
(US\$ million)

OECD Growth: Oil Price:	High "Constant"	Low "Constant"	High Declining	Low Declining
1972	1,089	1,089	1,089	1,089
1973	1,457	1,457	1,457	1,457
1974	2,904	2,904	2,904	2,904
1975	3,925	3,925	3,925	3,925
1976	4,517	4,479	4,498	4,461
1977	5,829	5,636	6,452	5,364
1978	7,272	6,846	6,452	6,124
1979	8,626	7,939	7,261	6,763
1980	9,806	8,868	7,918	7,274

The global flows in the availabilities version were consistent with the Bank's projections of official aid and private capital movements to developing countries. The allocation of this total among developing countries reflected the projected foreign exchange gap of different regions, and their absorptive capacity.

Table 23: NET CAPITAL FLOW CONSUMPTION/a 1973-80
(US\$ million, annual averages)/b

	1973-74	1975-77	1978-80
Mineral producers	180	335	255
South Asia	2,468	4,173	4,883
East Africa	390	534	652
Mediterranean	5,290	8,129	10,753
West Africa	-7	240	217
East Asia	1,045	2,896	2,517
Latin America	4,233	6,754	4,736
Total	13,599	23,061	24,013

/a From official and private sources.

/b Current dollars.

The requirements version of the model was run using a target rate of GDP growth of 6 percent per annum for all the sample panel countries for the period 1974-80. The assumed growth rates, which were considered to be feasible given the past performance of developing countries, implied a growth rate of only 5.9 percent for the decade 1970-80, somewhat short of the 6 percent target set for the UN second development decade.^{/41} On the basis of past performance, the target rate of growth for the lower-income countries was less ambitious than the target for the middle-income countries.

^{/41} General Assembly resolution 2626 (XXV) of 24 October 1970, International Development Strategy for the Second United Nations Development Decade.

Table 24: TARGET GDP GROWTH RATES (% PER ANNUM)

Region	1974-80
Mineral producers	6.0
South Asia	4.9
East/Central Africa	5.4
Mediterranean	7.3
West Africa	6.5
East Asia	6.9
Latin America	6.0
Low Income	5.0
Middle Income	6.4
Total - Non-OPEC	6.1

2. Impact of OECD Growth and/or Alternative Oil Prices on the Developing Countries

Table 25 illustrates the impact of OECD growth rates and/or alternative oil prices on the developing countries. The impact was examined from two points of view. The first four columns of the table calculated the growth rates consistent with the exogenously projected capital flows, under different assumptions concerning oil prices and growth in the OECD countries. The last column indicates the amounts of additional aid which would be required under each set of assumptions to achieve the target growth rates of the requirements versions.

Table 25: ALTERNATIVE SIMULATIONS: GROUP I

	1974-80 Growth (% p.a.) of:				Additional Capital 1975-80 (\$ bill./year)/ <u>a</u>
	GNP	Imports	Exports Adjusted	Export Volume	
Base Case (Medium OECD Growth "constant" oil price)					
Low Income	3.3	3.8	5.6	5.2	1.4
Middle Income	4.7	5.0	7.3	7.6	13.3
Total:	4.4	4.8	7.1	7.3	14.7
High OECD Growth					
Low Income	3.8	4.4	6.5	5.8	1.0
Middle Income	5.3	6.0	8.4	8.6	9.8
Total:	4.9	5.8	8.1	8.2	10.8
Low OECD Growth					
Low Income	2.8	3.2	4.8	4.6	1.9
Middle Income	4.1	4.0	6.1	6.6	16.9
Total:	3.8	3.9	5.9	6.3	18.8
Declining Oil Price/<u>b</u> Medium OECD Growth					
Low Income	3.8	4.3	6.0	4.9	1.0
Middle Income	5.0	5.4	7.7	7.5	10.9
Total:	4.7	5.3	7.5	7.2	11.9

/a Current dollars.

/b Different results could be expected if the price fell immediately to \$7.50, rather than to decline gradually as assumed here.

The simulations suggest that the elasticity of developing countries' GDP with respect to that of OECD countries was 0.75. The domestic product of lower-

income countries was somewhat less sensitive to OECD GDP than that of the middle-income countries (elasticities of 0.65 and 0.85, respectively). But because their rate of growth was lower, the reduced expansion of the developed countries' GDP was enough to bring the rate of growth of their per capita income close to zero.

It is interesting to examine the mechanisms through which lower growth of the developed countries influences the foreign exchange earnings of developing countries. As Table 26 shows, the volume of exports of primary product was relatively insensitive to this growth. Exports of manufactured goods were much more sensitive: with high OECD growth, export volumes of these products expanded at 15 percent per annum, but with low growth at only 11 percent. Exports of services were also quite elastic with respect to OECD growth.

Table 26: EXPORT VOLUME GROWTH PROJECTIONS BY
COMMODITY CLASS, 1974-80

	High OECD Growth	Medium OECD Growth	Low OECD Growth
Agriculture (food)	3.0	2.9	2.9
Agriculture (non-food)	3.7	3.6	3.6
Minerals & Metals	4.9	4.6	4.3
Petroleum & Fuels	10.0	10.0	10.0
Manufactures	15.2	13.2	11.0
Services	6.9	6.2	5.5

For export prices, the results were just the opposite. The primary commodities prices implied by the commodity models embedded in SIMLINK were sensitive to changes of the rate of growth of demand. It was assumed on the other hand that the prices of manufactured exports of developing countries depended only on world inflation.

Table 27: TERMS OF TRADE, 1967-69=100

	1973	1975	1980 OECD Growth		
			Low	Medium	High
Low-income countries	.936	.789	.815	.827	.838
Middle-income countries	1.029	.883	.906	.916	.923
Total	1.015	.869	.893	.904	.912

Table 27 assesses the sensitivity of the developing countries' terms of trade to growth in the OECD countries. A modest improvement was envisaged in all these simulations from the unfavorable 1975 level. Low-income countries would gain slightly more than the middle-income countries.^{/42} The terms of trade appeared moderately insensitive to OECD GDP: the elasticity for all developing countries was 0.26. It should be remembered that this was a medium-run price response; in the short run, the elasticity would probably be higher.

A decline in the real price of petroleum would benefit developing countries, although its impact on the purchasing power of their earnings would be partly offset by lower exports to the oil-exporting countries. The results suggested that one 1975 dollar reduction in the price of oil in 1980 would have raised the feasible LDC growth rate by about 0.17 percent.

The requirement simulation suggested that a substantial increase in aid was required to enable developing countries to achieve growth rates approaching the UN target. As shown by the table, it was the middle-income countries which accounted for much of this. The lower-income countries, in the South Asian

^{/42} Their loss in earlier years had, however, been large.

subcontinent in particular, had fairly closed economies, and an acceleration of their growth did not require very large additional amounts of foreign aid.

The amount of additional aid required by developing countries was quite sensitive to the assumptions on OECD growth and oil prices. The amounts listed in the last column suggest, however, that even under the most favorable oil price and OECD growth assumptions, unrealistically large amounts of capital would have been required to achieve "required" rates of increase of GDP matching the growth potential of developing countries. It was interesting, therefore, to use the model to examine whether a balanced set of policies consistent with these targets existed.

3. Policies to Achieve More Rapid Growth

A policy package which would have provided the foreign exchange required to achieve these higher rates of growth might have involved:

- higher exports of manufactured goods from developing to developed countries;
- higher exports from developing countries to members of OPEC;
- increased amounts of ODA.

An accelerated increase of manufactured exports could have been achieved through a combination of export promotion by developing countries and permissive import policies by developed countries. This might have brought the per annum increase from 13 to 17 percent, raising the growth rate of export volumes between 1974 and 1980 from 7.3 to 8.4 percent per annum, and the growth rate of GDP from 4.4 to 4.9 percent. The middle-income group received a disproportionate share of the benefits, as they were the main exporters of manufactures.

There also appeared to be scope for enlarging the developing countries' share of the OPEC market. The extremely rapid increase of demand in oil-exporting

countries was creating new export opportunities which could benefit those developing countries which adopted sufficiently active and flexible policies. It appeared quite possible to expand their market share from 5.9 to 8.5 percent by 1980. As the table shows, this would have been enough to permit an increase of the GDP growth rates from 4.4 to 4.7 percent. The impact on the low-income countries was particularly large: their GDP growth rates would have increased to 4.1 percent in the base case. Because of their proximity to OPEC markets, the lower-income countries of Asia and East Africa could derive substantial benefits from an expansion of OPEC markets.

It could be hoped finally that the declining trend of the share of official development assistance in the GDP of developed countries might be reversed. In the base case, the share of ODA in GNP was assumed to fall from 0.30 percent in 1973 to 0.24 percent by 1980. An increase to 0.37 percent would make available US\$3.8 billion of additional capital per year during the 1977-80 period. It was assumed that this amount would be allocated in a manner that would have enabled the lower-income countries to attain a 5 percent growth target between 1977 and 1980. This would have resulted in an overall growth rate of 4.9 percent.

As Table 28 shows, these policies were sufficient to bring the rate of growth of GDP of developing countries up to 5.6 percent. This did not match the UN development decade targets - nor even the more modest targets of the requirements version of the model.

E. Dynamic Multipliers of SIMLINK

Simulations of SIMLINK suggest that the model's response to exogenous variables appears to be roughly linear. A table of dynamic multipliers is

Table 28: ALTERNATIVE SIMULATIONS: GROUP II

	1974-80 Growth (% p.a.) of				Additional Capital 1975-80 (\$ bill./year)/ <u>a</u>
	GNP	Imports	Exports adjusted	Export	
E. High Manufactured Exports					
Low-income	3.6	4.1	6.0	5.5	1.2
Middle-income	5.3	6.0	8.4	8.9	9.9
Total	4.9	5.8	8.1	8.4	11.2
F. Increased LDC Exports To OPEC					
Low-income	4.1	4.6	6.7	6.2	.9
Middle-income	4.8	5.3	7.6	7.9	12.3
Total	4.7	5.2	7.4	7.7	13.2
G. Increased ODA					
Low-income	5.0	5.4	5.6	5.2	.2
Middle-income	4.9	5.3	7.3	7.6	12.1
Total	4.9	5.3	7.1	7.3	12.3
H. Combination of E, F, & G					
Low-income	5.0	5.5	7.0	6.5	.1
Middle-income	5.8	6.7	8.7	9.1	7.0
Total	5.6	6.6	8.5	8.8	7.1
I. Combination of E & G					
Low-income	5.0	5.4	6.0	5.5	.2
Middle-income	5.5	6.4	8.4	8.9	8.5
Total	5.4	6.2	8.1	8.4	8.7

/a Purchasing power of exports, at constant prices.

/b Current dollars.

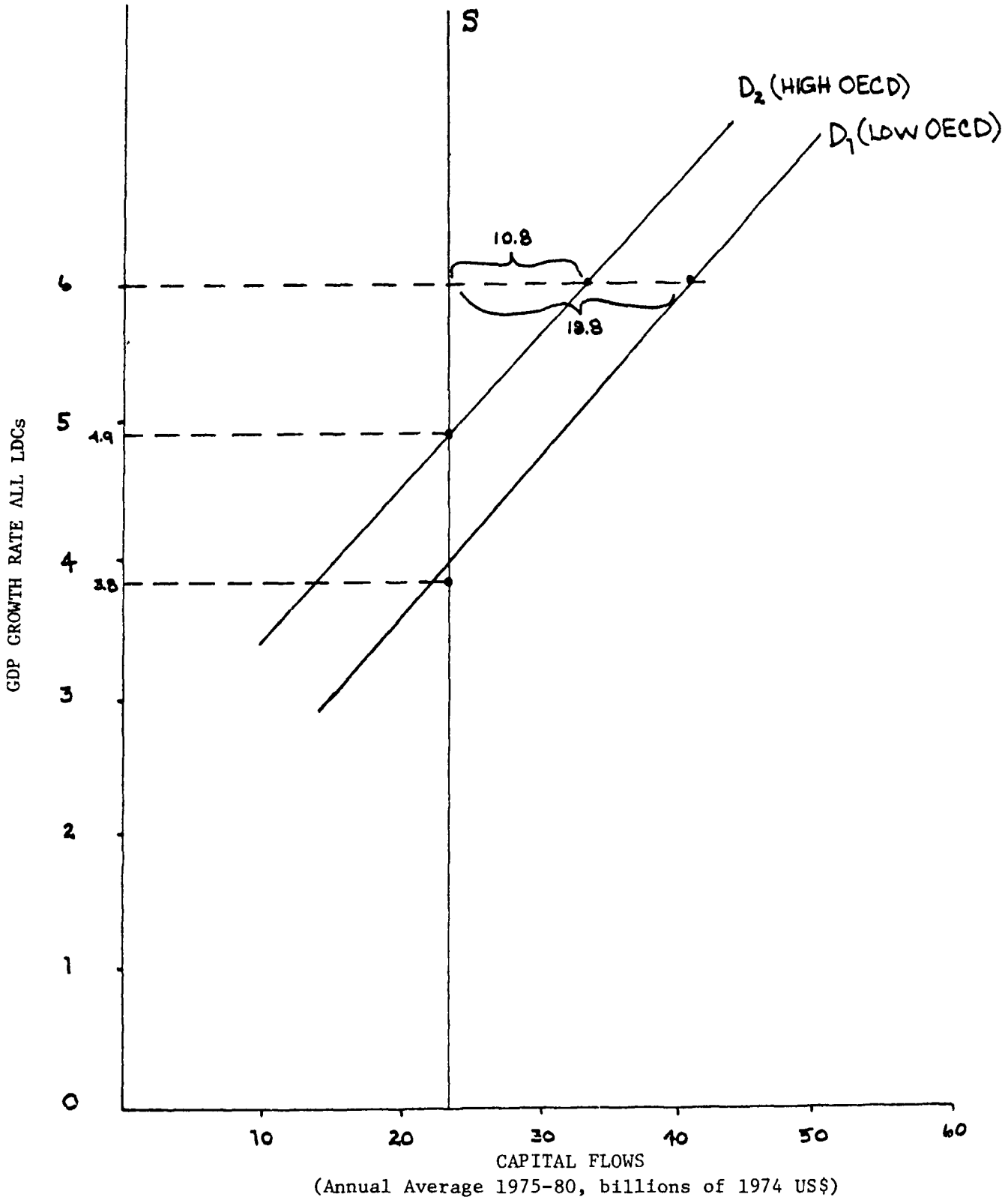
therefore a useful way of summarizing its properties. In Table 29 these multipliers are expressed in terms of the amounts necessary to raise the overall growth rate of developing countries by one percentage point.

Table 29: SENSITIVITY OF POLICY INSTRUMENTS' INCREASES REQUIRED TO RAISE DEVELOPING COUNTRIES' GROWTH RATES BY ONE PERCENTAGE POINT

Policy Instruments	Measured in	Amount of Change
GNP growth in OECD countries	average growth rate 1974-80	+1.2
Capital flows to LDCs	current \$ billions/year	+7.3 billion
Price of petroleum	real 1980 price in 1974 \$	-6.33
LDC exports of manufactures	annual average growth rate	+7.6
LDC share of OPEC imports	percentage of total OPEC imports in 1980	+8.7

Achieving the increase would have required any one of the following: an increase of 1.2 percent of the OECD growth rate; a rise of foreign capital inflows of US\$7.3 billion per year; a reduction in the price of petroleum of US\$6.33 at 1974 prices; an acceleration of the growth rate of exports of manufactured goods from developing countries by 7.6 percent; or an increase of these countries' share of OPEC markets by 8.7 percent. These magnitudes were not invariant; the model was not purely linear, and its multipliers depended in addition to a certain extent on the assumptions made about the distribution of changes between developing regions. Nevertheless, they provided information on the effectiveness of policy instruments and on the model's sensitivity to other exogenous variables.

