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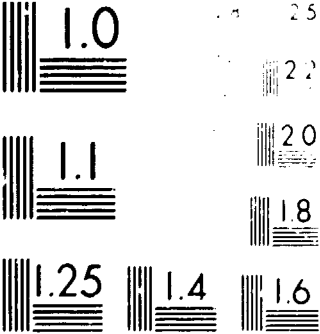
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THE UNITAD SYSTEM.*
1981 Report

Prepared by the
Global and Conceptual Studies Branch

World Modelling Working Paper

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This report has been prepared for UNIDO by J. Royer and A. Duval with the assistance of A. Cornia.

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INTRODUCTION - BASIC PURPOSE AND SCOPE OF THE UNITAD PROJECT

This report reviews the main technical features and results of the UNITAD project. It was prepared at the request of a group of international experts convened by UNIDO in June 1981 to evaluate and orientate the UNITAD project. Originally the project was financed by a group of donor countries. In 1981 the project operated as a UNIDO project with the financial support of the Department of International Economic and Social Affairs of the United Nations Secretariat and with UNCTAD co-operation. Using the UNITAD model or systems of models as an analytical tool, the project explores the potential long-term impact of different development strategies on the world economy, especially in the area of industrialization, trade and growth. In general the project was designed to contribute to an understanding of the structural transformation necessary between the North and South as well as within the domestic sectors of the developed and developing countries in order to attain a more equitable system of international economic relations.

The broad development framework used to explore the world economy follows the General Assembly resolutions and plans of action, in particular that of the New International Economic Order, and the guidelines provided by the UNIDO Second and Third General Conferences (Lima, 1975, and New Delhi, 1980), and by the Fifth UNCTAD Conference (Manila, 1979).

Due to the changes that have occurred in recent years, a new world model is necessary because of the need for new approaches and solutions. For instance, there is now a widely shared realization that industrialization in developing countries cannot expand indefinitely on the basis of the growth of their export markets in the more advanced economies, which seem to have entered into a long period of stagnation. This realization has given new importance to the development of policies of collective self-reliance. The implications of increased economic co-operation among developing countries have remained largely unexplored.[1/] This is due in part, at least, to the limited capability of existing global models:[2/] little evidence is available of the real prospects and limitations of policies aimed at substantially changing world industrial horizons or the direction and structure of world trade. Hence, a

1/ A.L. Goedz: "Beyond the Slogans of South-South Co-operation", World Development, Vol.9, No.6, June 1981.

2/ As a major exception, one should quote the evaluation of the UNITAR Project on the Future ("Technology, Domestic Distribution and North South Relations", UNITAR, New York, August 1981).

quantitative approach to these questions entails the elaboration of new tools and appropriate formalization.

In the past, there has been little attempt, at least in existing models, to examine the relative importance of the interactions of policies and decisions concerning the "external sector" (trade, capital flows, aid, etc.) on the one hand, and those concerning the "domestic sector" on the other. Admittedly, the theory in this area is still lagging behind. In reality, however, the external and the domestic sectors interact very closely. Restricting the analysis to the functioning of only one of the two would be misleading. The UNITAD project was, therefore, necessary to provide for an examination of the relative efficacy of domestic versus international policies in attaining given development targets.

The scope of the model has been broadened in order to take into account some of the crucial long-term aspects of development. The failure of traditional development policies, the poor perfomance of most developing countries, and the persistence and increase of most forms of poverty, have led both development theory and modelling to focus on a wide number of issues.[1/] Among these issues are: the relationship between income distribution and growth; the mobilization of productive resources such as labour, land and knowledge (which are too often grossly underutilized); and the balanced growth of the economy (with agriculture and industry reinforcing one another through the progressive expansion of their absorptive capacity). The importance of such issues is reflected in the text of the International Development Strategy for the Third United Nations Development Decade.[2/]

Although there has recently been wide use of the concept of appropriate technology, the real scope for its application and the implications for trade, growth and overall development has seldom been explored systematically by means of global models. In these cases too, new concepts, approaches and information need to be developed if this important aspect of development policies is to be analyzed thoroughly.

1/ For relatively recent reviews of global models, see S. Cole, Global Models and the International Economic Order, (Pergamon Press, 1977) and J. Richards, "Global Modelling", Futures, Vol.10, No.5, October 1978. See also S. Gupta et.al., ...

2/ A/35/464, Annex

To explore these broad issues even tentatively, a semi-aggregated world and economy-wide model guaranteeing the consistency of all aggregates is necessary. The model specification should explicitly include those variables representing the new issues of concern as well as flexibility for considering the old issues in a novel way.

The efforts in this direction are described briefly in part I. Even though the structure could be further refined and some of the initial estimates improved, the model itself has reached a reasonable degree of completeness and can now be used for simulation purposes. The results obtained with the model, as it now stands, provide some interesting insights into prospects for industrialization, trade and potential growth over the next two decades.

Part II contains a new description of the "Core" of the model, i.e., the trade and the technology subsystems. It includes a brief mention of the theoretical basis of the trade treatment which is meant to capture the effect of major policy options such as South-South co-operation, increased protection, and trade flows emerging from a different world equilibrium with new industrial structures. On the technology side, the major choices made by the model builders are described. In both subsystems, all specifications retained in the equations of the model are given for the first time.

Part III gives a sample of overall results derived from two scenarios which explore the possible effect on the world economy of policies embodied in the International Development Strategy for the Third Development Decade (1980-90). Important policy implications are derived in the field of agriculture, energy and South-South co-operation.

Part IV suggests orientations for further work, taking into account the recommendations of a forum of international experts convened by UNIDO in 1981 to evaluate and review the project.