Fig. 3: DEMAND FOR CAPITAL
(40 Sample Panel Countries)



Chapter VI

EXOGENOUS INPUTS FOR THE SIMLINK FRAMEWORK

The global system did not attempt to project, within that system, the economic developments in the industrial countries. The Bank had on occasion felt that it should have its own view about controversial issues with respect to the developed countries' growth, such as the OPEC surplus recycling problem, or the impact of higher oil prices on developed countries growth. But it did not possess firsthand knowledge about these countries comparable to its knowledge of developing countries.

Unfortunately, little work was being done elsewhere on the long-term perspectives of the industrial countries that could serve as an input into the Bank's global system. The IMF, which is mainly concerned with short-term balance-of-payments and monetary policies, regularly projects the growth and trade of the industrial countries in a global context for the next 12-18 months, but not beyond that horizon. The work of the OECD Secretariat has until recently been concerned only to a limited extent with longer-term prospects. The main concern has also been the next 12-18 months, and the economic policies which were expected to create or maintain stability and balanced growth. The OECD Secretariat's studies of long-term development projected a full decade ahead, but they have principally been a summary of national projections to which some consistency tests were applied. The Interfutures Project undertaken within OECD broke with this tradition, but its results were not available when the Bank was carrying out the analysis described in this book.

The projections made by the Bank made use of the OECD and IMF projections for the years for which those were available. Beyond that period, the basic assumption was that policies to contain inflation would be given

priority, even at the cost of some unemployment and idle production capacity. This suggested a slow recovery from the recession and the attainment of a situation around 1980 which would be characterized by somewhat slower growth than in the decade of the 1960s and a rate of unemployment about one percent above levels in the previous decade. In the first projections, when the depth of the recession and its duration were not foreseen, this return to a stable long-term rate of growth with somewhat higher unemployment was seen to occur in 1979; later projections have gradually shifted this point further into the future, to around 1981.

Projections of inflation had less analytical basis. It would be fair to say that the sources of inflation in the industrial countries, particularly in the years since 1972, were not well understood. The various changes that have occurred in the international monetary system, and particularly the introduction of floating exchange rates, have made the analysis considerably more complicated as the transmission between countries and regions took place under different conditions than those of the past.

The tools used for sensitivity analysis of OECD growth were described earlier. Chapter IV briefly described the MULTILINK system and the analysis of potential growth, and the SIMRICH model is described in Chapter VII. Implications for capital flows (particularly from official sources) were reviewed in Chapter III. The present chapter will thus be concerned mainly with the growth and inflation projections for the industrial countries.

Projections of Real Growth

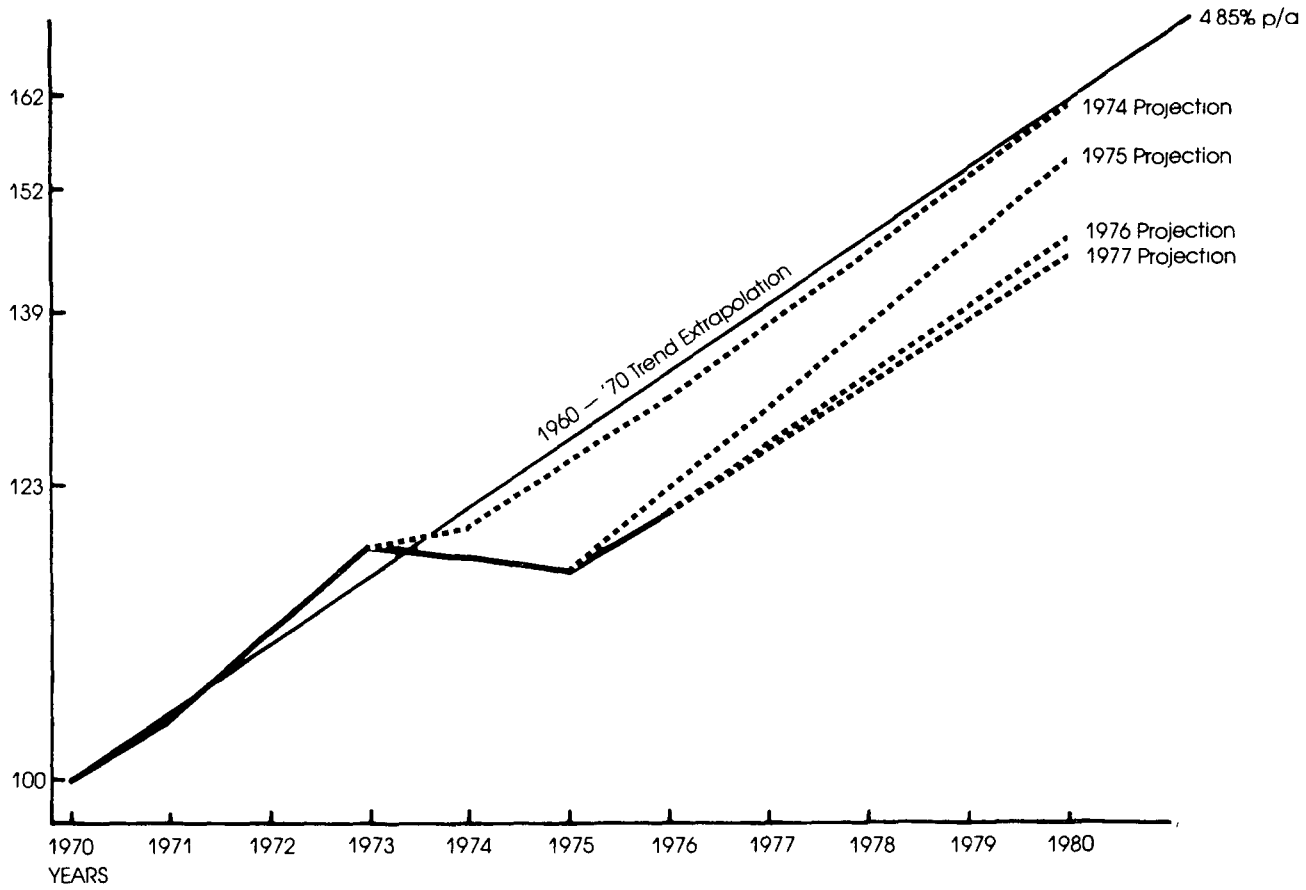
The growth projections for the industrial countries displayed a fair degree of optimism. The developing countries were linked to the industrial ones through trade and capital flows, and their prospects depended significantly on

growth in developed countries. The Bank was publishing projections of growth of developing countries which were substantially below those implied by the UN Development Decade targets. Perhaps to avoid the impression that the projections for the developing countries were unfavorable simply because of a pessimistic set of assumptions for the industrial countries, the latter were biased to the optimistic side.

The comparison of the projections shown in Figure 5, which presents the successive estimates of 1974 through 1977, is clear in that respect. The first projection presented only a very mild recession and a rather speedy return to "normal" growth, equal to the rate observed during the 1960s. The GNP of the industrial countries would thus deviate below the trend only slightly, and return to that trend within a few years' time. The policy assumptions behind this projection suggested measures designed to stimulate economic growth, partly to shorten the recession, but also to offset the real income loss caused by the oil price increase. The 1974 version also contained a lower alternative growth path which assumed less adequate policies to promote recovery, and also stated that this alternative was not considered the most realistic. In fact, most of the subsequent analysis of the world economy was based on the higher growth path.

The next version, made in the middle of 1975, could not take so sanguine a view. The recession had taken on larger proportions in the course of 1974 and early 1975, making it rather unlikely that full recovery could be achieved in the course of 1974 and early 1975, making it rather unlikely that full recovery could be achieved in the course of just a few years. Policies in the industrial countries were strongly centered on the containment and reduction of inflation, and it became doubtful whether a reasonable degree of full employment could be regained before the end of the decade.

Figure 5
 OECD Growth Projections in Successive Years
 Indexes of Real GDP, 1970 = 100



World Bank--24574

The 1975 version nevertheless maintained some optimism, as the basic assumption remained the restoration of a reasonable level of employment around 1980. It was, however, considered unlikely that the trend of the 1960s could be regained, even though long-term growth rates might again become equal to the average of the previous decade. Thus, a new growth trend parallel but lower than the old trend was adopted in this version.

An interesting point might be noted here with respect to the composition of growth in a geographical sense. The dependence on imported oil is highest in Japan, followed by the European industrial countries, and lowest in North America. Thus, the income transfer as a consequence of the oil price increase was seen to affect North America least, the other countries more. In addition, alternative sources of energy and the technology related to the substitution of imported oil by other forms of energy were to a large extent located in North America, and could cause considerable earnings to be obtained by North America as a result of energy substitution in Europe and Japan. Finally, the adjustment of exchange rates in the early 1970s had greatly improved the American competitive position in international markets. These three factors together were considered of sufficient importance to project higher than historical rates of growth for North America, somewhat lower ones for Western Europe, and considerably lower ones for Japan. The latter also to some extent reflected the changed development priorities in Japan which preceded the events of 1973 and 1974. As a result of these changes between the past and the perceived future, all versions uniformly projected a higher growth rate for North America compared to Western Europe, reversing the past relationship.

The projections made subsequently in 1976 were more pessimistic, although the differences tended to decline over time. A significant element in the lowering of projected growth rates was the actual growth performance since

1973, which each time had to be lowered from earlier estimates. But in addition, the insistence of policymakers in the majority of industrial countries on the priority of price stability and the unexpected persistence of inflation led to the conclusion that expectations of future growth had to be cut.

A set of rather bothersome questions concerning long-term growth has as yet not been resolved. The first one relates to the actual performance of the industrial countries in the past, on which much of the reasoning for the future is based. There is a rather common assumption that the industrial countries together increased their real output in the past by an average rate of 4.8 to 4.9 percent per year. This rate applied in fact to the period between 1958 and 1973, or to "the 1960s," variously defined, but may not be representative for the long-term trend. When a longer period is considered, starting with 1950 and extending to 1973 or 1975, a lower rate is observed, at about 4.2 to 4.3 percent per annum. Compared to the latter trend, it appears that the 1960s were a somewhat exceptional period which started and ended above that trend.

The thesis that the lower rate, found for the longer period, was more relevant for long-term projections could be defended. The steeper gradient of the actual growth curve in the 1960s could be attributed to the effects of international trade liberalization and the creation of the European Communities. But by the early 1970s these factors could not provide the same impetus to growth as they did during the 1960s. One could also argue that efforts to restore the higher rate of growth of close to 5 percent per year would bring back the problems of the early 1970s, with scarcities of major commodities, tight labor markets, and a strong stimulus to inflation in many industrial countries and in international trade. The projection contained in the 1977 version of the Bank's global projections, which suggested a long-term growth rate of about 4.4 percent, may thus still have been on the high side. A second problem arose with

respect to the terms-of-trade loss due to the rising oil prices. From the national accounting point of view, this was interpreted as a sudden cut in real national income in 1974. In practice, as oil-exporting countries could not use the additional foreign exchange and accumulated surpluses which were reinvested in developed countries, the cut in purchasing was a gradual one.

Income losses of this nature do not necessarily translate into production losses. Policies can be devised to replace purchasing power lost through terms-of-trade changes by stimulating domestic demand. In order to avoid large imbalances between industrial countries which would follow from such policies and their consequences for import demand, that approach would need to be carefully orchestrated between the industrial countries themselves. A return to the long-term growth trend would then be possible, although this does leave out of consideration the effects of the oil price increase on the productive value of the existing stock of capital goods. The latter point is, however, one of the main themes in the SIMRICH model.

Projections of Price Development

Inflation projections were of importance for two purposes. One was the need for a nominal projection of the gross domestic product of the donor countries who were members of the DAC in order to provide the basis for future flows of official resources to the developing countries. There was also the need for a price index representative of price developments of manufactured goods exported by the industrial countries. The latter index played an important role in the estimation of the import prices of the developing countries and the projection of their terms of trade.

Inflation in the industrial countries rose to unprecedented rates in the years 1973 and 1974. On average, the GDP deflator of the industrial countries,

measured in U.S. dollars, rose by more than 10 percent annually between 1970 and 1974. The boom of commodity prices in international trade and markets, which started about the middle of 1972, contributed to inflation, but the direct impact was modest. According to calculations by the OECD Secretariat, non-oil commodities contributed about 1 percentage point to inflation in 1973 and in 1974; the contribution of oil was 0.3 percent in 1973 and rose to 1.5 percentage points in 1974. Together, these commodities therefore affected price movements in the OECD area only modestly compared to the overall inflation rates prevailing at the time. But this should be considered only part of the impact which commodity prices had on the general price developments. Prices of other sources of energy rose in sympathy with the oil price, and higher costs were passed on to the consumers by higher prices of final outputs.

Internal market imbalances in the industrial countries no doubt played an important role in fueling inflation. And once high rates of price increases became a common feature in virtually all of these countries and in international trade, the inflation fed on itself as confidence in a return to more stable conditions waned and economic agents came to base their plans on the expectation of continuous price increases. These developments have made it extremely difficult to devise a reliable method for projecting future price developments. Certainly models and relationships which appeared valid in the past could be relied on only to a limited extent. Uncertainty about future oil prices, combined with the fear that cartelization could occur for other primary commodities, added to the problem. And beyond that, it was considered by some that serious supply bottlenecks might arise in coming years for an increasing range of commodities.

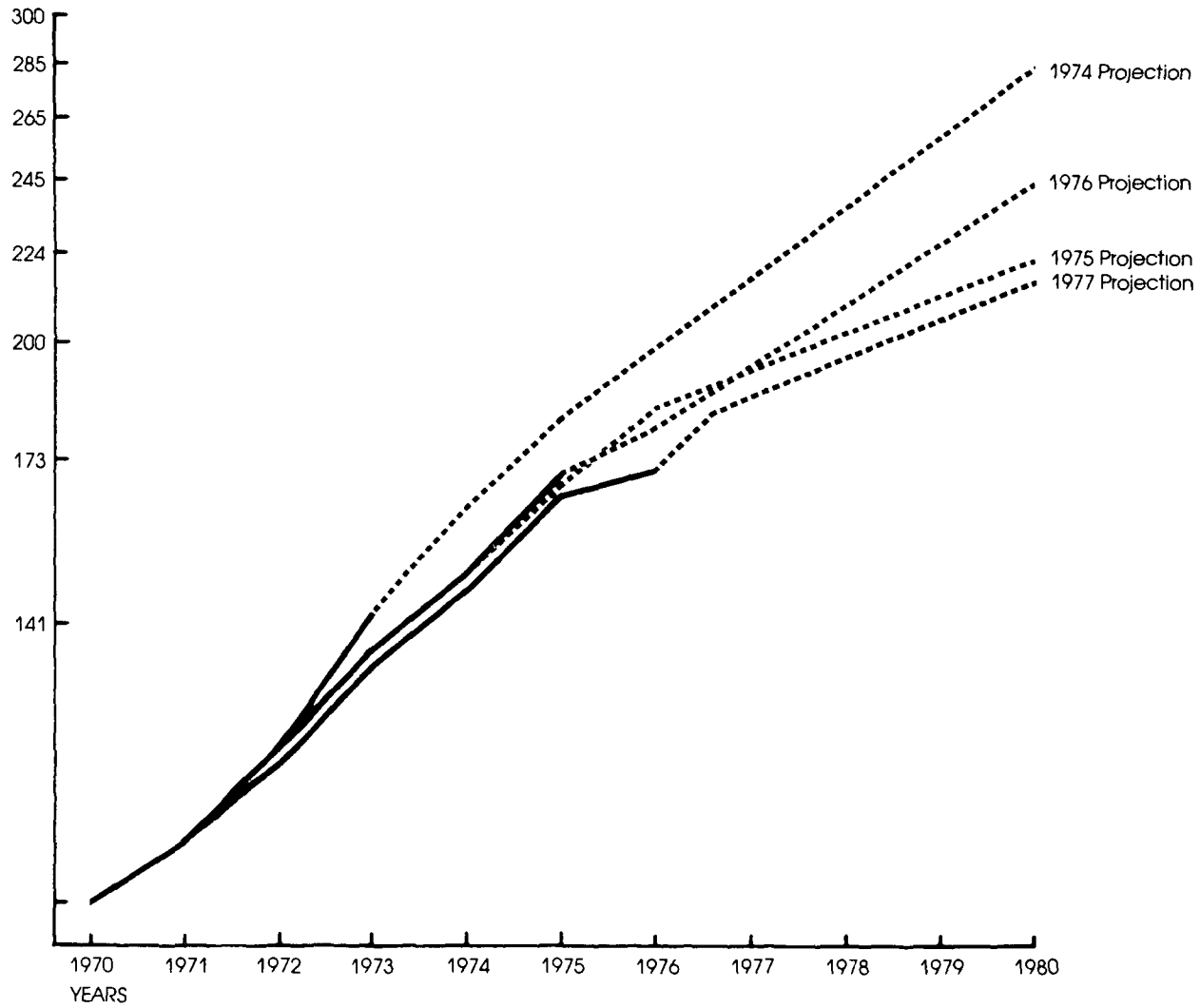
The analysis is equally, or even more, difficult with respect to export prices. In most of the OECD countries, there used to be a fairly stable

relationship between the general price developments in the country and the behavior of export prices. The latter tended to increase at a slower rate. This was to be expected on the basis of the differences in the composition of GDP as compared to exports. The large weight of services in the GDP particularly tended to raise the GDP deflator above the export price index. This was reversed after 1970, when input prices rose either because of international developments (particularly in primary commodity markets) or because of supply constraints in the face of strong demand. In a strongly expansionary situation, producers were able to pass on these costs increases as much to foreign as to domestic clients. In fact, internal demand was so strong for a few years that export markets increasingly became residual and export prices began to rise even faster than domestic prices. It is hard to say exactly to what extent and how quickly the past relationship between domestic and export prices would be reestablished.

With floating exchange rates, exchange rate uncertainties made it difficult to choose a yardstick for measuring inflation. The U.S. dollar was used to measure changes in prices. To measure a country's export price development, it is thus necessary to project its domestic currency as well as its exchange rate movements. Implicitly, this raised the issue of the estimated equilibrium exchange rate for each country. This was a question which the Bank for obvious reasons did not want to answer.

The price projections made in successive years since 1974 are presented together in Figure 6. It will be noted that there is less of a consistent pattern over time for these projections than for the GNP projections. This demonstrates the uncertainty which has surrounded these estimates. But to some extent an interrelation with the growth projections can be discerned; the optimistic growth projections of 1974 were accompanied by inflation projections ranging around a rate of 9 percent per year. In more recent years, the avowed

Figure 6
US \$ — Measured Inflation in OECD
(Indexes of GDP Deflator, 1970 = 100)



policy objectives and their emphasis on curtailing inflation were reflected in both lower rates of inflation and lower rates of real growth. In passing, it should be noted that some of the differences between successive versions are caused by variations in country coverage; this is particularly the case for the 1977 version, which includes all industrial ("OECD North") countries, whereas earlier versions were limited to the major industrial countries only.

The projections of manufactured export prices changed less over time than the projected GDP deflator. In the 1974 version, export prices were assumed - as in the past - to rise less steeply than the GDP deflator. Thus, the inflation rate projected for GDP, at 9 percent per year, was accompanied by an export price increase of 7.5 percent per year. In subsequent versions, however, this differentiation was dropped, as it was felt that the uncertainty about the prospective development of prices was too great to permit this kind of refinement. It was also argued that strong demand from the oil-exporting countries, combined with efforts to substitute (more expensive) domestic energy for imported oil, could even lead to a relative rise of manufactured goods prices as compared to the GDP deflator.

The inflation rates presented in Figure 6 were measured in U.S. dollars, and included assumptions on domestic inflation rates in each country's own currency as well as assumptions about exchange rate changes. For the longer run, the simple assumption made was that differences of inflation rates measured in national currencies would be compensated for by changes in exchange rates. This implied that the exchange rates in some base periods were taken to be equilibrium rates. This is an easy assumption to work with, but not a very good one in reality, as in each year cases can be observed where exchange rates are in the process of adjustment, too high or too low. Average rates for any base year are therefore misleading. The assumption can therefore lead to distortions in the

projections. Each year an effort was therefore made to predict exchange rate movements over the next 6-12 months which would tend to equilibrate a country's currency against the U.S. dollar. These "adjusted" rates were then taken as the base for the projections. As this exercise was a rather speculative one, only aggregate price projections for groups of countries not the detailed calculations, were presented.

Chapter VII

THE SIMRICH OECD MODEL: ESTIMATION OF THE IMPACT OF HIGHER OIL PRICES ON THE GROWTH OF THE DEVELOPED COUNTRIES*

I. Background

The construction of the SIMRICH model/43 was motivated by the need to evaluate the widespread feeling that the sharp increase in energy prices might substantially reduce the rate of growth of developed countries. From the point of view of developing countries, such a slowdown would reduce the rate of growth of world demand for their exports, and make it difficult to finance the imports required by their growing economies. It was therefore essential to try to estimate this impact.

Higher oil prices may affect developed countries in two ways, which are reflected by two quite different sets of mechanisms. The suddenness of the increase will be a cause of disequilibrium, by perturbing aggregate demand and upsetting capital markets. These disequilibrium impacts have been discussed previously./44 The emphasis in this chapter is on the analysis of the lengthy adjustment process of the capital stock of developed countries exposed to a sharp and sudden increase in the price of energy.

The energy price impact is too large to be studied in isolation: The repercussions extend to the whole economy and must be examined in a general equilibrium context. In addition to direct impacts on the energy sector ;and on

* This chapter was written by J. W. Gunning, M. Osterrieth, and J. Waelbroeck. The authors are grateful to B. Balassa, W. Tims, and E. Yudin Sachse for suggestions which were valuable in improving the model.

/43 SIMRICH OECD stands for Simulating an International Model for Research on the Indirect Consequences of Higher Oil and Energy Costs in the Developed World.

/44 IV, appendix.

energy-consuming industries in developed countries, it is necessary to take into account the impacts on saving and capital imports, on wages, and on the rate of return of capital and the length of life of capital goods.

The adjustment process triggered by the increase in energy prices would be lengthy. As a result of the price change, energy users would find themselves impelled to replace energy-intensive capital goods by goods which used less energy per unit of output; energy producers would find it profitable to develop resources of energy which were not profitable before the price increase. A dynamic growth model was required to study this long, drawn-out adjustment process.

II. The SIMRICH Global Framework

The global framework of SIMRICH was similar to that of the SIMLINK model. Like the latter model, SIMRICH distinguished three regions in the world economy: oil-exporting countries, developing countries, and developed market economies. The key difference was that the model emphasized relations between developed and oil-exporting countries rather than between developing countries and the rest of the world. In SIMRICH, oil-exporting countries set the relative price of energy production and consumption in other regions. The oil-exporting countries adjusted their imports to their foreign exchange receipts with a fairly lengthy lag, which reflected the lack of absorptive capacity of a number of them.

Developing countries trade primary commodities and manufactures against the exports of developed countries at terms of trade which were thought of as independent of the level of energy prices. Their imports were equal to the sum of their exports of their net capital imports from the rest of the world (including foreign aid), so that their balance of payments was thought to remain in equilibrium.

Developed countries, finally, served as a capital market to the rest of the world; in particular, they absorbed the capital exports of the oil-exporting countries, and used these to close the deficit of their balance of payments./45

Methodology

As the goal was to study the impact on the economy of a major price change, it was felt that the model constructed should be based on a careful analysis of the equilibrium behavior of a growing economy. SIMRICH was accordingly strongly influenced by the neo-classical analysis of the growth of market economies. It, of course, differed from most other models described in the literature in being quantitative, and more complex in structure than theoretical models./46

Models of this type are well suited to study the impact of the disequilibrium aspects of economic behavior. We were interested in the following of these:/47

- (a) OPEC's fixing of energy prices was, of course, the primary focus, as the main goal was to examine how serious the impact of energy prices was on potential growth of developed countries.

/45 This feature of the model turned out not to be wholly realistic: oil-exporting countries have directed a certain amount of foreign aid to developing countries. Furthermore, there is reason to think that it is partly the accumulation of OPEC surpluses in the developed countries which has enabled OECD banks to extend very large Eurodollar credits to developing countries.

/46 There are, of course, other neo-classical quantitative growth models, the earliest being the well-known Johansen model (1960). Some recent examples are Hudson and Jorgenson (1971), and Adelman and Robinson (1976).

/47 The term "disequilibrium behavior" is used here merely to characterize behavior which is not consistent with the assumptions of the theory of general equilibrium under perfect competition. There is no implication that disequilibrium behavior is per se better or worse than equilibrium behavior.

- (b) It also appeared worthwhile to assess the impact of energy price policies in developed countries on their oil imports and GNP, particularly where these policies were designed to keep domestic prices of energy below or above the world level.
- (c) Because of the suddenness of the increase of energy prices, it was not possible to open up new sources of energy sequentially - as would be the case in a situation of equilibrium - with low-cost sources being fully developed before higher-cost sources are opened up. In practice, the increase in supply involved a range of alternative energy sources with widely varying costs.
- (d) OPEC countries adjusted their imports to their exports only gradually; as a result, they accumulated large foreign exchange balances, a substantial part of which was invested in OECD countries.
- (e) The return on such balances was kept below the equilibrium level by inflation and by corporate taxes. As a result, the return on these balances was far below the marginal productivity of capital in developed countries.

Choice of Coefficients and Assumptions

We did not try to estimate the coefficients of the SIMRICH model, but instead chose to use values suggested by the judgment of experts or by other econometric studies. This approach to choosing coefficients was inspired by the practice followed by builders of many programming planning models. The OECD 1974 energy study played a particularly important role by guiding the choice of coefficients of the energy supply and demand functions. By the time the SIMRICH was built, it had become apparent that this study had overstated the probable increase of domestic energy output in OECD countries and the sensitivity of

demand to prices, and this fact was taken into account in our work. The choice of the consumption function was based on a survey of available economic studies, while the import functions of OPEC countries were chosen so as to be consistent with World Bank projections of their imports. The choice of price elasticities of demand for energy was based on the judgment of experts; here econometric estimates could provide little guidance, since the estimation period was characterized by a very stable energy price level. A crucial parameter was the 15 percent rate of return on capital assumed to prevail in all sectors of the economies of developed countries in 1973. This was based on a survey of estimates reported in the projects analysis literature. The figure is slightly higher than that arrived at by M. Feldstein (1977) on the basis of a similar survey. Another crucial parameter - the 4 percent per year growth of labor productivity - reflected historical experience.

III. Description of the Model

An Analysis of Inputs and Outputs

The developed countries submodel is more detailed than those for the other two regions. It is convenient to start the description of the model by its input/output structure. This is represented in Table 32.

In the Table, the various goods and services are represented by the rows; the agents, by the columns. A "+" indicates that the column sector is a source of the good; a "-", that it is a user. Sectors which neither produce nor consume a good, or whose production or consumption of that good is constant, are designated by a zero.

Table 32: INPUT/OUTPUT STRUCTURE OF THE SIMRICH DEVELOPED COUNTRIES SUBMODEL

	OECD Production Sector			Final Users		
	Primary Energy	Transformed Energy	Prod. Other Goods	Domestic OECD	Foreign LDCs OPEC	
Primary Energy	+	-	0	0	0	+
Transformed Energy	0	+	-	0	0	0
Other Goods	0	0	+	-	-	-
Capital Services	-	-	-	0	0	0
Labor	0	0	-	0	0	0

The market structure is accordingly very simple. Primary energy, supplied by OPEC and by domestic energy producers, is used only by the energy transformation sector (electricity production, oil refining, etc.). Transformed energy is bought only by the other goods sector. Other goods are sold to domestic final users, and to the rest of the world. This is a stark simplification of reality, which neglects minor feedbacks represented, e.g., by the primary sector's input of other goods or of transformed energy. Likewise, we merged the consumption of energy of households with that of other sectors. Primary energy production and energy transformation were assumed to require a fixed amount of labor. For the sake of simplicity, the different types of energy and of other goods were aggregated. This is valid if the prices of goods in each category move together, which, of course, is only approximately true.

The Pricing of Energy

The relative price of imported oil was set exogenously by OPEC with respect to the price of other goods, the numeraire in the model. This assumed perfect cohesion of OPEC. It is probable that these pricing decisions of oil-exporting countries were not independent of oil sales, and that if these sales dropped too much, the cartel might even break down. We did not take this possibility into account in this study, because too little was known about how oil prices might have responded to sales changes. Tentative experiments with the model suggested that changing this feature of the model would have had a large impact on some of the conclusions, especially on those which referred to the impact of protection of domestic energy sources on GNP of the developed countries.

The governments of developed countries were reluctant to increase the price of domestically produced energy as much as that of imported oil. The reluctance was particularly great in countries such as the United States and Canada which had large sources of low-cost, domestically produced energy. This was represented in the model by assuming a lagged response of the price of domestically produced primary energy to world prices. In the base case solution, this price, PSUB, was adjusted to the world price (POIL) according to:

$$PSUB = (POIL)^{.5} (PSUB_{-1})^{.5} \quad (1)$$

But it was clear that other responses might be assumed, and that in simulating the model over the past, it was appropriate to drop this equation and to substitute instead the observed price path of energy.

The base case equation assumed that the price of domestically produced energy eventually caught up with the world price. Political pressures might in fact have kept it permanently below the world level. Alternatively, the desire to achieve energy independence appeared to have led some countries to protect

domestically produced energy to the point of raising its price above the world level. Such policies could be simulated by modifying equation (1) to reflect a price discount on domestically produced energy, or a tariff reflecting the protection granted to domestically produced energy.

The other goods sector used transformed, not primary, energy; and the margin between the two energy prices was considerable. Our estimate of the transformation margin was based on estimates by the staff of Shell Oil, who updated an OECD study for an earlier year for Western Europe. We adjusted these figures to cover North America and Japan, to obtain a transformation margin of \$10.69 per barrel in 1973.

This figure included both net indirect taxes, and the value added by sectors such as electricity generation and distribution, and the distribution and refining of oil. We took the view that the tax component, in fact, covered the cost of infrastructure investment in roads, and the antipollution and other investments required to offset the environmental costs of energy consumption. This implied a broad definition of the transformation sector to include these activities.

The price of transformed energy (PEN) was assumed to adjust with a lag to changes in the world price:

$$PEN = (POIL + 10.69) \cdot ^5 P_{-1} \quad (2)$$

In addition to the lagged adjustment of domestic to world prices, there was a further delay in the adjustment of energy supply and demand as a result of a lagged reaction of the expected prices which guided investment decisions. We assumed that these prices could be described by a simple moving average:

$$PSUB^e = (PSUB + PSUB_{-1} + PSUB_{-2}) / 3 \quad (3)$$

$$PEN^e = (PEN + PEN_{-1} (+ PEN_{-2}) / 3 \quad (4)$$

The Price Response of the Domestic Supply of Primary Energy

The OECD and other studies of prospects for increasing the domestic supply of primary energy in developed countries point to the considerable differences in the costs of different types of energy. It is the price of energy which determines the energy sources which are worth exploiting -- from North Sea oil as a relatively low-cost source, up to very costly sources such as oil shale and synthetic oil.

Another crucial characteristic of energy supply is the length of time needed to develop a particular energy source. Ideally, it would be desirable to open up energy resources in sequence, starting from the cheapest ones and ending with the most expensive. In practice, this would be too slow: Any rapid increase of supply requires parallel development of both low- and a higher-cost sources of energy.

These ideas inspired the specification of the energy supply function. This assumed that prices determined what deposits are worth opening up; but it was the rate of increase and not the level of output which depended on prices. Such a specification, which recognized the long periods required to open up new sources of energy, was appropriate in a model meant for simulation over an 11-year period. It would, of course, not be appropriate if the model was to be used, as other models have been, to study the future well into the next century.