A series of annexes complete the technical description of the model. Annex I gives a summary analytical expression of regional models as well as the classifications used; annex 2 gives the flow charts which describe how the different subsystems operate; annexes 3 and 4 include a description of the agriculture and consumption subsystems respectively, which were published in the 1980 report; and annex 5 includes some results of the sensitivity analysis of the model.

PART I: OVERALL VIEW OF THE SYSTEM

A. Some general features of the model

This section illustrates some basic choices regarding the structure of the model which were thought appropriate to capture the policy issues spelled out in the introduction while keeping the econometric estimation and computer work within manageable limits.

A first issue relates to the size of the system and its geographical disaggregation. From the outset, the sponsoring agencies of the project made it clear that the model should provide a bird's-eye view of the world system while remaining of a manageable size from a numerical and heuristic point of view. At the same time, despite its global scope. the model was required to display the minimum degree of detail necessary for identifying and dealing with the policy issues, and the associated variables, towards which the system is geared.

The system includes a set of eleven regional models, of which five for developed and six for developing countries[1/]. A major feature of the model is the basis of the disaggregation, which is by and large geographical vicinity. It should be noted, in this connexion, that in many cases, neighbouring countries have comparable economic structures and, to a large extent similar institutional and social conditions, hence, the geographical approach overlaps with other approaches. Geographical vicinity was used as a criteria essentially in order to provide a framework for the simulation of economic co-operation among neighbouring countries. In this respect the UNITAD system differs from other world models in which countries are grouped according to per capita GDP level, i.e. a structure implying a specific linkage to the world system, more apt to picture North-South than South-South relations[2/].

The system is highly interactive, in that the growth of each region reacts on the system as a whole and, conversely, is influenced by other regions. Accordingly, the eleven regional models are interconnected

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1/ The following division of countries and regions is used: North America, Western Europe, Centrally Planned Economies of Europe (CPE, Europe), Japan, Other Developed, Latin America, Tropical Africa, North Africa and West Asia, South Asia, East and South-East Asia, Centrally Planned Asia (CPE, Asia) (see annex 2).

2/ Attempts are sometimes made to combine conomic and geographical criteria (as, for example, in the World Bank model). A solution of this type might eventually be worked out for the UNITAD system, so as to introduce results by broad categories of countries within regions, e.g. oil-exporting versus oil-importing countries.

through a Trade Module and a Financial Flows Module. The former includes seven bilateral trade matrices, each of which corresponds to a specific traded commodity group, and a pool of services. All traded goods and services are subdivided exhaustively in the following categories: agricultural products, other raw materials, energy, intermediate products, consumer non-durables, equipment goods, consumer durables and services (see annex 5 for a precise description of the various groups). The Financial Flows Module includes four tools of financial resources: official development assistance (ODA), non-concessional capital flows (including direct private investment), interest payments (including repatriation of profits) and migrants' remittances. Each regional model generates the import requirements as well as, where applicable, the outflows of ODA, capital movements, migrants' remittances and interest payments which are associated with the pattern of growth simulated in each region. These data are fed into the Trade and Financial Flows Modules which compute for each region the export vectors as well as the inflows of ODA, capital, interest and remittances. The Trade and Financial Flows Modules (and a few other related variables) as well as the price system define therefore the world trade and financial structure. Modifications in their values make it possible to investigate the effects of the international environment on the growth potential of each region. As mentioned earlier, assumptions of world trade and financial structures can be combined with other assumptions of regional growth patterns for the purpose of comparing the relative efficacy of these two broad families of policies in attaining given targets.

Any model's specification is influenced by its purpose, data availability and existing methodologies. Among growth models, the main distinction which is usually drawn is that between demand and supply driven models. The latter explain growth mostly in terms of the existing stock of factors of production and are generally better suited for longer-term analysis, especially in the case of developing economies suffering from severe supply constraints and market rigidities. Demand-driven models, those, for instance, belonging to the Keynesian family, are more apt to explain the short or medium-term fluctuations of economies with significant idle capacity and few supply constraints. Although combining aspects of both approaches, each UNITAD regional model can be featured as a supply-constrained model in the sense that the stock of factors of production (including those transferred from abroad) does limit the growth potential of the economy. The Input/Output core of each regional model, on the other hand, introduces explicitly the structure of final demand by eight sectors, so that shifts in the composition of final demand (because, for instance, of changes in consumer preferences, or in technology, or in export demand) will release or commit part of the productive resources and allow the economy to achieve a higher or lower GNP. Hence, it can be said that, for a given stock of production factors, the structure of demand has an influence not only on the composition of output but also on its level.

Another choice to be made, which was heavily influenced by the time horizon of the model (i.e. from 1980 to 1990 and 2000), was that between simulation and forecasting. The distinction between these two categories is often a matter of degree rather than of kind. However, two main features differentiate them, i.e. the degree of openess of the system and the interpretation of the results. Forecasting models generally have a limited number of exogenous variables (which are under the control of the policy-maker or belong to the external environment), and a dominant endogenous structure made up of systems of econometric equations with coefficients implicitly embodying past and current economic structures. Any forecast based on such models is made on the assumption that the parameters of the underlying economic structures will assume their trend values as revealed by the estimation period. The results of the model can then be interpreted as the expected future (a forecast) under the strong hypothesis of structural stability. Besides the futility of any attempt to forecast the long-term future, the rigidity of the parametric structures of such models does not make it possible to simulate or to generate, for instance, new industrial structures, consumption patterns and institutional changes which would sharply differ from observed trends. Given the policy orientation of the project, preference was therefore given to the creation of simulation models, which are less deterministic, and in which a greater number of exogenous variables permits an analysis of the effects of structural and institutional changes. For example, a simulation of economic co-operation among developing countries (ECDC) requires the trade shares of developing countries to assume certain values, while the simulation of appropriate technology requires the technical coefficients to deviate from existing trends.