The specification set out to investigate what would have been the increase in supply if prices had remained at the 1973 level; it then examined the implication of higher prices. Equation (5) specified the annual growth of energy production if prices had remained at the 1973 level. The assumed constant increase of 1.753 million barrels (equivalent to about 3.7 percent per year) represented 85 percent of the increase in the OECD's (1974) base case forecast;

the 15 percent scaling down of this forecast reflected our belief that it was too optimistic.

$$\overline{\Delta\text{SUB}} = 1.753 \quad (5)$$

The investment cost of creating this extra capacity was calculated on the basis of a capital at the 1973 price.^{/48} Energy production can be increased more rapidly than the rate implied by $\overline{\Delta\text{SUB}}$ only at a rising capital cost. We assumed that the capital cost per unit of additional capacity (CAPCO) increased linearly with the increase in investment:

$$\text{CAPCO} = 5.91 + f (\Delta\text{SUB}_{+3} - \overline{\Delta\text{SUB}}) \quad (6)$$

where "f" was a calibration parameter, the choice of which determined how strongly the capital coefficient increased as the increase of domestic energy output accelerated. This is discussed below. Investment (VSUB) was then:

$$\text{VSUB} = 5.91 \overline{\Delta\text{SUB}}_{+3} + \text{CAPCO} (\Delta\text{SUB}_{+3} - \overline{\Delta\text{SUB}}) \quad (7)$$

Equations (6) and (7) together implicitly define a production function relating the output SUB to increases in the capital stock; they took a gestation lag of three years into account.

Profit maximization implies equality between the marginal cost of increasing production capacity and the expected return. Hence, taking the three-year gestation lag into account:

^{/48} The base year price was \$3.21 per barrel. Since investment was measured in billions of dollars per year and output in millions of barrels per day, and since we assumed a three-year construction lag, the capital coefficient was given by $\frac{(0.365)(3.21)}{(0.15)(1.15)^2} = 5.91$, where (0.365)(3.21) was the value of output from a well of one barrel per day capacity; $\frac{(0.365)(3.21)}{0.15}$ was the value of the capital required for a producing well of 1 barrel per day capacity; and $\frac{(0.365)(3.21)}{(0.15)(1.15)^2}$ was the value of a 1 barrel per day well which has just been dug and will start producing after three years.

$$\frac{dV_{SUB}}{d(\Delta_{SUB}_{+3} - \overline{\Delta_{SUB}})} = \frac{0.365 PSUB^e}{r(1+r)^2} \quad (8)$$

where 0.365 is the number of thousands of days per year. Using (6) and (7) gives V_{SUB} as a quadratic function of W_{SUB}_{+3} . Applying the optimality condition (8) then gives the profit-maximizing increase in energy production as:^{/49}

$$SUB^*_{+3} = \overline{SUB} + .058 \frac{PSUB^E}{(1+r)^2} \quad (9)$$

It is interesting to note that equation (9) implies that the increase in energy output is a function of the interest rate as well as of the price of energy. This, of course, reflects the fact that the profitability of developing new energy sources depends on the cost of capital as well as on the price of energy. The interest rate was an endogenous variable, being determined by developments in the other good sector (see section "f" below). This turned out to be a significant mechanism in the model. Introducing (9) into (6), we find that the optimal capital coefficient is^{/50}

^{/49} Equation (9) was obtained by combining (6), (7), and (8) and choosing for the calibration parameter a value based on our appraisal of the prospects for increasing the supply of energy. It is readily checked that (6), (7), and (8) imply that

$$SUB^*_{+3} = \overline{\Delta_{SUB}} + \frac{0.365}{2f} \left(\frac{PSUB^e}{r(1+r)^2} - \frac{PSUB^e_0}{r_0(1+r_0)^2} \right)$$

The calibration constant "f" obviously determines the relation between the increase in domestic production of energy and its price. Its value was chosen to ensure that the difference between the energy output attained in 1985 when the price of energy is \$3 and \$9 per barrel is 75 percent of the difference between the corresponding OECD projections. Inserting this value of f (3.16) and the values of $PSUB^e_0 = 3.21$, $r_0 = 0.15$, gives equation 9.

^{/50} From (5) and the equation in the previous footnote, $CAPCO = 5.91 + \frac{0.365}{2} \left(\frac{PSUB^e}{r(1+r)^2} - \frac{PSUB^e_0}{r_0(1+r_0)^2} \right)$; substituting $5.91 = \frac{0.365 PSUB^e_0}{r_0(1+r_0)^2}$ gives (10).

$$\text{CAPCO} = \frac{.365}{2} \left(\frac{\text{PSUB}_o^e}{r_o (1 + r_o)^2} + \frac{\text{PSUB}^e}{r (1 + r)^2} \right) \quad (10)$$

Energy Transformation

Primary energy was transformed into final energy by a single technique, which used only capital, and neither labor nor inputs of other goods. As explained above, the transformation sector was defined broadly to include all activities involved in making energy available to users, i.e., it included infrastructure investment in roads and investment required for pollution abatement as well as energy transformation in the narrow sense of the term. On the "polluters pay" principle, SIMRICH considered taxes on energy as payment for the public investment connected with energy consumption.

Value added (in constant prices) was given by multiplying output by the base year value of the transformation margin./51

$$\text{TRAN} = 3.90 \text{ EN} \quad (11)$$

Investment in the sector was determined by applying to output increases a constant capital coefficient. This was consistent with the assumed 15 percent base year rate of return./52

$$\text{VTRAN} = 26.01 (\text{TRAN} - \text{TRAN}_{-1}) \quad (12)$$

Production Function and Choice of Techniques in the Other Goods Sector

The analysis of energy demand in the model involved a sharp distinction between two types of adjustment. In the short run, the scope for energy conser-

/51 Again a correction for difference in units is needed: the base year margin is \$10.69 per barrel per day, so that converting to billions of dollars per year gives $10.69 \times 0.365 = 3.90$.

/52 It is readily checked that $3.90 = (0.15) (26.01)$.

vation is quite limited, as the consumption of energy is narrowly conditioned by the characteristics of the existing capital stock. Even if a large car is run economically, it will use more energy than a small model. In the same way, the energy required to heat homes or to operate factories is heavily dependent on their design.

The situation is quite different in the long run. Comparisons of energy consumption per unit of GNP between countries indicate that the energy intensity of output is substantially lower in countries where energy prices have been high for a long time than in countries where they have been low. These differences are explained by pervasive differences in the organization of production and everyday life. To illustrate the argument by an example from everyday life, not only are European automobiles smaller and operated with more efficient engines, but European cities are also more densely populated, and their public transport networks are more widespread and are used more intensively by the population.

An increase in energy prices therefore evokes a long, drawn-out response by stimulating a broad adaptation of the capital stock and of the organization of the economy. Adjustment is a complex process, which involves not only the replacement of existing machines by equipment which uses less energy, but changes in habits and technical innovations.

It was felt that this long, drawn-out adaptation could be best modeled by assuming that after the rise in energy prices, investors would select capital goods which differed from those which they purchased when these prices were lower. These capital goods would be more energy efficient than the latter, but they would cost more per unit of output; it was the rise in energy prices which made them more profitable than the old capital goods.

These ideas were implemented by specifying an ex ante production function in which investors could choose a combination of energy, labor, and

capital at the time of investment, and ex post production functions, with much less substitutability, to which they were restricted once that decision has been taken.

The choices open to firms are represented in Figure 7, which describes a two-factor production function consistent with the ideas just set out. In the diagram the curve EA described the techniques between which firms could choose ex ante at the time of investment. If the prices of energy and of capital were in the ratio described by the isocost curve I_1 , then the technique selected by the firm would be T_1 .

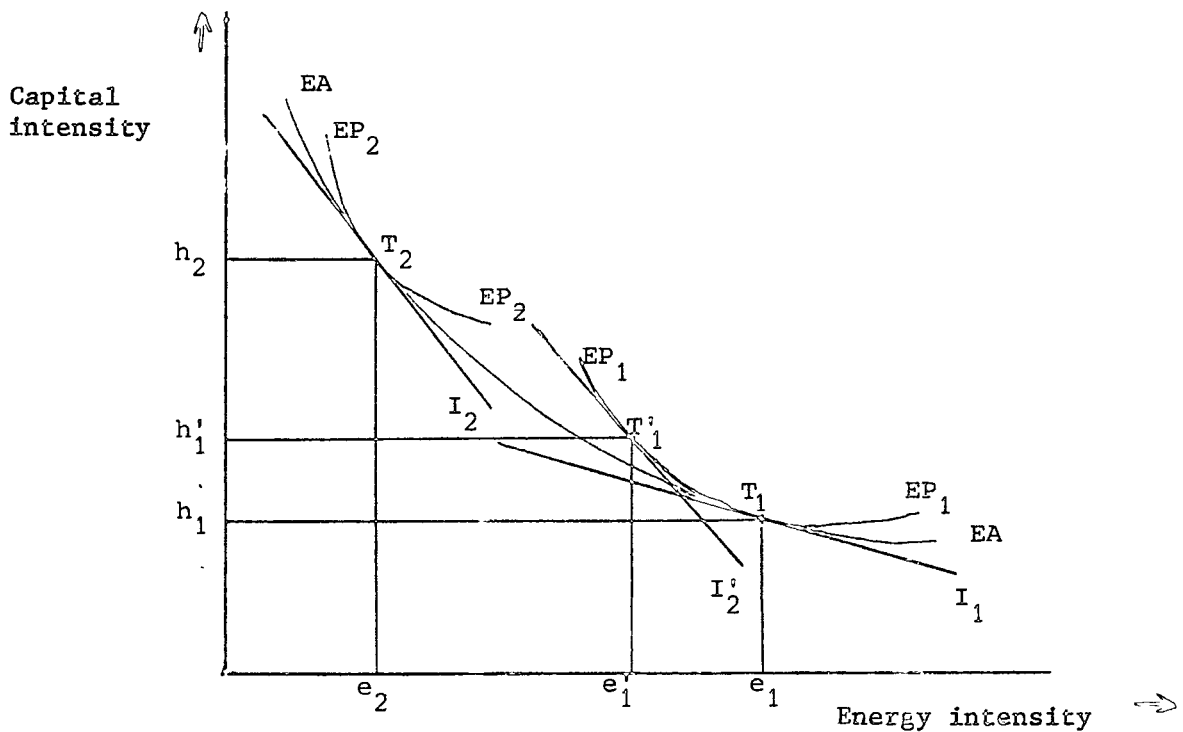
If the price of energy suddenly increased, yielding the isocost curve I_2 , the new investment of firms would take the form of capital goods of type T_2 . There was, however, less scope for substitution of capital for energy on the capital goods bought before the price increase: the more restricted range of substitution for the goods was described by the ex post curve EP_1 , the profit-maximizing point for this old equipment being T'_1 .

The ex post substitution possibilities for technique T are likewise described by curve EP_2 . It was clearly assumed that such an ex post curve existed for every point of EA. Each of these was tangent to EA, which accordingly was the envelope of the set of EP curves.

The approach illustrated in the diagram had important implications for the way energy demand responded to a price change in the model. The energy intensity on the capital stock existing at the time of a price increase could only be adjusted from T_1 to T'_1 , whereas new investment would be in technique T_2 , which was more capital- and less energy-intensive. The immediate effect of the price increase was a drop in the energy use per unit of output from e_1 to e'_1 . The sector's average energy use would, however, be a weighted average of e'_1 and e_2 , with the weight of e_2 increasing over time as old capital was scrapped and

the stock of new capital (of type T_2) increased. Hence energy demand in the model depended on past investments as reflected in the composition of the capital stock. The speed of adjustment to the higher price depended on the amount invested in the sector. This feature distinguished SIMRICH from approaches which related energy demand to output and price levels with fixed coefficients and took the past into account only by specifying a distributed lag structure. Implicit in the model was a distributed lag, but its coefficients were not constant but endogenously determined by investment behavior over time.

Fig. 7: EX ANTE AND LY POST ISOQUANTS IN THE OTHER GOODS SECTOR



The mathematical specification used in SIMRICH was slightly more complicated than the mechanism illustrated in the diagram, because it reflected the role of labor as a factor of production in addition to that of energy and capital. The specification was as follows.

To simplify the algebra, we only considered substitution possibilities between energy and capital, assuming that labor and capital were joint factors of production: the number of workers per unit of capital was independent of the

choice of technique and changed only as a result of (exogenous) productivity growth.

The ex ante substitution possibilities between capital and energy were defined by a CES production function:

$$OTH_{\tau} = (a \cdot VOTH_{\tau}^{-c} + b \cdot EN_{\tau}^{-c})^{-1/c} \quad (13)$$

where OTH, VOTH, and EN were output of other goods, capital, and energy use; τ denoted the vintage; and the substitution chosen ($s = 1/(1 + c)$). The ex ante elasticity of substitution chosen ($s = 0.6$) made possible a reduction of 8 percent of the average energy intensity of production by 1985. (On newly invested capital goods, the reduction is 14 percent.) This choice of coefficient was guided by the estimates in the OECD energy forecasts that the upper limit of possible energy saving was in the 10- to 15 percent range. The coefficients "a" and "b" were derived from the share of energy and other costs in the sector in 1973./⁵³ The entrepreneur who invested at time "t" selected a point on the ex ante production function by maximizing the present value of expected profits over the machines's lifetime. Since labor use per unit of capital was independent of the choice of technique, and since we assumed that the entrepreneur expected the

⁵³ The model assumed that the equipment available prior to 1973 was homogenous with respect to factor intensities, and could be handled as a single vintage. The profit maximization conditions (14) and (15) below, adapted for this initial vintage, could be used to derive "a" and "b" from the 1973 factor intensities. The formulae were:

a = (share of non-energy input in value of output) x 1973 capital coefficient)^c, and

b = (share of energy in value of output) x 1973 energy input per unit of output)^c,

where the capital coefficient was derived from the equilibrium growth assumption that the return on capital equaled the sum of profits over a 25-year lifetime of the investment, discounted at 15 percent per year.

machine's lifetime also to be independent of that decision,^{/54} this was equivalent to maximizing current profits.

Partial differentiation of (13) with respect to EN , and equating the marginal product of consumed energy to the expected energy price PEN^e , gave

$$EN_{\tau}^* / OTH_{\tau}^* = (b/PEN^e(\tau))^S \quad (14)$$

where the asterisk denoted ex ante optimal levels of output and energy use.

Solving for "b" and substituting into ex ante production function yield

$$VOTH_{\tau} / OTH_{\tau}^{\bar{x}} = \left[\frac{1}{a} (1 - PEN^e(\tau) \frac{EN_{\tau}^{\bar{x}}}{OTH_{\tau}^{\bar{x}}}) \right]^{-1/c} \quad (15)$$

At each point of time, (14) and (15) defined the technological characteristics of the new equipment being bought.

Once a machine has been installed, ex post substitution possibilities were again given by a CES function:

$$OTH_{\tau}(t) = (\alpha_{\tau} VOTH_{\tau}^{-\gamma} + \beta_{\tau} EN_{\tau}^{-\gamma})^{-1/\gamma} \quad (16)$$

with substitution elasticity $\sigma = 1/(1 + \gamma)$. The model assumed an ex post elasticity of 0.15, which was consistent with econometric estimates of the demand for energy.

It was clear that if the price expectation were realized, the profit-maximizing factor intensities had to be the same on the ex ante and ex post production functions. In other words, the ex ante and ex post isoquants had to be tangential at the point $(VOTH_{\tau}/OTH_{\tau}^*, EN_{\tau}^*/OTH_{\tau}^*)$ which defined the ex ante choice of technique.

^{/54} This was not correct, since the mechanism of the model implied that energy-saving equipment had a longer useful life than other equipment. But this effect of the choice of technique on the machine's lifetime was so weak that it could be ignored in the investment decision.

This implied two conditions sufficient to derive the two unknown parameters α_τ and β_τ in (16). Indeed, it must be true that

$$EN_\tau^*/OTH_\tau^* = (\beta_\tau / PEN^e(\tau))^\sigma$$

Hence,

$$\beta_\tau = PEN^e(\tau) (EN_\tau^* / OTH_\tau^*)^{1+\gamma} \quad (17)$$

Similarly,

$$\frac{VOTH_\tau}{OTH_\tau^*} = \left[\frac{1}{\alpha_\tau} (1 - PEN^e(\tau) \frac{EN_\tau^*}{OTH_\tau^*}) \right]^{-1/\gamma}$$

Hence,

$$\alpha_\tau = \left(\frac{VOTH_\tau}{OTH_\tau^*} \right)^\gamma * (1 - PEN^e(\tau) \frac{EN_\tau^*}{OTH_\tau^*}) \quad (18)$$

The ex post production function was now completely known. In future periods, factor intensities would move along the ex post production function, so as to maximize profits at the prevailing energy prices, so that

$$OTH_\tau(t) = VOTH_\tau * \left[\frac{1}{\alpha_\tau} (1 - PEN(t) \frac{EN_\tau(t)}{OTH_\tau(t)}) \right]^{1/\gamma}$$

and

$$EN_\tau(\tau) = OTH_\tau(\tau) * \left[\beta_\tau / PEN(\tau) \right]^\sigma \quad (19)$$

Pricing of Labor and Capital

Wage Determination

We assumed that labor productivity would increase at its past rate of 4 percent per year. Then the most recent vintages would also be the most profitable ones. The level of wages would determine which of the vintages yielded positive or zero profits, and were therefore worth operating, and which should be scrapped because their operation would result in losses. In

equilibrium, the wage level had to be such that enough vintages were used to ensure full employment of the available labor force.

The labor use L_τ on machines of vintage τ was then given by

$$L_\tau = l_e^{-0.04(t-1973)} VOTH_\tau \quad (20)$$

where l_e was the number of workers per unit of capital in 1973. Only the most recent and efficient vintages would be used at any point of time, older vintages being scrapped. If machines of vintage " t " came on stream in year $t + 1$ and if the oldest vintage in use in year " t " was of vintage t_1 , then total labor demand was

$$L_t^d = \sum_{\tau=t_1}^{t-1} L_\tau \quad (21)$$

and, given an exogenous projection of the labor force and the full employment assumption in the model, this equation enabled us to calculate for each year the age of the oldest vintage in use t_1 . /55

The next step was to calculate the corresponding equilibrium wage rate, which would be deduced from the condition that profits at the marginal vintage of capital were zero. Given the length of the projection period 1974-85, only pre-1973 vintages would be scrapped. As energy prices were roughly stable before 1973, these vintages were assumed to use equal amounts of energy per unit of

/55 Technically it was convenient to treat pre-1973 investment in continuous time.

The right-hand side of (21) was then replaced by the sum $\sum_{1974}^{t-1} L_\tau$ corresponding to employment of vintages created after the oil price increase, plus an $\int_{t_1}^{1973} L_\tau d_\tau$ describing employment on older vintages. We assumed that the technical lifetime of capital goods was 25 years and that, before 1973, investment grew at a constant rate equal to the observed long-term GDP growth range.

output and to differ only in labor productivity. For the marginal vintage "t", profits on those machines had to be zero at time "t".

$$OTH_{t_1}(t) = PEN(t) EN_{t_1}(t) + W_t L_{t_1} \quad (22)$$

More recent capital goods which were more efficient yielded a positive surplus after payment for current inputs. Capital created before the cutoff date t_1 was scrapped.

It is interesting to examine further the behavior implied by equations (21) and (22). Because of the assumption that the capital/labor ratio depends only on time, equation (21) implies that, in the short run, the scrappage cutoff date is independent of the price of energy. This would not be true in the longer run, as energy prices influence the level of investment and thereby the economic lifetime. Equations (21) and (22) imply that any acceleration of investment would accelerate scrappage and raise the wage rate, and that any deceleration would reduce it.

According to equation (22), the short-run relation between wages and energy prices would depend on the elasticity of substitution between capital and energy.^{/56} If this was zero, then equation (22) defined the wage rate as a linear function of the price of energy, as represented by curve c, Figure 8. If it was possible for firms to adjust their energy input to the prices, then the wage/energy price relation would be a curve which was convex to the origin, such as c_2 in the diagram. Three linear factor price frontiers are shown in the

^{/56} Remember that in SIMRICH, the capital/labor ratio is assumed to depend only on the age of the vintage.

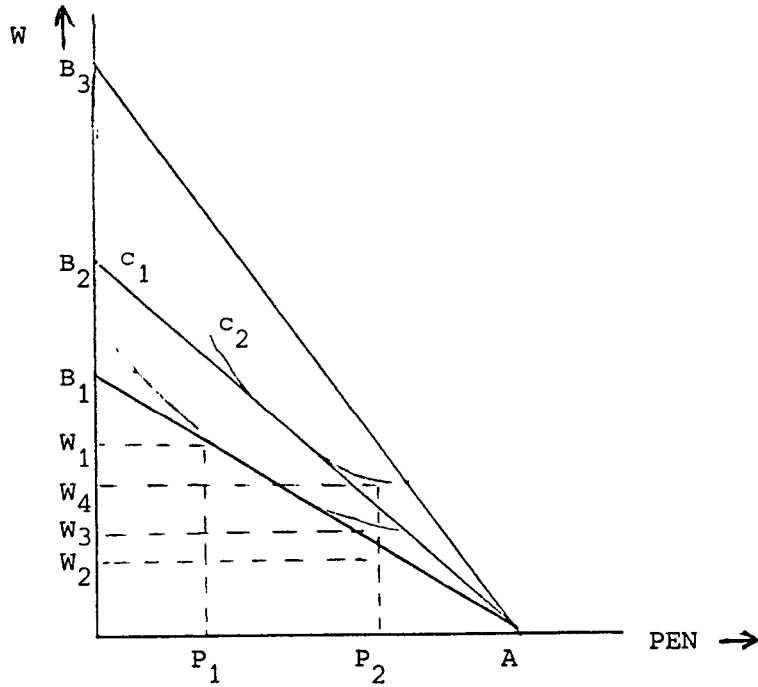
diagram, the steeper ones corresponding to more recent vintages.^{/57} At an energy price P_1 , the wage rate would be W_1 . If the price now rose to P_2 , the economic lifetime of machines would initially remain unaffected. Hence, the wage rate dropped to W_2 , or, recognizing substitutability, to W_3 . But the economic lifetime (t_1) was dependent on the energy price only in the short run. Scrapage in the model depended on the level of investment in the other goods sector, which was related in a complicated way to the energy price. The latter influenced both savings and capital flows from abroad (the accumulation of petro-dollars) as well as investment in the primary energy and energy transformation sectors. These variables determined investment in the other goods sector (which was derived residually); hence scrapage, the age of the marginal vintage and therefore, finally, the wage rate.

If the effect of the price rise was to increase investment in the sector, more recent vintages would have to be scrapped (t_1 rises): in terms of the diagram, the factor price line swings from AB_1 to AB_2 . This further mitigates the pressure on the wage rate: it now falls only to W_4 .^{/58}

^{/57} The line AB gives the frontier for 1973 machines. The three lines all go through A because this point is given by $PEN = OTH_{t_1} EN_{t_1}$ and since we assume that pre-1974 machines differ only in labor productivity, this gives the same point (for all t_1 1973).

^{/58} The line AB_3 gives the frontier for 1973 machines. The three lines all go through A because this point is given by $PEN = OTH_{t_1} EN_{t_1}$ and since we assume that pre-1974 machines differ only in labor productivity, this gives the same point (for all t_1 1973).

Figure 8



Determination of the Interest Rate

Whereas in the model the wage rate was determined by the characteristics of the marginal vintage, the characteristics of the newest machine determined the interest rate. We assumed that the interest rate was at its equilibrium value in the sense that it was equal to the internal rate of return on the latest vintage. Discounting profits (value added minus the wage bill) over the economic lifetime of a machine gave for vintage τ (assumed to be scrapped in year $t_1(\tau)$):

$$VOTH_{\tau} = \sum_{t=\tau+1}^{t_1(\tau)} (OTH_{\tau}(t) - EN_{\tau}(t)PEN(t) - L_{\tau}W_t) / (1+r)^{t-\tau} \quad (22)$$

We had to make a number of assumptions in order to be able to use this equation to calculate the interest rate.^{/59} We assumed that investors had rational expectations, i.e., they correctly anticipated the energy price and the wage rate they would have to pay over the capital goods lifetime as well as that lifetime itself.^{/60}

The interest rate thus determined had an important effect on the choice of technique in energy production, since there were long construction lags in that sector. A lower interest rate would induce additional energy output, and the model's results suggest that this effect was of some importance (see Section IV below).

It is important to realize that different profit rates are realized on different vintages. Profits are maximal when the machine is new and then decreases over time as the wage rate rises until profits are reduced to zero and the machine is scrapped. The assumption of rational expectations allowed us to assume that the internal rate of return calculated from this time-profile of profit is the interest rate. Hence, the interest rate depends on (a) the production function (which determines energy and labor use and the extent to

^{/59} As it turns out, this effect was fairly important: whereas the substitutability reduced the fall in the wage rate projected by the model only from 4.3 percent to 4.1 percent, the projected decrease in the economic lifetime further reduced it to 3.4 percent. See section IV below.

^{/60} Technically, this meant that the model had to be run far beyond the 1974-85 projection period. This gave us the value of $t_1(1977)$ and the time paths of PEN and W. We then used equation (22) to calculate the ex post internal rate of return. Call this r_1 . Since we assumed rational expectations, this should also be the rate of interest. But to derive $t_1(1977)$, we had to assume a rate of interest, say r_2 . This introduced a problem of simultaneity: a change in the value of r_2 would affect investment in the other goods sector. Hence, the choice of r_2 affected scrappage and thereby the wage rate and the value of $t_1(1977)$, both of which affect r_1 . We iterated until the values for r_1 and r_2 converged.

which these can be adjusted), (b) the energy price, (c) the wage rate, and (d) the expected lifetime of the most recent vintage (which, as we have noted, indirectly depends on the interest rate itself).

In summary, three effects of a change in the energy price were modelled for the other goods sector: first, a change towards less energy-intensive techniques (a movement along the ex ante production function for new machines); second, a change in the economic lifetime of machines; and third, a change in factor prices.

Interest During Construction

A second refinement in the model, which turned out to be of some significance, concerned the treatment of interest during construction. We assumed that the value of capital goods with a gestation period¹ of a year or more grew by "r" percent per year. For the transformation sector, no gestation lag was assumed; the instantaneous output was then offset by an "r" percent charge. Hence, we added to GDP and subtracted from total investment a term:

$$r(1 + r) VSUB_{t-2} + rVSUB_{t-1} - rVTRAN = rUNF$$

Note that for the other goods sector, where a gestation lag of one year was assumed, no such adjustment is needed.

National Accounts

The consumption function was

$$CONS = 0.53GNP + 0.33CONS_{-1} \quad (23)$$

Total investment then followed from the GDP identity given a resource surplus - ΔACC - FSR + FSE:

$$V = GDP - CONS - INV - \Delta ACC - FSR + FSE + (POIL - POIL_0)MOIL \quad (24)$$

where INV stands for increase in stocks, defined by:

$$INV = 0.2(GDP - GDP_{-1}) \quad (25)$$

Investment in the other goods sector was determined residually:

$$VOTH = V - VSUB - VTRAN - \left[r(1 + r)VSUB_{t-2} + rVSUB_{t-1} - rVTRAN \right] \quad (26)$$

Total energy use and output of other goods were given by summation over all vintages actually in use:

$$EN = \sum_{\tau=t_1}^{t-1} EN_{\tau}(t) \quad (27)$$

$$OTH = \sum_{\tau=t_1}^{t-1} OTH_{\tau}(t) \quad (28)$$

Oil imports now followed from the material balance:

$$EN = SUB + MOIL \quad (29)$$

GDP consisted of value added in each of the three sectors plus the value of interest during construction ($rUNF$):

$$\begin{aligned} GDP^* &= (OTH - PEN_o \cdot EN) + (PEN_o - POIL_o)EN + POIL_o \cdot SUB \\ &= OTH - POIL_o \cdot MOIL \end{aligned} \quad (30)$$

$$GDP = GDP^* + r(1 + r)VSUB_{t-2} + rVSUB_{t-1} - rVTRAN = GDP^* + rUNF \quad (31)$$

$$GNP = GDP - FSR + FSE \quad (32)$$

(where FSR and FSE stand for factor service receipts and earnings of oil producers).

Balance of Payments

As shown above, total investment in the economy was derived residually from the expenditure identity. Hence, it remained to derive the current account surplus. For this purpose the model distinguished, in addition to developed and oil-exporting countries, a third group of countries, the developing ones. These countries were assumed to be in balance-of-payments equilibrium in the aggregate.

There were, then, seven trade flows among these three groups of countries.

- a. oil exports from OPEC to OECD (POIL.MOIL)
- b. oil exports from OPEC to LDCs (POIL.MLDC)
- c. (gross) exports of other goods (manufactured exports) from OPEC to the OECD ($MANEX_1$)
- d. (net) exports of other goods from OPEC to LDCs ($MANEX_2$)
- e. imports of other goods by OPEC from the OECD (ABS_1)
- f. imports of other goods by OPEC from the LDCs (ABS_2)
- g. net exports of other goods from LDCs to the OECD

The volume of the first flow was determined by the model; the next three flows were forecast exogenously; the last flow followed from the assumption that LDCs were in balance-of-payments equilibrium. Hence, total net OECD exports of other goods were defined by:

$$EXPOTH = ABS - MANEX_1 - MANEX_2 - POIL.MLDC$$

We assumed that OPEC imports, ABS , were determined by a distributed lag on OPEC's foreign exchange receipts ($XANGE$):

$$XANGE = POIL.MOIL + POIL.MLDC + MANEX_1 + MANEX_2 + FSR - FSE$$

$$ABS = \sum_{i=0}^{14} c_i XANGE_{t-i}$$

where the coefficients of the distributed lag were .200, .104, .097, .090, .082, .074, .066, .059, .052, .045, .039, .033, .027, .023, .011. This specification implied a rather slow adjustment process: it would take six years before imports adjusted to only half of an initial increase in revenues.

Factor service receipts, were projected assuming an average real rate of return on oil exporters' foreign assets of 2 percent:

$$FSR = 0.02ACC_{-1}$$

where assets are defined by:

$$ACC = ACC_{-1} + XANGE - ABS.$$

Hence, the OECD resource surplus is equal to

$$EXPOTH - POIL.MOIL = - (\Delta ACC - FSR = FSE)$$

Gross national savings (corrected for the terms-of-trade loss) are:

$$\begin{aligned} SAV &= GDP - CONS - FSN + (FOIL - POIL_0)MOIL \\ &= GNP - (POIL - POIL_0)MOIL - CONS \end{aligned}$$

and, by definition:

$$V + INV = SAV + CAPIMP$$

where CAPIMP are capital imports ($XANGE - ABS = \Delta ACC$).

IV. Results^{/61}

Short-Run Effects

The model was run under two price assumptions, one corresponding to the 1973 price (\$3.21 per barrel), the other to the early 1975 price (\$8.19 per barrel in 1973 prices). The short-run effect of the price increase can be measured by comparing the two versions for 1974. The only effect operating in that year was the ex post substitution away from energy on the existing capital stock: increased investment in domestic energy production and investment in less energy-intensive techniques in the other goods sector could reduce the terms-of-trade loss in the initial year because of the assumed gestation lags. Given the low value of the ex post substitution elasticity (0.15), the difference between the two cases in the level of oil imports is very small. Even if domestic prices

^{/61} The reader who is interested in a theoretical discussion of the results is referred to the companion paper: J. W. Gunning, M. Osterrieth, and J. Waelbroeck, "The Price of Energy and Potential Growth of Developed Countries: An Attempt at Quantification," European Economic Review, #7 (1976), pp. 35-62.

were adjusted instantaneously, oil imports dropped by only 3.44 million barrels a day, or 12.9 percent. In this case, the terms-of-trade loss was \$48.50 billion if measured at the \$3.21 level of imports, \$41.69 billion if measured at the new level. As a result of the price increase, the domestic product (at current prices) dropped by \$44.92 billion, or 1.5 percent. The fact that this GDP loss was smaller than the terms-of-trade loss measured at the \$3.21 level of imports reflected the ability of the economy to adjust its pattern of energy consumption to the new price. This "flexibility effect" was $\$48.50 - \$44.92 = 3.58$ billion. Similarly, the fact that the GDP loss was larger than the terms-of-trade loss measured at the new price level of imports reflected the import substitution cost of reducing imports to the new level. This "import substitution cost" was $\$44.92 - \$41.69 - \$3.23$ billion.