Accommodating such structural changes can make it more difficult to manipulate the model; these problems can be overcome, however, through the help of information given by external data, relationships or even partial models outside the main system, to project the range of the exogenous variables, as well as by an appropriate sensitivity analysis. Obviously, the results of any such simulation should be interpreted as conditional projections. They indicate only the direction and the magnitude of change subject to the projected values of exogenous values, i.e. with a margin of uncertainty which is imposed by the long-term horizon.

A related problem is the choice between a model which would reproduce the year-to-year evolution of the world economic system with all the interactions of real, monetary and financial variables, and a model which would yield a range of consistent structural targets for a final year and, perhaps, a few intermediate years. It is clear that policy-makers should ideally dispose both of a vision of long-term structural changes and of a development path indicating how to attain such targets. However, it is well known that it is most difficult, if at all possible, to combine the two approaches in one and the same model. Indeed, forecasting models which allow for limited structural modifications of the economic system are normally capable of indicating a development path for the next few years, but even so they should be used with caution in a situation where institutional or structural changes are taking place. This caution is dictated by the considerable uncertainty likely to prevail during the "maturation period" of such changes. For instance, it may take anything from five to ten years for the economy to adjust to the establishment of a new economic grouping. Past behaviour relations can hardly be used to forecast the dynamics of such a process.

These considerations call therefore for a true "long-term" model which would picture the direction of change and attempt to describe the economic system beyond the maturation period, thus skipping intermediate fluctuations. Accordingly, the UNITAD system does not provide year to year solutions and computes directly the results for the target years 1990 and 2000. Intermediate results for five-year intervals could be introduced if deemed necessary. For the periods included between two benchmark years the model assumes that stock variables grow according to a flexible exogenous time path (arithmetic, exponential, etc.). From a formal point of view, the model may be considered predominantly static. The opposition between static and dynamic, however, can be misleading in such a context. What is more dynamic, a model based on an assumption of rigid economic structures, or a model generating new structures and simulating the impact of institutional changes?

A final choice was that between a "gap" and a "general equilibrium" type of model. Should the model be designed so as to achieve automatically equilibrium on the commodity and factor markets, domestically and internationally, through the operation of market clearing prices? Or should the model draw the attention of the policy-maker to the potential disequilibria (or "gaps") that the world economy might face in the next ten or twenty years? A choice of the first type would imply an assumption of perfect competition and transparency on all markets as well as observed conditions of quasi-equilibrium on the same markets. Prices, in such a context, would represent indicators of relative scarcities providing rational signals for policy decisions and resource allocation. The assumption of perfect competition, however, strongly contrasts with the observed situation on several markets where monopoly, monopsony, oligopoly, cartelization, regulation and semi-feudal conditions are frequent. Phenomena such as unemployment, underutilization of land and capital, let alone large payments deficits and inflation, are eloquent symptoms of structural disequilibria and economic disorder; similarly, the price behaviour of several commodities and/or factors reveals, on closer scrutiny, the strong influence of existing power relations. Furthermore, even if conditions of perfect competition actually existed, a last methodological query, rarely addressed in the description of models, should be raised, i.e. the aggregation problem: for example, to what extent can "prices" or large baskets of commodities in a semi-aggregated model be treated as prices of a micro-economic nature, disregarding the changes in the composition of the basket?

Unfortunately however, despite some recent interesting contributions 1/, a generally accepted disequilibrium theory does not yet exist. The decision was therefore taken to design the system so as to ensure equilibrium on the commodity markets, while generating gaps on the investment-savings side, on the trade side and on the labour and land markets. The first two gaps are equalized by the solution procedure so that, if the growth rate of a region is fixed as a target, the model generates three main gaps: investment-savings gap (equal ex post to the balance of current payments), labour gap and land gaps. If, on the other hand, one of the gaps is fixed as a target, the model generates the growth rate and the other two gaps.

Prices in such a context play by necessity a different role from that in a context of general equilibrium. While the price indices of labour and capital, exogenously assumed, determine the inflation rate, final demand prices are generated through the Leontief relation and should therefore be interpreted

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1/ See I.G. Korliras: "Disequilibrium theories and their policy implications: Towards a synthetic disequilibrium approach", Kyklos, Vol.33, 1980, Fasc.3, pp.449-474, and by the same author: "A disequilibrium macroeconomic model", Quarterly Journal of Economics, February 1975, pp.56-80.
See also E. Malinvaud: The theory of unemployment reconsidered, Cambridge University Press, 1976, and Profitability and unemployment, Cambridge University Press, 1980.

as costs. However, the export prices of agricultural products, raw material and energy include, besides the cost-component, an exogenously given price differential reflecting market tensions. Relative prices influence household decisions concerning the allocation of consumption expenditure among different categories of goods and services. Similarly, the ratio between import and domestic prices contributes to regulate import levels.

B. A brief review of regional models and the linkage system

1. Regional models and domestic policy issues

Four different specifications of regional models have been built for Market Developing Regions, Market Developed Regions, the European Centrally Planned Economies (CPE, Europe), and the Asian Centrally Planned Economies (CPE, Asia), respectively. The four types of models, however, have several common features, besides adopting to a very large extent the same production, consumption and trade breakdown. The specific features of the two models for Centrally Planned Economies will be reported in the next section.

No attempt will be made here to describe the 3,000 equations of the system[1/], though reference will be made in footnotes to relevant methodological papers. The considerable work of econometric estimation performed will not be alluded to[2/]. However, bearing in mind the research objectives mentioned earlier, it may be relevant to list briefly the main policy issues addressed by regional models, with a few explanations of their potential uses in the investigation of such issues.