Any delay in adjusting domestic to world prices would lead to a waste of resources. This effect could be measured by using the lagged adjustment of equation (2) instead of the instantaneous adjustment ($PEN = POIL + 10.69$). In this case, the domestic price rose by only \$2.3 in 1974, compared to a world price increase of \$15. In this case, the domestic product dropped to only .93 billion more than in the case of full price adjustment. This loss, a mere 0.03 percent of GNP, was negligible; it was also transitory and vanished as soon as the domestic price was fully adjusted.

Dynamic Effects of the Price Increase

The main results of the simulations for the two cases are given below. They imply that, if oil prices remained at the level of early 1975 (in real terms), oil imports of OECD countries would continue to grow until 1985 but much more slowly than if prices had not increased. Oil producers would increase their foreign assets rapidly until 1980, more slowly thereafter. Under the higher oil

price, OECD energy production exceeded by 17.3 percent the level which would have been reached had the oil price remained constant; energy demand was 10.3 percent lower.

The effects of the price increase on growth can be decomposed into a change in the supply of funds (savings) and a change in the efficiency of investment. Gross national savings (including net factor service income and the terms-of-trade loss) were \$146 billion lower over the 1974-84 period at the higher oil price. This was, however, more than offset by higher capital imports, i.e., by the investment by oil producers of oil revenues in the OECD. The net result was that savings were slightly (\$46 billion, or about one-half of one percent) higher.

To evaluate the changes in the efficiency of investment, it is convenient to use a two-sector analysis:

$$GDY^* = GDP^* - (POIL - POIL_0)MOIL = (OTH - POIL EN) + POIL SUB$$

$$V_1^* = \sum_{t=1974}^{1984} VOTH_t + \sum_{t=1975}^{1985} VTRAN_t$$

$$V_2^* = (1+r) \sum_{t=1972}^{1982} VSUB_t$$

$$\theta = V_2^* / (V_1^* + V_2^*)$$

$$e_1 = \frac{\Delta ENERG}{V_1^*}$$

$$v_1 = \frac{\Delta OTH}{V_1^*}$$

$$v_2 = \frac{\Delta SUB}{V_2^*}$$

$$v = \frac{\Delta GDY^*}{V_1^* + V_2^*}$$

where $\Delta_x = x_{1985} - x_{1974}$. Hence, θ is the share of investment going to domestic energy production; v , v_1 , and v_2 are inverses of incremental capital/output ratios in the economy as a whole in sector 1 (other goods plus

Table 33: SIMRICH PROJECTIONS FOR 1980 AND 1985

	1973	1980	Growth Rate 1973-80	1985	Growth Rate 1980-85
\$3.21 OIL PRICE (1973\$)					
OECD real national income (billions of 1973\$)	2918	3961	4.46	4938	4.51
OECD energy production (million barrels/day)	44.10	46.37	3.57	65.13	2.93
OECD energy consumption (mil. barrels per day)	69.40	94.52	4.51	118.05	4.55
OECD oil imports (million barrels/day)	25.30	38.15	6.05	52.92	6.76
Foreign assets of oil producers (billions of 1973\$)	26.90	17.31	-6.10	35.51	15.45
\$8.19 OIL PRICE (1973\$)					
OECD real national income (billions of 1973\$)	2918	3918	4.28	4860	4.43
OECD energy production (million barrels/day)	44.10	59.81	4.45	7639	5.02
OECD energy consumption (million barrels/day)	69.40	87.98	3.45	105.92	3.78
OECD oil imports (million barrels/day)	25.30	28.16	1.54	29.59	1.00
Foreign assets of oil producers (billions of 1973\$)	26.90	202.64	33.44	222.37	1.88

energy transformation) and sector 2 (energy production), respectively, and e_1 is the incremental energy/capital ratio in sector 1.

Thus, by definition,

$$v = (1-\theta)v_1 + (\theta v_2 - (1-\theta)e_1)POIL$$

The simulation results show:

- a. the efficiency of investment in sector 1 ($v_1 - e_1 POIL$) falls by 3.5 percent. This is the result of a significant (21 percent) drop in the energy intensity of the sector (e_1). The new technique is less efficient at the old price ($POIL_0$) but more efficient at the new price ($POIL_1$)

Table 34: CAPITAL PRODUCTIVITY AND ENERGY INTENSITY

	<u>\$3.21 Price</u>	<u>\$8.10 Price</u>
v_1	.2096	.2082
e_1	.004939	.003885
$v_1 - POIL_0 e_1$.2038	.2036
$v_1 - POIL_1 e_1$.1948	.1966

- b. there is a considerable increase in capital costs in the energy sector: v_2 rises by 20 percent compared to the \$3.21 oil price case.
- c. the share of the energy sector in investment (θ) doubles (from 1.6 percent to 3.2 percent). The net effect of these changes is a 1.4 percent drop in the efficiency of investment (v). This leads to a large accumulated loss: by 1985, \$17 billion of output is lost, and this is only partly offset by higher savings.

We considered the relative importance of the four effects distinguished in Section III in changing the energy intensity of the other growth sector:

- a. investment in less energy-intensive techniques;

- b. ex post substitution of capital for energy;
- c. changes in the economic lifetime of machines;
- d. changes in factor prices.

Without either ex ante or ex post substitutability, energy demand would have been 116.67 million barrels per day. Hence, energy use per unit of output was 9.2 percent lower than it would have been without a change in technique. By 1985, the value of oil imports thus saved was \$32 billion (in 1973 prices). The reduction was a weighted average of 15 percent drop in energy use by machines which are optimal at the higher oil price compared to the 1973 energy use and a movement along the various ex post isoquants. The latter effect varied from 4 percent for the machines existing in 1973 to 0 percent for the very last machines, installed when price expectations were fully adjusted to the higher price level. Of the total reduction in energy use resulting from substitution (10.68 million barrels per day), 77 percent was due to a movement along the ex ante curve (8.19 mb/d); the remaining 2.49 mb/d reflected ex post substitution, mostly (2.12 mb/d) on the capital stock existing in 1973).

The effect of the price increase on the economic lifetime of capital goods was small. Investment in the other goods sector was higher and was in less energy-intensive (i.e., in more labor-intensive, since capital and labor are complementary) techniques. Hence, more labor had to be released from old machines: in the \$8.19 case, the economic lifetime was 25.36 years, only 0.8 percent less than in the \$3.21 case (25.56 years). This small change, however, had important implications for the wage rate. In terms of Figure 8, w_1 was the wage rate in 1985 for the \$3.21 case. We calculated w_2 and w_3 by keeping the economic lifetime constant, raising the oil price and assuming ex post substitutability only in the latter case; w_2 and w_3 was 6.73 compared to w_1 , which is 7.02. Hence, the price increase alone caused a 4.3 percent drop in the real wage

rate, which was offset to only a very small extent by ex post substitution. More important, however, was the change in the economic lifetime: with the economic lifetime reduced, labor productivity on the vintage to be scrapped was higher; hence, the wage rate did not have to drop as far: w_4 turned out to be 6.78, or only 3.4 percent below w_1 .

Once the wage rate was determined, the realized rate of return could be calculated. The lower wage rate and the lower energy intensity were not sufficient to offset the negative effect of the energy price increase: the rate of return dropped from 14.92 percent to 14.18 percent, or by 5 percent. Given our specifications of the energy production sector, this led to a lower capital cost and a higher profit-maximizing level of output in that sector. This effect was not trivial: by 1985, it accounted for 1.4 million barrels per day of additional domestic energy production.

The main impact on factor prices was, however, on rent. Whereas at the margin, the rate of return in energy production was equal to the return in the other goods sector, all other capital in energy production (which was created when oil prices and capital costs were lower) earned a rent. In 1985, this rent was given by:^{/62}

$$R = \text{POIL} \cdot \text{SUB}_{1985} - r \left[(1+r)^2 \sum_{1971}^{1982} \text{VSUB} + (1+r_0)^2 \text{SUB}_{1973} \text{CAPCO}_0 \right]$$

The rent was, obviously, zero in the \$3.21 case. At the higher price, it was quite substantial: \$135.5 billion (1973 prices) in 1985, which was almost 60 percent of the sector's output valued at the world price. It is not

^{/62} This concept differs somewhat from that used by the OECD (1974). The main difference is that we valued energy at the opportunity cost of imported oil - which probably overestimated the intrinsic value of coal and underestimated that of natural gas; whereas the OECD assumed that some forms of energy, such as U.S. natural gas, would be underpriced as a result of price control regulations.

surprising, then, that energy pricing and taxation have attracted so much attention since the oil price increase.

Impact of Protection and Domestic Price Policies

A small part of this rent will be left to energy producers as a reward for increasing output and to cover the extra capital costs of accelerated development. By far the largest part will be taxed away by governments. A major issue in energy policy will be whether taxes should absorb less than the full rent, so as to make it possible to subsidize consumers by keeping prices below the opportunity cost of imported energy; or whether, in the interest of energy autonomy, taxes should push domestic prices above world prices of energy. Both tendencies can be observed today. It is assumed in the model that they will cancel each other after some years, but events may disprove this.

The models were therefore simulated under two alternative pricing assumptions. In the first, domestic energy prices were kept \$1.50 per barrel below world prices by price controls./63 In the second, the price was raised above the world price by the same amount. Accumulation of OPEC countries' foreign assets was constrained to remain at the same level in all three cases to avoid bias of the calculation from the impact of capital imports on GNP.

The impressive result of the model was that a divergence between the domestic and the world price of energy had a very small welfare cost but a very large impact on oil imports. The \$1.5 "subsidy" reduced welfare by \$0.7 billion, but increased oil imports by 28 percent; whereas the equivalent "tariff" reduced welfare by \$4.2 billion and reduced imports by 27 percent./64 Domestic oil

/63 This would cost \$58.5 billion, about half of the economic rent on energy which arose as a result of the oil price increase.

/64; This represented \$0.78 per barrel of imports saved and \$0.95 per barrel of additional imports.

policies have a major impact on the achievement of energy self-sufficiency. This figure has a wide margin of uncertainty, because of the likelihood that demand and supply functions are less smooth than is assumed in SIMRICH, with "steps" corresponding to the prices at which large energy sources become economic. The real price impact could, therefore, be either substantially larger or substantially smaller than the figures obtained.

The Welfare Triangle Rule-of-Thumb

A commonly used shortcut in welfare analysis is to measure welfare gains or losses by taking half of the product of a price difference and the corresponding quantity difference. The formula is exact if the relevant demand and supply curves are linear.

The relevant equations of SIMRICH are not linear, but it is interesting to note that the welfare triangle approximation predicts the results of the model quite accurately. The 1974 response of the model implies a 3.51 "flexibility offset" and a 2.74 "import substitution cost." According to the welfare triangle rule-of-thumb, these figures should be half of the import saving, i.e., 3.12. Imperfect adjustment of domestic to world prices in 1974 implies a welfare loss of \$730 million. This is close to half of the product of the price distortion and its impact on imports, i.e., $(2.33 \text{ per barrel/day} \times 365 \text{ days} \times 1.69 \text{ million barrel days})/2 = 719 \text{ million}$. Dynamic simulation of the model shows that a \$1.50 subsidy to consumers causes a 7.45 million barrel/day increase in imports, i.e., $(1.5 \times 7.45 \times 0.365)/2 = \2.04 billion . The "dynamic" welfare loss is \$0.7 billion. The correspondence is less close, perhaps because of the complexity of the dynamic adjustment process; but the orders of magnitude correspond.

Impact on Growth of the Reinvested Foreign Assets of Oil-Producing Countries

We finally turned to the bankers' gain realized on capital imports into developed countries. This was very difficult to measure, both because the parameters which determined it were not well-known and because of conceptual difficulties. The bankers' gain was not the depositors' loss, and the results presented should not be misinterpreted. We presented two measures, which reflect different theoretical concepts.

- a. On a cash basis, the gain may be measured as the difference between the internal rate of return on additional capital invested in developed countries and the rate of interest paid to the oil-producing countries.
- b. The gain defined in (a) contributes to national income; part of it is reinvested and thus contributes to the growth of GNP. A second measure of the gain is therefore obtained by comparing the levels of national income in simulations in which oil producers either reinvest or do not reinvest their surpluses in developed countries.

Table 35: ALTERNATIVE MEASURES OF THE BANKERS' GAIN REALIZED BY OECD COUNTRIES

	1974	1975	1976	1977	1978	1979
Interest difference	3.3	8.5	12.5	15.9	18.8	21.2
Difference in GNP	-0.7	5.1	11.5	16.2	20.0	23.3
	1980	1981	1982	1983	1984	1985
Interest difference	23.0	24.3	25.2	25.7	26.0	26.2
Difference in GNP	26.0	28.0	29.4	30.3	30.9	31.2

Both measures show, however, that the reinvestment of foreign assets of oil-producing countries makes a significant contribution to the national income of developed countries. The "difference in GNP" measures implied that, by 1985, GNP of developed countries would be \$31 billion higher if oil-producing countries reinvested their surpluses in these countries than if they did not. The total impact on GNP of higher oil prices was \$95 billion if there was no reinvestment of surpluses, compared with \$64 billion if surpluses accumulated to the extent predicted by SIMRICH.

The figures, of course, were the result of the assumed wide divergence between the return on capital (14.2 percent at the high oil price) and the 2 percent real rate of return on foreign assets of oil producers. The latter figure reflects postwar experience. As to the former, it must be realized that about half of the return on capital was taxed away by governments in most countries; the model rate of return was a "social return" which included external economies associated with investment, such as so-called learning effects. The net rate of return to investors in equity probably did not exceed 4-5 percent, so that it was not unbelievable that the interest discrepancy would persist in the future.

V. Conclusions

The SIMRICH model was built to study the long-run impact of higher oil prices on the growth of developing countries, and hence on the export markets of developing countries. This suggests that the SIMRICH model be used to examine the long-run impact of higher oil prices on developed countries. Though the imperfections of any such models make it necessary to be cautious in interpreting their results, three conclusions seem to emerge.

The conclusion which we felt was most strongly established was that the pessimistic views sometimes presented about the impact of higher oil prices on

the growth potential of developed countries were devoid of justification. This judgment, which seems optimistic in the light of subsequent developments, must be qualified by the fact that the model describes only potential growth, and says nothing about the short-run problems of income distribution struggles, demand, price, and balance-of-payments management which result from the increase in oil prices. These problems can be overcome by national and international economic cooperation which we thought would be manageable; growth could then resume at rates very close to those which seemed possible before the increase in oil prices.

A second conclusion was that - provided that the balance-of-payments surpluses of oil-exporting countries were recycled without causing undue perturbation - they might make a significant contribution to the growth of GNP of developed countries, helping to offset the unfavorable impact of higher energy prices. The figures presented in the paper were, however, subject to a substantial margin of error, reflecting uncertainty about rates of return, and about the amounts of capital which might be forthcoming, and their allocation between developed and developing countries.

The third conclusion was that domestic price policies in developed countries would have a large impact on their oil imports. To the extent that these imports influence the prices which oil exporters find feasible to impose, these policies may therefore have a significant impact on the terms of trade of the non-oil-exporting developing world. Here again, it was stressed that the results presented were no more than very broad orders of magnitude.