1/ A summary analytical expression and a series of flow charts are shown in annexes 1 and 2. A series of flow charts and the complete system of equations are available in the paper "The UNITAD Model: Main Methodological Features" (UNIDO/IS.22), May 1981.

2/ The originality of the UNITAD system lies indeed in the fact that the team had access to large data banks of the United Nations agencies and a generous allocation of computer time. Thus, a systematic attempt was made to measure the effect of structural and institutional changes on the basis of pooled cross-section data and time series. The production subsystem was based on a series of 49 original I/O tables (UNIDO), and Enterprises Surveys for 28 manufacturing sectors in the United Nations, Yearbook of Industrial Statistics (UNSO and UNIDO); the agricultural production functions were derived from FAO samples of Farm Management Surveys covering 18 countries; the trade equations were derived from original country tapes (full coverage) from 1963 to 1975 (UNSO); the consumption equations were computed on the basis of the United Nations, Yearbook of National Accounts Statistics and an ILO Collection of Household Surveys covering 12 large developing countries, etc.. For detailed explanations, see part II and annexes 3 to 4.

On the production side, every effort has been made to interrelate technology choices with other variables (employment, investment requirement, savings, and main economic equilibria). This can be done by using the coefficients of the Input/Output cores and productivity functions at a relatively disaggregated level (8 sections for the Input/Output core and 12 for productivity functions). Thus, a broad variety of concepts of "appropriate" technologies can be reflected in the model (see part II, B on the technology sub-system).

Energy, further disaggregated into two primary sources and two processing sub-sectors, is one of the key policy sectors. The system can generate energy balances at the regional and world levels, with all related effects on trade and payments balances. If required, energy can be treated as a supply-constrained sector.

Agricultural production in developing countries has been pictured as taking place in farms of different size, i.e. small, medium and large. The distinction is important since it has been observed[1/] throughout the developing world that farms of different size adopt widely diverse technologies, land and labour use patterns and cropping intensities which determine, accordingly, different yields per unit of land. The introduction of farms of different sizes therefore makes it possible to test the possible effects of land redistribution policies on farm-output growth, labour absorption and income distribution. Investment in agriculture includes the capital expenditure required for land extension and increased cropping intensity (see annex 3 on the agricultural sub-system).

Households allocate their income between savings and eight consumption categories (traditionally used in national accounts statistics, i.e. food, clothing, rent, furniture, health, transport, education and miscellaneous). Note that for the developing regions the household sector is broken down into rural and urban, with rural households showing higher marginal propensity to save and consumption baskets different from those of their urban counterparts. In this way the effects of exogenous changes in the rural-urban income distribution can be assessed in the system (see annex 4 on the consumption sub-system).

1/ See for instance R.A. Berry and W.R. Cline: Agrarian Structure and Productivity in Developing Countries, Johns Hopkins University Press, 1979. See also ILO: Poverty and Landlessness in Rural Asia, Geneva, 1977.

Government allocates its disposable income between savings and current consumption in administration, defense, health and education. Again, by changing the exogenous structure of government consumption, it is possible to reckon the effects of alternative government expenditure patterns in terms of overall growth and standard of living.

Import requirements have received an elaborate treatment (see part II, A on the trade sub-system). For each regional model, imports of eight groups of goods and services are computed on the basis of econometrically estimated import functions. The main arguments of the latter are an activity variable (generally the domestic production of one or more industrial sectors), the ratio of domestic versus import prices, and two policy variables, i.e. the level of protection (tariff and non-tariff) and the average domestic market size, i.e. and indicator measuring the degree of economic co-operation among neighbouring countries and/or the effect of the enlargement of the domestic market. The activity variable is expected to measure complementary imports, while the other three tend to decrease import dependence through import substitution. In particular, the domestic market size is instrumental in determining the level of imports and, via the input-output framework, in apportioning final demand between domestic supply and imports. This spurs the growth of the basic products and of the capital good sectors in those regions with a large industrial base and introduces a means of measuring the long term impact of economic groupings or income distribution policies[1/].

Labour and land gaps are computed for each region by subtracting an endogenously determined demand from the respective supply given by sub-models. For developing countries, the labour gap is obtained separately for urban and rural populations, so that the full impact of policy choices governing the industry-agriculture technology and interrelations can be expressed by the model.

2. The system as a whole and international policy issues

Three families of international issues, i.e. prices, trade and finance respectively, are embodied in the system[2/].

1/ The market size, as distinct from plant size, was underlined as an important externality in the pre-war period by Allyn Young, and more recently analysed by P.B. Rayment in a paper on "Intra-industry specialization and the foreign trade of industrial countries" to be published in a collection of essays in honour of C.T. Saunders. See bibliography of part II, A.

2/ See summary analytical expression (annex 1) and flow charts (annex 2).

An international price system can be superimposed on endogenous regional price-costs to simulate a world scarcity of any of the seven commodity groups, whether as a result of natural supply constraints (e.g. on the oil and gas market) or of a monopolistic or oligopolistic behaviour of a group of regions (e.g. sophisticated equipment as suggested by the product-cycle theory). As was already observed, the model can trace the effects of such scarcities on the allocation of resources at the world level, but the price increase itself is not generated by the model and must be derived from outside sources.

On the trade side, any change in import requirements of a specific region influences the exports of all other regions of any specific commodity, through the trade share matrices. As was already seen, such regional changes can result from import substitution effects, which in turn can be endogenously generated by the growth process or result from a deliberate policy embedded in the parameters governing intra-regional trade or protection level. Another important group of parameters are the trade shares themselves which can be changed to simulate policies or economic processes. Policy changes are deemed to reflect decisions made by a group of countries affecting the regional level (e.g. CMEA decisions for the group of centrally planned economy countries. Europe, or the EEC for Western Europe). Economic processes can simulate the effects of export-push policies such as those observed in Japan or in East Asia; to that effect, a gravitational model was estimated on observed data, so as to provide (outside the system) values of trade shares resulting from growth assumptions (see on this point section III A on the gravitational model).

Finally, assumptions of ODA, migrants' remittances, international banking facilities, interest rates and maturity of loans influence directly the payments and basic balances of every region. Moreover, the current payments gap affects the volume equilibria via the equality between the current payments gap and the investment-savings gap. It should, however, be observed that the financial structure of the system has been deliberately kept rudimentary and is not meant to determine reliable levels of financial variables. It should, nevertheless, convey an idea of the implications of changes in the institutional financing system for the world economy.

3. Centrally Planned Economies, Europe

The regional model for Centrally Planned Economies, Europe (CPE, Europe), like the other regional models, is built around an input-output core for the region, but specific features of the economic system of the region are also introduced.

A first difference is that all aggregates are expressed in the Material Product Concept[1/] (MPS) of national income and product; this can be justified not only on account of the available statistical data in national sources, but also in order to simulate in the model planning decisions expressed in the same conceptual framework, (e.g. a growth target in terms of material product).

Equations in value terms are restricted to those linking the region to the world economy. This is a recognition of the fact that the growth of Centrally Planned Economies is determined to a large extent by relations expressed in real terms and that the financial flows and price changes influence the economy to a much smaller extent than market economies. However, material activities, in the model, are financed mainly through sales on the market, which are influenced by prices; non-material activities are financed mainly via state budget (the observed value of non-material services purchased by households amounts to about 3% of total expenditure of households).

Another feature which tries to simulate the regulation of Centrally Planned Economies is that full employment is automatically assured. This implies an original treatment of technology in the model. In the non-agricultural non-services material sectors full employment is achieved throug ale-off (computed by the model) between new technology, reflecting de tal/ labour ratios, and old technology which is more labour-intens he rate of withdrawal of old technology is endogenously determined in the model as a compromise between decisions to introduce modern technology with a priority ranking of sectors, and the need to achieve full employment. As a consequence the average labour productivity determined by the model lies between the lower

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1/ The number of sectors used in the model is the same as for the other regions, except for the split of the services sector into two: material and non-material services. The sector frontiers, however, differ slightly (especially the capital goods sector) to fit data available in national publications (see classifications in annex 1).

and higher limits set by the old technology and the new technology components respectively[1]. The productivity equation of the former (old technology) is restricted to a trend of neutral technical progress, on the assumption that the equipment is more efficiently utilized at the end of the projection period that at the beginning. For the latter (new technology), the productivity is a "Cobb-Douglas" function, with neutral technical progress and capital/labour ratio as explanatory variables.

The model is designed to trace up the impact on the regional economy (including trade gap) of an array of decisions, as taken at the central level, on the following issues:

(i) a selected growth rate of the Gross Material Product (GMP) over the medium-term period;

(ii) employment figures in agriculture, material and non-material services (but sectoral employment in other sectors is endogenously determined);

(iii) desired technology (ies) (capital/labour ratio), by sector;

(iv) the relative amount of resources devoted to investment[2] (but the amount of fixed assets to be scrapped due to economic obsolescence, on top and above the scrapping due to physical deterioration, is endogenously determined);

(v) the ratio of growth of labour productivity to the growth of average real wage, which is the main factor influencing the level of private consumption; average real wages in non-material sphere and average social benefits are proportional to the growth of real wages in the material sphere;

(vi) the amount of resources devoted to the financing of the non-material sphere;

(vii) a minimum growth rate of private consumption acceptable from the social point of view;

(viii) a minimum growth rate of collective consumption.

The classifications, the analytical expression and flow charts illustrating the model are given in annexes 1 and 2 respectively.

1/ This holds true for six "industrial" sectors, i.e. agri-food processing, oil refineries and coal product, primary processing of basic products, light industry, capital goods industry and construction. There remains four sectors, i.e. the mining and utilities sectors, in which an average productivity function has been derived from past data.

2/ Gross fixed capital formation (GFCF) and inventory changes, using for the latter the conventional definition used in the largest Centrally Planned Economies of Europe.

4. Centrally Planned Economies, Asia[1/]

The regional model for Centrally Planned Economies, Asia (CPE, Asia) can be considered in many respects as a simplified version of the generic model for market developing regions but its specific features, derived from an original problematic, are worth being considered.

Like for market developing regions, the model uses the Standard National Accounts (SNA) concepts and the common sectoral and commodity classifications, in particular an eight-sector Input-Output core. However, income and financial relations are expressed in real terms (except trade and external financial relations), using the same general approach as for CPE, Europe.

The original feature relates to the elaborate treatment given to the rural area. It starts with the split of the output in 12 sectors, between urban and rural activities. This is governed by a transition matrix of exogenous shares, but it might be improved, in further versions, by using a 16 x 16 Input-Output core. Productivity functions similar to those of market developing regions are then computed on the basis of exogenous figures of capital/labour ratios for rural and urban areas separately. On the basis of output and productivity figures, the model generates separate vectors for urban and rural income, consumption, employment and investment.

Although a formal labour gap can be computed for both urban and rural areas, the growth of rural income per head in the rural area is computed as proportional to a given fraction of the growth of an average "rural productivity" defined as total rural output divided by total active population in the rural area. In other words, it is assumed that the whole active population in the rural area (computed outside the model) shares in the gains resulting from agricultural, industrial and service activities. It is worth noting that the assumptions on urban-rural migrations, together with the growth rate of agriculture and the shares assigned to rural industry are determinant in generating rural income.[2/]

1/ This model was built-up late in 1981 in co-operation with a group of UNIDO consultants from China. In all scenarios and sensitivity analyses reported in parts II and III, the CPE, Asia region played a purely passive role, i.e. importing from and exporting to other regions without any feedback to the regional economy. 1982 scenarios will, however, make use of the model described in this sub-section, with the CPE, Asia region fully interactive in the system.