Chapter VIII

ALTERNATIVE POLICIES AND THE GLOBAL ANALYSIS

The model system described in the preceding chapters was used in the first place to derive a "most likely" scenario of economic developments in the world economy. The assumptions behind that scenario in some cases implied unchanged policies compared to the past; in others, policies "most likely" under the prevailing circumstances. The selection of these policies for the base case projections is the first issue discussed here. The selection of alternative policies is then reviewed.

As has already been mentioned, the policy emphasis of the successive annual studies gradually shifted. The first versions focused on the international policies which could help the developing countries to adjust to the new and more difficult environment. As time went by, increasing attention was devoted to the policies of the developing countries themselves in the adjustment process. Thus, over time, a more balanced approach evolved. This shift in emphasis reflected not just the changes in the international situation, which required first of all an international response, but also the initial difficulty in obtaining a coherent view of the actions which developing countries themselves were undertaking.

The discussion of policy alternatives can therefore best be structured by distinguishing international policies from national ones, and within the latter those characteristics of the main economic regions of the world: the industrial countries which are members of the OECD, the oil-exporting countries which are members of OPEC, and the developing countries which in the main are importers of oil. Within the latter group a further distinction between the

lower-income countries and middle-income countries is useful, as there are significant differences between them in terms of alternative policies available to them.

International Policies

The recession in the industrial countries and the sharp increase of the oil price had immediate repercussions on the balance of payments of the oil-importing developing countries. There was therefore an urgent need for improved international policies for trade and aid. A number of developing countries had fortunately benefited substantially from high commodity prices in 1973, and continued to benefit during part of 1974. As their import levels had not yet adjusted to the larger availability of foreign exchange, their reserves had increased. This provided them with a cushion to withstand, at least temporarily, the deterioration of the current accounts of their balances-of-payments.

The scope for changing trade policies is small in the short run. The best that can be hoped, particularly under recessionary circumstances, is that the industrial countries would not try to protect their own balances-of-payments by protectionist measures. There was a real temptation to do so as the industrial countries experienced a deterioration of their balances-of-payments of an unprecedented magnitude as a consequence of the oil price increase. It was thus an act of considerable importance when the OECD countries issued a joint declaration early in 1974 pledging themselves to the maintenance of free-trade policies.

In the short run, therefore, the main emphasis of international policy recommendations had to be in the area of capital flows. A large part of the policy discussion, particularly in 1974, therefore centered on ways of increasing official flows to developing countries, and on the need to maintain or improve

their access to capital markets. As a corollary, issues of creditworthiness and of debt management became central to the discussion. It was pointed out that many developing countries had derived significant benefits from inflation in the international economy, as it had reduced the burden of debt service on their foreign exchange earnings. It was far from easy to analyze capital flows in a satisfactory manner, as data from a variety of sources had to be combined into a consistent presentation. Around the same time, considerable changes were taking place with respect to the sources of capital for the developing countries. Capital from private sources had been growing in importance for some years, and a number of developing countries found that they had access to a rapidly growing international capital market. It was clear that a distinction between the lower-income countries depending mainly on concessional capital and the middle-income countries with access to a wider variety of sources was important for the analysis. This distinction also led to a discussion on the distribution of concessional assistance among recipient countries. It was found that within the total availability of concessional resources, considerable benefits could be obtained for the lower-income countries through shifts of these flows between destinations.

The emphasis on short-term measures to improve the balance-of-payments situation of developing countries was from the beginning matched by a discussion of the longer-term trade policies which would help the developing countries to regain a more tenable balance of payments and stable growth without excessive dependence on external capital. The 1974 analysis contained a summary of a study concerning the effects of trade liberalization on primary commodities. It also discussed, in a general manner, ways of maintaining and improving access of the developing countries to manufactured goods markets in industrial countries. This analysis was much improved in subsequent years.

Policy of OECD Countries

Economic developments in the industrial countries enter the model system exogenously. Nevertheless, considerable attention has been given over the years to policies considered beneficial for growth and stability in the industrial countries. To demonstrate the importance of growth-oriented policies, all of the global studies included alternative assumptions with respect to growth in the industrial countries. The models illustrated the impact of growth policies in the OECD area in easing the adjustment of the developing countries to the new international circumstances.

For capital flows, the main issue was the level of concessional capital flows which could be expected to originate in the industrial countries in future years. The decline of the share of concessional resources in the national income of the industrial countries had already continued for a number of years, and it was clear that continuation of these trends could only aggravate the outlook for the developing countries. This was particularly the case for the lower-income countries which are virtually entirely dependent on concessional capital. As about 40 percent of all concessional resources used to be directed to the middle-income countries, alternative assumptions illustrating how a redistribution could improve the prospects of the lower-income countries seemed appropriate.

The analysis of the composition of concessional assistance made it clear that it is far from easy to increase disbursement levels in the short-run. A substantial part of concessional flows represents technical assistance which is not freely available to the recipient country, and another part is linked to projects with long gestation periods. A shift between groups of recipient countries, or an increase of total disbursements, can therefore only be achieved if a large proportion of additional aid is given in the form of program assistance.

The OECD countries were the recipients of large flows of deposits reflecting the large balance-of-payments surpluses of most oil-exporting countries. A substantial part of these inflows found its way to the international capital market, where it could be tapped by a number of developing countries considered creditworthy for such capital. The issues related to these capital flows became known as the recycling problem, and the early versions of the Bank's global analyses devoted considerable attention to this issue. In contrast to a view which was widely held, the Bank at no time considered the problem of recycling to be insurmountable; emphasis was placed on the need for cooperation between the industrial countries in order to forestall undesirable movements of capital between industrial countries for speculative purposes. The belief that recycling was manageable led to studying how it could be made beneficial to the developing countries. This became a major area of policy concern.

The discussion of trade policies for the industrial countries emphasized longer-run issues. Better policies for both primary commodities and manufacturing goods were viewed as a key way of promoting the restoration of manageable balance-of-payments positions of developing countries. As was stated before, most of that discussion was initially of a rather general nature, but developed over time into a more penetrating analysis of tariffs and effective protection, quantitative restrictions, and the need for adjustment assistance to sectors in the industrial countries which would be unable to compete with imports from the developing countries.

Policy of OPEC Countries

For the oil-exporting countries, the primary focus was, of course, on their oil price policies. In each successive version of the Bank's global

analyses, considerable attention was given to the prospective developments of oil supply and demand. It was found that the oil market would probably support maintenance of the oil price in real terms, although demand was expected to be weak during the recession period. Recovery in the industrial countries, would, however, increase the demand for oil sufficiency to balance available supplies from the oil-exporting countries, and it was therefore considered likely that in the long-run a major decline of the oil price was unlikely. As an alternative to a stable real price of oil, the early versions envisaged a gradual decline of the real price, considering in particular its effects on the balance of payments of the developing countries. The purpose of that analysis was to measure the implications of oil price alternatives for developing countries; there was no suggestion that the oil market would be weak enough to create a price decrease. The basic analysis of the world economy assumed the maintenance of the oil price with perhaps a moderate drop of that price in real terms.

The acceptance of the oil price as given led to considerable emphasis on the trade and aid policies of the OPEC countries. Oil-importing developing countries had only a very small share of about 7 percent of OPEC's total imports. It was expected that these imports would rise very rapidly, and SIMLINK confirmed that developing countries would derive substantial benefit from such a trend. An element in the picture which was initially overlooked was the substantial transfers of workers' remittances caused by substantial labor migration from several developing countries to the oil-exporting countries. For some countries, the magnitude of these transfers has considerably eased balance-of-payments problems.

Finally, capital flows from the OPEC countries to the oil-importing developing countries were analyzed with some care. These capital flows were not very well recorded, and initially the numbers were only crude estimates.

Alternative policies were studied for each of the oil exporters which took into account their balance-of-payments prospects and the distribution of these capital flows over recipients. Similarly to the OECD countries, it was found that the OPEC countries allocated aid flows rather unevenly between recipient countries, and a shift in the distribution to the benefit of the lower-income countries was advocated.

Policy in the Oil-Importing Developing Countries

It was far from easy in the beginning to obtain a picture of the situation and adjustment policy in the developing countries, as such information tends to become available only with a considerable time lag. It was clear, however, that for many countries in the absence of additional capital flows, imports had to be restricted. But there were considerable differences among countries as to the degree to which they followed this course of action. Curtailing import demand is in many countries highly unpopular and in others even impossible because of the essential nature of the imported goods. It was only in later versions of the global analyses that countries could be distinguished by the types of policies they adopted and the effectiveness with which they adhered to them. The same applied to borrowing from abroad, which was managed well by some but unwisely by others; a clear link could be established between the quality of each country's balance-of-payments policies and the domestic price policies which it adopted. The clearest example of the latter was, of course, provided by the degree to which countries passed on the oil price increase to their domestic consumers.

Each of the versions of the global analysis was addressed to a series of long-term policy issues for the developing countries. Here a wide range of issues was discussed at increasing depth over the years. Initially, the emphasis

was on energy substitution and the management of external debt; later, there was increasing emphasis on export promotion, the efficiency of allocating investment resources, and the crucial importance of promoting domestic agricultural and food production.

Objectives

The base case of all projections aimed at estimating prospective growth in the developing countries. It was clear that under conditions of unchanged or most likely policies there was little chance that the 6 percent growth target would be achieved. Policy alternatives were therefore tested to assess their contribution to achievement of the original 6 percent growth target and to a smooth adjustment of the developing countries to the new external environment.

Sensitivity

As indicated earlier, the central projection, or base case, was derived from an aggregation of country projections, each of which embodied the basic assumptions about growth and international trade of the industrial countries, a set of projections of capital flows, and a derived set of commodity price projections. A proper analysis of alternative development scenarios would have therefore gone back to the individual country models to derive new projections from each of those which subsequently would have had to be aggregated again. The alternative projections which were presented in the World Bank's analyses were instead based on the SIMLINK model of trade and growth. This generated a base case forecast which was roughly consistent with the aggregated country projections; any simulations outside that range would have resulted in doubtful estimates and projections. The actual use of the SIMLINK framework for alternative scenarios probably went to the extremes of its capability, as very

large variations of some of the basic assumptions were incorporated in the projections.

The sensitivity test centered on four major areas. Alternative assumptions were introduced for:

- a. the growth rate of GNP in the industrial countries;
- b. the future movements of the oil price;
- c. alternative trade policies of the industrial countries; and
- d. alternative levels of capital flows.

The first three assumptions all related to exogenous inputs into the model framework, which generated projections of the developing countries subject to assumptions on capital flows. The last one therefore constituted a reversed test in which capital flows were the closing element to generate a particular target rate of growth in the developing countries. Each of the alternatives tested the impact of alternative assumptions on the rate of growth of GNP of the developing countries, and on the development of their balances-of-payments. A particular characteristic of the capital flows projections needs to be stressed here. As concessional flows were given from the supply side and creditworthy countries were assumed to borrow additional capital to the extent their debt position permitted, any additional flows beyond those specified in the base case needed therefore to be entirely on concessional terms. Any other assumption would have generated levels of debt and debt service in excess of amounts dictated by prudent management.

The projections of growth and the balance of payments of developing countries were made by regions and income classes. As will be seen in what follows, the economic structure of the country groupings and the impact of alternative assumptions differed widely. Part of this reflected levels of development and to some extent the degree to which countries were integrated

through international trade and payments. The discussion which follows distinguishes such country groups to a lesser extent than was the case in most of the successive versions of the World Bank's global projections. Of the three country groups discussed, South Asia and Sub-Saharan Africa both belong to the lower-income country category, and a third category, the middle-income countries, was not further specified as there were no great differences between the impact of alternative assumptions on the development of the regional subgroups.

OECD Growth

In the version of the global analysis issued in the middle of 1976, the base case assumption of growth in the industrial countries was put at 5 percent per year for the period 1978-85. This growth rate was assumed to follow from somewhat higher growth rates in the years 1975-78, reflecting the recovery from the depression after 1973. Alternative assumptions were made for both sub-periods, but in the discussion of alternative projections only the 1978-85 period is discussed as they lend themselves better to a discussion of long-term interrelations between groups of countries. The alternatives for OECD growth were put at 0.3 percent above and below the base case assumption; the high alternative assumptions affected the growth of the developing countries, and there were marked differences between the lower- and the middle-income countries. For South Asia, the model projected almost the same changes of GDP growth rates as were assumed for the OECD group. In other words, over the range of these sensitivity tests, the elasticity of growth in the lower-income countries to growth in the industrial countries appeared to be equal to 1.0. By contrast, the middle-income countries appeared to be much more sensitive to what happened in the industrial countries; the changes in their growth rates were about twice as large over the relevant range as those assumed at the beginning

for the OECD countries. The reason for this difference was clearly the fact that the lower-income countries had much weaker ties, both in terms of trade and capital inflows, with the industrial countries. The middle-income countries' dependence on trade made them more sensitive to growth in the industrial countries.

The causation of those differences was seen more clearly when trade developments were brought into the picture. It was then found that the sensitivity of the lower-income countries' exports to growth in the OECD area was expressed by an elasticity somewhere between 2.0 and 3.0. For the middle-income countries, this elasticity was about 7.0, more than twice as high as applied to the lower-income countries. In other words, the swings which could take place in export growth under the assumption of alternative rates of development in industrial countries were considerably larger in the middle-income countries than in the lower-income countries.

The effect on imports was even more marked than on exports, because export earnings had to finance factor costs and debt service charges which changed very little over the range of the basic assumptions. The growth of imports was always at a lower rate than for exports over the projection period, as a result of the heavy borrowing after 1973 and the increase in debt service. As projected import growth rates varied about as much as export growth rates, but around a lower average, the elasticity of imports to OECD growth exceeded the elasticity of exports. The large difference between the lower- and middle-income countries in terms of the sensitivities of international trade to growth in the industrial countries explained a significant part of the differences in the sensitivity of their GNP growth. The fact that international trade constituted a much larger share of the GDP of the middle-income than the lower income countries increased the impact of the alternative assumptions.

The character of the model used for the projections did not permit the testing of large divergences from the base path and therefore could not be a guide for the analyses of developing countries' prospects under extreme conditions. It would be inappropriate, for example, to suggest that the proportionality of growth between the lower-income countries and the industrial countries would have applied over a broader range of alternatives. In fact, it may well be that higher growth rates in the industrial countries would not result in higher growth in the lower-income countries given the latter's limited ability to absorb investment resources. Similarly, further reductions of growth in the industrial countries may have less impact on the lower-income countries, because large segments of the economy are almost entirely segregated from international influences. It was thought, however, that this reasoning might not apply to the middle-income countries which were more closely integrated with international trade and payments, could absorb larger investment resources, and could generate considerably higher growth rates if the necessary resources could somehow be made available. Intuitively, it seemed, therefore, that the high degree of sensitivity of these countries to growth in the industrial countries could very well extend over a fairly broad range of alternative assumptions.

Export Growth

The base case assumptions assumed no significant changes in international trade policies. Under that condition, exports of the developing countries were projected to grow at about 7 percent per year through 1985. As an alternative assumption, the analysis of international trade policies suggested considerable scope for a more rapid growth of exports in volume terms by about 1 percent per year. The effect of these higher exports were distributed unequally over groups of developing countries. As Sub-Saharan Africa hardly exports

manufactured goods, improved trade policies with respect to imports of manufactures would not have benefited these countries over the course of the projection period, through 1985. For South Asia, the situation was somewhat better, as the lower-income countries in that region have traditionally exported manufactured goods and could therefore have benefited from improved trade policies toward such goods. The main beneficiaries of such policies would have been the middle-income countries which have expanded their manufactured goods exports in the past at a very rapid rate and would be able to make use of additional opportunities quite quickly. The effect on the GDP of the latter group of countries was as large as that of faster OECD growth.