2/ For the urban sectors, the growth rate of productivity is dependent not only on the shares or urban output but also on the technology used in urban activities (via the capital/labour ratios which determine the productivity functions).

The philosophy of the model is therefore to plan rural development per se so as to enable rural people (85% of total population in 1990) to satisfy most of their essential needs from their own activities. Rural industries also contribute a significant amount of intermediate and capital inputs to agricultural output, thus feeding productivity growth in agriculture. The latter relationship might be modelled more adequately with the planned extension of the Input-Output core into 16 sectors, in which own-consumed rural inputs could be identified separately from deliveries to the urban sector.

Altogether, the model can be said to remain crude, since a number of behaviour equations were approximated by fixed proportions reflecting base year data with assumed trends. As it stands, however, it has two merits, the first being to yield 1975 figures consistent with what is known from the economic situation of the region[1/], and the second, from a methodology angle, to pave the way for the modellisation of essential needs policies in the UNITAD system.

In future simulations, the real difficulty will be to use the model to project the future development pattern of the region, i.e. to translate an adequate planning strategy into the parameters of the model. This raises a number of substantive economic issues: To what extent is it possible to push the development of the rural area further without intensifying the two-way relationships with the urban sector? In such a case, what would be the level of the required infrastructure, the price system, the level of urban migrations? In turn, can the urban sector keep growing without more active trade with other regions? These are but a few complex questions for consideration if meaningful projections are to be made.

1/ Figures published by the governments were used for most estimates. A systematic comparison with World Bank estimates convey the impression that the latter overestimate structural changes and growth in China for the period 1965-75.

PART II: THE TRADE-INDUSTRY CORE OF THE MODEL

The main assumptions of the model relate to policy choices on trade and technology. On the trade side, these choices address the degree of protectionism, the degree of market integration within regions in specific sectors and trade direction policies embodied in trade shares. On the technology side, choices refer to the capital-intensiveness in every sector, and small-scale versus large scale plants in some sectors.

Once these assumptions are made, the model generates a world equilibrium, i.e. if growth assumptions are made, trade balances are determined or alternatively, a growth rate can be derived for each region under a given trade gap constraint. Implications on employment are also determined[1/].

A. The trade sub-system

The interplay between trade and development issues constitute the core of the UNITAD system. This note will attempt to give an overall view of the trade subsystem in relation to a number of policy issues. The first part outlines the theoretical background of the model, the second describes in general terms the substitution and complementarity mechanisms determining the level of imports in the eleven regions, the third concentrates on the competition between exporters and the determination of their shares, as embodied in the seven trade matrices.

1. The theoretical background of the model

The abundant economic literature on international trade in the last thirty years generally confirmed and sometimes ignored or contradicted Ricardo's views on comparative advantages. Among the former, the most important contribution is the well-known factor proportion theory based on the Heckscher-Ohlin-Samuerlson theorem, which can be contrasted with the product cycle theory based on the technological gap: among the latter,

1/ This part leaves out the imports of agricultural goods, which are exogenous in developing regions; furthermore, the technology of the agricultural sector is governed by a subsystem described in annex 3. The technology of food-processing industries is however described as part of the technology subsystem.

new insights on specific trade aspects such as intra-industry trade appear equally important[1/]. A few paragraphs - over-simplifying these theories - may be useful to justify the choices made in the UNITAD system.

The factor proportion theory is based on strong hypotheses, inter alia a world of perfect and pure competition. It predicts a positive trade balance of developing countries with industrialized countries in sectors with a low capital, low skill content and the reverse, i.e. a negative balance in sectors with a high capital, high skill content.

Using an index of value-added per employee popularized by H. B. Lary (1968) as an indicator of labour intensiveness[2/], Fels (1972) and Tuong and Yeats (1980) have convincingly analysed the penetration of labour exports from developing countries into developed markets. For example, the share of labour-intensive exports from all developing countries reached in 1975 as much as 31 per cent of United States imports of the same commodity package (17.7 per cent in 1965), the corresponding ratio in the import series of other developed countries being lower (8.9 per cent in 1975, 5.7 in 1965). These interesting findings hide a large array of differences from item to item: the penetration of the US market was extremely fast for textiles, clothing and accessories (65 per cent in 1975, 27.2 per cent in 1965), fairly fast for other light manufactures, excluding food (24.8 per cent in 1975, 8.2 per cent in 1965), and moderate for labour-intensive food manufactures (44.3 per cent in 1975, 41.9 in 1965) and industrial materials (32.5 per cent in 1975, 31.2 in 1965). Many queries can be raised on the interpretation of these figures: Dayal (1980) for example, observed that the penetration rates of most items (defined as the relative change of imports shares over time) can also be explained by the differential growth rate of demand and the natural resources content. Another point is the difference among penetration rates from different origins, a point hardly touched by authors: can the factor proportion theory explain the fast penetration of East Asian goods relative to African or Indian goods? On

1/ - On the factor proportion theory, see in the bibliography H.B. Lary (1968), G.C. Hufbauer (1970), W. Leontief (1956), G. Fels (1972);
- on the product cycle theory, see S. Hirsch (1975), D.S. Keesing (1965), R. Vernon (1970), S. Cole (1981);
- on other theories, references are made in the text to research published by Bela Balassa, B. Herman, P.B. Rayment, G.K. Helleiner, S.B. Linder, J. Tinbergen.

2/ A low value of this indicator actually denotes a low-wage/low-capital good, a high value points to a high-wage/high capital good, with a grey area in between (low-wage/high-capital or high-wage/low-capital).

this competition among exporters, specific export push factors seem to be at work. Similarly, one may question the interpretation given by Tuong and Yeats to the faster penetration of labour-intensive goods in the American market compared to other developed areas, i.e. the fact that the American industry ranks as the most capital-intensive. From Helleiner's studies (1979), another approach suggests itself: the strategy of the transnationals controlling the marketing of these goods in Europe versus the USA. On the other hand, the explanatory power of the theory is improved if, instead of two factors, capital and labour, other components such as qualified manpower or human capital or technology content are considered.

There is however, fundamental criticism to the theory. Firtsly, a grey area seems to be ist application to "intra-industry" trade (more than 60 per cent of the trade of manufactures among developed countries) where statistical tests based on factor proportions for intermediary goods, equipment and machinery, and consumer durables are generally not conclusive. This will be studied further in the text, but as will be seen, it now applies to a growing, though limited, share of the trade of developing countries. Secondly, while comparative advantages in terms of natural resources (Ricardo's original paradigm) generally operate over long periods, man-made advantages, as advocated by Heckscher-Ohlin, cannot be considered as stable over the long run, in other words the theory provides a static explanation of certain trade flows. This is a serious handicap to equip a model trying to describe the long term dynamics of trade in developing countries where factor proportions considerably change from one decade to the next. It can even be said that as a tool for predicting the trade of manufactures over the long term, the factor proportion theory is perverse since it tends to put the international North-South trade into a strait-jacket, with developing countries exporting cheap labour/low technology goods versus high capital/high technology goods for ever. Japan, at such a yardstick would still be a developing country in 1980. Finally, one cannot help to observe that Samuelson's theorem predicts a maximization of welfare for all trade partners, while permanent disequilibria, which cast serious doubts on the perfect competition hypothesis, seem to prevail in many trade partners, whether developing or developed countries, over long periods. Indeed, according to a recent UNCTAD publication (1981) more than 80 per cent of international trade flows are dominated by oligopolistic or monopolistic forces.

More appropriate, in that respect, seem to be those theories, like the product-cycle theory, postulating the existence of monopolies or oligopolies governing international trade for differentiated goods (and implicitly restricting the area of application of the factor proportion theory to standardized goods). For equipment and machinery and consumer durables, these theories identify a hierarchy of countries according to the control of sophisticated technology, so that the technology gap combined with large home markets allows the development of monopolistic positions vis-à-vis trade partners. Two adverse factors would then seem to handicap developing countries, firstly the narrow size of the home market and next, the R-D expenditure level and the skill level required to control technology. It may be observed in this respect that the concept of technology should be compared to a stock variable which accumulates over time (or even over generations). It is not sufficient for a country to produce a high technology good to immediately absorb the technology and even less to control advanced technology progress, while the monopolistic behaviour or world enterprises makes it even more difficult. Yet the only way to break the technology barrier is to develop the capital goods sector, as advocated by UNCTAD and UNIDO. On the methodology side, a major issue for long term models is therefore the treatment of import substitution in technology intensive goods, i.e. mostly in the primary processing and equipment and machinery sectors.

In the same sectors, the focal point of many analyses is the spectacular growth of intra-industry trade. The latter concept is defined here as the trade of commodities for which domestic production is matched by similar imports in a proportion close to the exports of the sector. A promising explanation presented by Rayment (1982) and other authors[1/] is the development of a dynamic process of industrial differentiation. Manufacture goods are seen as produced by a chain of activities taking place in distinct production units; as the market for the end product grows up, economies of scale or comparative advantages in factor proportions induce the separation of new components in the chain and hence a further industrial differentiation. This theory can be reconciled, at the micro-level, both with the factor proportion and the economies of scale theories. If applied in a context of fast development of telecommunications and trade facilities among neighbouring countries, it goes a long way in explaining the "explosion" of intra-industry trade within advanced industrialized regions. It is useful to observe here that one of the main point made by Rayment is that

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1/ We leave aside Linder's ingenious theory explaining intra-industry trade by overlapping consumer preferences for a given commodity at the same level of development; as Rayment observed, consumer preferences cannot be the determinant for explaining intra-industry trade for capital and intermediary goods which constitute the major part of intra-industry trade (90 per cent according to Rayment).

partners should preferably have similar technology level. Yet there seems to be a policy of transnationals to locate component plants in developing countries, so long as they have full control both of the technology and the sales of the product which is part of a chain of activities located in different countries. This internationalization of activities can be reconciled with Rayment's approach, but on conditions unacceptable by developing countries. Moreover as eloquently shown by UNCTAD, the prices of both the inputs and outputs, as internally decided by the transnationals, introduce a serious bias in international competition[1/]. These characteristics, at first glance do not leave much room for an autonomous process of intra-industry trade growth in developing countries.

Yet a recent analysis, made by Laird (1981), draws attention to the growing importance of intra-industry trade for developing countries, measured at the three-digit level of SITC, for 150 groups of manufactures, excluding food (SITC 5-8). Using the intra-industry trade ratio developed by Grubel and Lloyd[2/] (1971), the analysis suggests that intra-industry trade predominates in 1975 in the trade among developed market economy countries, with a ratio around 64 per cent (the ratio equals 100 if the value of exports is equal to the value of imports, and to 0 if there are no imports or no exports in the same 3-digit units). For developing countries instead, the trade with developed market economies (80 per cent of their total trade) is predominantly inter-industry, "although their trade with each other (1? per cent of their total trade) has a much higher intra-industry component (ratio around 28 per cent) than that of their trade with development market economies (ratio around 9 per cent) or the socialist countries (ratio around 5 per cent)"[3/]. More importantly, the intra-industry ratio seems to grow fastly in economic groupings of developing

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1/ The US custom duty legislation (items 806.30 and 807.00) allows for the computation of the value added by the exporting country to the imported goods, and provides the best information so far on related-party trade. Other countries (Canada, Germany (Federal Republic of), Netherlands) have adopted similar legislations.