Supply conditions were also of importance. To make use of better export opportunities, the South Asian countries had to focus more strongly on the international market, and on the export of those goods and services for which they have a competitive advantage. Such policies were lacking in the past, at least sufficiently continuously to make use of the export possibilities which were being grasped by other developing countries. Such a change of policy in South Asian countries would have led them to pay more attention to the efficient use of resources, and this would in itself have stimulated even further their economic growth. A significant change in policies had to be assumed to permit higher export growth rates in those countries. The higher GDP growth rate which was assumed to result would not have resulted entirely from the growth of exports, but rather related to a complex set of policy alternatives implemented in those countries.

Aid Flows

With the base case assumption of 5 percent OECD growth, 7 percent export growth, and concessional aid flows at a virtually constant percentage of the GNP

of the richer countries, the developing countries grew at about 5.2 percent per annum over the decade of the 1970s. This was clearly well below the target of the second development decade. A higher rate of growth in the industrial countries and liberalization of trade to promote exports from the developing countries could raise this growth rate, but it seemed unlikely that the target of 6 percent for the decade could be achieved even under the best of circumstances. It was thought that in the years after 1980 this target rate could probably be achieved under optimistic assumptions. But the average for all developing countries hid the fact that the lower-income countries were much below the target rate, although the middle-income countries achieved it. This reflected to some extent the limited participation of the first group in trade, but even more the very difficult development problems which they faced. The alternative of increasing the flows of concessional assistance above the levels assumed in the base case was therefore considered. For many of the lower-income countries, it would have been unrealistic to assume that a target growth rate of 6 percent per annum could be achieved even under the best circumstances of international trade and the availability of capital. As already indicated, some of these countries needed to make major adjustments in their domestic policies to improve the efficiency of resource use before growth rates could be accelerated. Such changes take time and the best assumption that could be made here is that policy changes introduced in the next few years could gradually accelerate their rate of growth over the early 1980s, reaching 6 percent per year around 1985. The average for the years between now and 1985 would, of course, remain below 6 percent, probably somewhere around 5 percent per year.

The additional aid requirements for a growth rate performance of this kind did not seem to be excessive. By 1985, net disbursements of concessional assistance to the lower-income countries would have needed to be \$3.5 billion

higher than in the base case, that is, about 10-20 percent higher than the levels projected for that year. In terms of the share of concessional assistance in the donor countries' GNP, an increase from the base case projection of 0.35 percent of 0.40 percent of GNP was implied. This was still barely half the target level incorporated in the strategy for the second development decade.

About two-thirds of this disbursement would have needed to be allocated to South Asia and the other one-third to the lower-income countries in Africa south of Sahara. In earlier versions of the Bank's global analysis, attention was also given to the possibility of shifting concessional resources between groups of recipient countries. In the early 1970s, about 10 percent of official capital transfers went to the oil-exporting countries and about half of the remainder went to the middle-income countries. When account was taken of the level of per capita income in many of the middle-income recipient countries, and also the high per capita aid receipts in some of these countries, it appeared that considerable shifts in the allocation of concessional assistance were feasible. Under these circumstances, it was clearly possible to find the \$3.5 billion needed for the lower-income countries in 1985 through shifts in allocations. This would not necessarily have resulted in significantly lower growth of the middle-income countries, for they would be able to adjust to smaller flows of concessional capital. Many of these countries which benefited from concessional flows would also borrow in capital markets on commercial terms. A shift of concessional resources at the expense of some other middle-income countries, however, may have retarded their rates of growth. However, this analysis was not carried beyond simple estimates of the additional requirements of the lower-income countries for more rapid growth.

Reliability

The limitations of the analysis should not, of course, be ignored. The dominance of the ability to import as a determinant of growth was a weakness of the system. Clearly, this is a gross oversimplification which for many country groups cannot withstand the test of historical analysis. Particularly for the lower-income countries, the link between imports and growth is weak or even nonexistent. This emphasis also tended to detract from more detailed analysis of the impact of domestic policies on growth. The formulation of the models in terms of a straight linkage between imports and growth made it rather difficult to introduce the domestic policies of the developing countries other than in a verbal sense, as they were not a part of the quantitative framework itself.

A second problem was the lack of integration between developments in the real sphere and the behavior of prices. The entire system contained only one exogenous determined projection of inflation which was not affected by the alternative assumptions concerning growth and trade in the world economy. Here, of course, it can be claimed that the discussion on the causes and sources of inflation has not yet advanced to the point where a clear theory lends itself to application in a quantitative setting. Still, the absence of inflation alternatives and a full specification of the relation between inflation in the industrial countries and the prices which developing countries have to face externally remained a weakness of the analytical system.

Another important omission related to the recursiveness of the modeling system which started from assumptions about the industrial countries and oil price policies by OPEC and ended with projections for the developing countries. The latter did not have an impact in the reverse direction, so that OECD growth was seen as entirely independent of the development and policies in the developing countries. In earlier years, this assumption could have been

defended, as the impact of developing countries on the world economy was indeed very small. In more recent years, this assumption has proven to be no longer tenable, as the size of the trade, particularly of the middle-income countries, has grown significantly and as their access to capital markets allowed them considerable flexibility in balance-of-payments policies. Thus, in an independent exercise which used the MULTILINK system, Holsen and Waelbroeck have demonstrated that in 1974 and 1975 the export and borrowing policies of the middle-income developing countries maintained their imports at considerably higher levels than otherwise would have been the case. As these imports originated to a large extent in the industrial countries, the latter experienced somewhat more favorable export growth than would otherwise have been the case. Holsen and Waelbroeck estimated that, as a consequence, the GNP of the industrial countries increased by 0.3 percent more (or decreased by 0.3 percent less) than would have been the case if developing countries had not pursued these policies.

Table 36: ALTERNATIVE ASSUMPTIONS AND PROJECTIONS, 1978-85/a

Variables for which Alternative assumptions are made	Alternative Assump- tion for 1978-85 (in % per annum)	Derived Projections for Developing Countries								
		South Asia			Sub-Saharan Africa			Middle-Income Countries		
		EXP.	IMP.	GDP	EXP.	IMP.	GDP	EXP.	IMP.	GDP
<u>OECD Growth:</u>										
High	5.3	7.0	5.8	4.4	6.4	7.0	5.6	9.6	9.1	7.2
Medium	5.0	6.0	4.5	4.1	5.7	6.0	5.3	7.3	6.5	6.6
Low	4.7	5.2	3.4	3.9	5.1	5.2	5.1	5.6	4.5	6.2
<u>Export Growth:</u>										
Base Case	7.1	6.0	4.5	4.1	5.7	6.0	5.3	7.3	6.5	6.6
Liberalization	8.6	6.7	4.7	5.0	5.7	6.0	5.3	8.9	9.1	6.9
<u>Capital Flows/b:</u> (in billion \$)										
Base Case	17.9			4.1			5.3			6.6
Increased Flows	21.4			5.0			6.0			6.6

/a From the 1976 version of the global analysis.

/b Concessional capital to lower-income countries only; amounts are for 1985 current U.S. \$.

Appendix to Chapter IV

THE MULTILINK SYSTEM OF DYNAMIC MULTIPLIERS

The MULTILINK system of dynamic multipliers was derived from the Link model of the world economy, and the Desmos model of the EEC countries. The multipliers described the impact of GNP of exogenous changes in income and expenditures, which are interpreted as tax and spending multipliers. Because they were based on linked models, they took into account cross impacts transmitted between countries via international trade and international price linkages.

The system combined information derived from simulations of the Link and Desmos models. Each of these sources provides only a part of the desired information. Simulations of the Link system provided data on the impact of autonomous expenditure changes, not on the impact of income changes; these simulations covered a period of three years only. The Desmos multipliers covered a five-year period, but they were available only for the first, third, and fifth years. The Desmos model treats the rest of the world as exogenous, and therefore neglected feedback originating from relations between the EEC countries and the rest of the world. It was thus necessary to combine the two types of information by making a number of adjustments:

- a. Desmos multipliers were interpolated for the second and fourth years;
- b. For the EC countries, the Desmos multipliers were used in preference to the Link multipliers for those countries;
- c. For other countries, the Link multipliers were used. These were extrapolated for the fourth and fifth years on the basis of Desmos results;

- d. Income multipliers were not available for non-EEC countries. For those countries, income multipliers were calculated by reducing expenditure multipliers proportionally to the ratio between the Desmos expenditure and income multipliers.

The multipliers presented a simplified picture of the properties of the models. The "expenditure" multipliers were used to represent the impact of any type of autonomous change of expenditures, although in practice the structure of Link and Desmos was such that the impact of, say, an autonomous consumption change would be different from that of an autonomous change of exports. Likewise, the "income multipliers" were used to represent the impact of any autonomous change affecting the incomes of consumers. Yet the impact of, for example, changes in direct taxes would differ from that of a change in indirect taxes. The MULTILINK system was thus a rough and ready tool of analysis, and was useful mainly to provide quick estimates of the impact of major unexpected events affecting the world economy.

Appendix to Chapter V

Table 30: SAMPLE PANEL COUNTRIES' IMPORT COMPOSITION
(1972, millions \$)

		Food and Food Products	Inter- mediate Goods	Fuels	Capital Goods	Consumer Goods	Total
Mineral producers	\$	701	1,256	207	1,307	1,685	5,155
	%	13.6	24.4	4.1	25.4	32.7	
South Asia	\$	889	1,736	260	1,029	254	4,168
	%	21.3	41.7	6.2	24.7	6.1	
East/Central Africa	\$	180	626	63	489	206	1,564
	%	11.5	40.0	4.1	31.3	13.2	
Mediterranean	\$	1,045	3,631	479	2,956	654	8,765
	%	11.9	41.4	5.5	33.7	7.5	
West Africa	\$	236	452	59	339	193	1,279
	%	18.4	35.3	4.6	26.5	15.1	
East Asia	\$	826	2,578	624	2,012	628	6,667
	%	12.4	38.7	9.4	30.2	9.4	
Latin America	\$	932	4,197	755	4,749	956	11,589
	%	8.0	36.2	6.5	41.0	8.2	
Total	\$	4,809	14,476	2,447	12,881	4,576	39,189
	%	12.3	36.9	6.2	32.9	11.7	

Table 31: EXPORT SHARES BY REGIONAL GROUPS
(1972)

	Mineral Prod.	South Asia	East Afr.	Mediterranean	West Afr.	East Asia	Latin America
Primary Products:							
Beef	.000	.000	.002	.009	.000	.000	.058
Cocoa	.001	.000	.000	.000	.183	.043	.006
Coconut oil	.000	.006	.001	.000	.000	.011	.000
Coffee	.011	.010	.190	.000	.119	.028	.121
Copper	.395	.000	.008	.000	.000	.027	.016
Copra	.000	.002	.000	.000	.000	.014	.000
Cotton	.002	.023	.168	.084	.007	.000	.027
Groundnuts	.000	.002	.020	.001	.002	.001	.001
Groundnut oil	.000	.000	.000	.000	.035	.001	.003
Iron ore	.051	.042	.000	.000	.006	.003	.022
Jute	.000	.140	.000	.000	.000	.007	.000
Maize	.000	.000	.003	.001	.000	.011	.015
Palm oil	.004	.000	.000	.000	.007	.016	.000
Petroleum	.019	.006	.000	.029	.008	.043	.013
Rice	.000	.011	.002	.006	.000	.026	.001
Rubber	.011	.011	.000	.000	.004	.079	.001
Sugar	.010	.010	.001	.004	.000	.029	.049
Tea	.000	.111	.046	.001	.000	.000	.001
Timber	.005	.002	.004	.010	.107	.069	.006
Tin	.026	.000	.000	.000	.000	.058	.001
Tobacco	.001	.028	.023	.033	.001	.007	.008
Wheat	.000	.000	.001	.002	.000	.000	.008
Other agricultural (Food)	.095	.155	.157	.162	.094	.029	.192
Other agricultural (Non-food)	.007	.068	.067	.000	.008	.054	.033
Other minerals & metals	.143	.019	.003	.038	.058	.000	.035
Manufactures	.038	.322	.035	.260	.089	.266	.149
Non-factor services	.182	.072	.269	.359	.272	.178	.236
Total exports (in millions \$)	4,579	4,225	1,828	8,453	1,959	8,110	13,878

Note: Total shares may not add to 1.0 due to rounding.

Appendix to Chapter VII

LIST OF PARAMETERS AND VARIABLES

Parameters

a	2.581	}	- parameters of the <u>ex ante</u> production function in the non-energy sector
b	$2.822 \cdot 10^{-3}$		
s	.06		- <u>ex ante</u> elasticity of substitution in the non-energy sector
	0.15		- <u>ex post</u> elasticity of substitution in the non-energy sector
l_c	0.02524		- labor force per unit of capital invested in 1973 (workers per thousand \$ of investment)
MARG	10.69		- margin between domestic and world price of energy in 1973 (dollars per barrel)
$\overline{\text{SUB}}$	1.7525		- increase in OECD production of primary energy if oil price equal \$3.2 (million barrels/day).

Exogenous variables

POIL		- world price of crude oil (dollars per 0.365 barrel)
MLDC		- oil producers' oil exports to developing countries (million barrels/day)
MOTH		- oil producers' non-oil exports to non-OECD developed countries (million barrels/day)
MANEX		- oil producers' non-oil exports (billion dollars)
FSE		- oil producers' factor services expenditure (billion dollars)
L		- labor force in OECD non-energy sector (million workers).

Endogenous variables

Energy prices

PEN	- domestic price of final energy (dollars/0.365 barrel)
PEN ^e	- expected domestic price of final energy (dollars/0.365 barrel)
PSUB	- domestic price of primary energy (dollars/0.365 barrel)
PSUB ^e	- expected domestic price of primary energy (dollars/0.365 barrel)
r	- rate of return on investment.

OECD energy sector

Δ SUB	- increase of production of primary energy (million barrels/day)
Δ SUB*	- profit-maximizing increase of production of primary energy (million barrels/day)
MOIL	- imports of oil from oil-producing countries (million barrels/day)
VSUB	- investment in primary energy production (billion dollars)
CAPCO	- incremental capital/output ratio in the energy sector (thousand \$ per barrel/ day)
TRAN	- value added in energy transformation (billion dollars)
VTRAN	- investment in energy transformation (billion dollars).

OECD non-energy sector

w	- wage rate (thousand \$ per worker per day)
t ₁	- date of latest vintage in use

$\alpha(\tau)$, $\beta(\tau)$	- parameters of the <u>ex post</u> production function relating to <u>vintage</u>
OTH_{τ}^*	- <u>ex ante</u> production on vintage "t" (billion dollars)
$OTH_{\tau}(\tau)$	- actual production on vintage "t" (billion dollars)
$OTH(\tau)$	- total production of the sector (billion dollars)
EN_{τ}^*	- <u>ex ante</u> energy inputs of production on vintage "t" (million barrels/day)
$EN_{\tau}(\tau)$	- actual energy inputs (million barrels/day)
$EN(\tau)$	- total energy inputs of the sector (million barrels/day)
$VOTH_{\tau}$	- investment at time "t" (billion dollars)

Oil Producers' Balance of Payments

XANGE	- total foreign exchange receipts (net of factor services payments) (billion dollars)
ABS	- actual imports (billion dollars)
ACC	- accumulated surplus (billion dollars)
FSR	- factor services receipts, (billion dollars)
FSN	- factor services receipts, net (billion dollars)

OECD National Accounts

GDP*	- value added at constant prices (billion dollars)
GDP	- gross domestic product at constant prices (billion dollars)
GNP	- gross national product at constant prices (billion dollars)

UNF	- stock of unfinished capital goods
EXPOTH	- exports of other goods (billion dollars)
V	- total investment (billion dollars)
INV	- change in inventories (billion dollars)
CONS	- consumption (billion dollars)
SAV	- savings (billion dollars)

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ISBN 10-4108-8, L8,800.

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The Johns Hopkins University Press, 1982. 398 pages.

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French: Redistribution et croissance. Presses Universitaires de France, 108, boulevard Saint-Germain, 75006 Paris, France, 1977.

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