2/ If Xi and Mi stand for exports and imports of commodity i (i=1....n) from and into country j, the ratio is defined as the sum for i's of:

$$(Xi + Mi) - [Xi - Mi]$$

divided by total trade, i.e. the sum for the i's of:

$$Xi + Mi.$$

3/ See Laird (1981) p.87. The optimistic views expressed by the author on the development of intra-industry trade between developed and developing countries can be contrasted with the arguments derived in this note from Rayment's analysis.

countries, and is close to a 50 per cent ratio, in 1975, for CACM and ASEAN groupings[1].

The growth of intra-industry trade among neighbouring countries, should be reflected in the development of intra-regional trade for intermediary products and for equipment and machinery. A well known indicator of trade intensity between two partners is the delta coefficient, as obtained from a matrix of bilateral trade flows (here 11 exporting regions times 11 importing regions) by dividing each bilateral trade flow by the two margins, i.e. the total imports of the importing region and the total exports of the exporting region[2].

The value of delta (ij) if compared to 1, reflects the relative importance of trade partner j for the exports of region i (and delta (ji) for the reverse flow); by definition, a value higher than 1 for delta (ij) corresponds to the case where the share of the bilateral exports from i to j in the total exports of region i is higher than the share of total imports of region j (the size of the j^{th} market) in the world total. The interest of the delta coefficient (and its limitation) is that it is dimensionless, which is an advantage when comparing the relative importance of small flows.

The following results obtain:

1/ Central American countries in CACM, and grouping of Indonesia, Malaysia, The Philippines, Singapore and Thailand for ASEAN.

2/ More precisely, all flows must be divided by total world trade for the sake of homogeneity. If normalized flows are denoted Z_{ij}, $Z_{i.}$ and $Z_{.j}$ for exports from region i to region j, total export of region i, total import of region j, delta(ij) is defined by:

$$Z_{ij} = \text{delta}_{ij}\, Z_{i.}\, Z_{.j}$$

See, on this indicator, ECE studies in the bibliography. A number of authors have used this indicator, e.g. Froment and Zighera in France, F. Carré and J. Cuddy in ECE, A. Nagy in Hungary.

Table 1

Delta coefficients for intra-regional trade, 1963-75

	Intermediary products		Machinery and equipment	
	Average 1963-75	Trends (growth rate in %)	Average 1963-75	Trends (growth rate in %)
NA	2.5	2.5	2.1	0
WE	1.4	no trend	1.5	0.5
EE	6.3	no trend	6.4	variable, increasing
JP	...	...	...	...
OD	3.4	no trend	6.6	variable, increasing
LA	3.3	5.8	7.3	no clear trend
TA	3.0	17.7	14.4	no clear trend
NE	7.4	no trend	10.9	variable, increasing
IN	2.7	1.7	7.5	14.5
AS	5.5	-8.1	11.4	-12.0
OA	...	...	...	...

Note: for the definition of regions, see annex 1 on classification.

The first finding is the relative importance of intra-regional coefficients, (all coefficients are higher than 1), which, it may be said, is firstly due to a wealth of factors like relatively low transport cost, a better knowledge of markets, etc., as may exist, for example between United Staes and Canada within the NA region. But an economic integration process can be presumed when increasing trends are observed, as is the case for intermediary products within specific individual regions, i.e. North America, Latin America, Sub-Saharan Africa and Indian Sub-Continent. Even more interesting are the high delta coefficients and their increasing trends, found for machinery and equipment within Western Europe,[1/] within West Asia and North Africa, and within Indian Sub-Continent. Finally, the results found for intra-regional trade for East and South-East Asia confirm the high intra-industry ratios found within economic groupings in that region, but the fastly decreasing trends also reflect the trade orientation of many countries towards developed markets, especially North America and the "other developed" region (including Australia and New Zealand); actually delta coefficients higher than 1, with increasing trends, are found for the exports of that region (1.5 and 2.2 respectively) towards NA and OD regions.

The interesting point in this analysis, is the similar behaviour which seems to characterize the two indicators of intra-industry and intra-regional

1/ The relatively low coefficient for intra-regional trade of machinery and equipment in Western Europe should be assessed keeping in mind the large trade flows involved and also the fact that the region includes much more than the EEC. The coefficient found for EEC alone is higher than 2.

trends in the machinery and equipment sector. This gives a clue how to quantify the phenomenon of the explosion of intra-industry trade, i.e. to capture it through the growth of indicators of economic integration on intra-regional and inter-regional flows, such as, for example, delta coefficients or more generally, as will be seen, a gravitational model.

This brief review of trade theories may seem ambiguous since no clear choice seems to command itself from so many sources. Following the empirical tests carried out by Hufbauer (1970), it seems widely accepted that no panacea is ready for application to the projection of international trade. However, it seems possible, from this analysis, to sort out some theories wi[illegible] long-term horizon, capable of recognizing factors which can influence a world system ten or twenty years ahead in time, with different industrial structures and market sizes than today. A long-term model, in particular, must be able to simulate the influence of changing industrial structure on trade as well as the growth of intra-industry and of intra-regional trade; it must also identify the potential for South-South co-operation and the dynamics of exports of developing countries beyond the present stage of international division of labour as dominated by the factor proportion paradigm. With these requirements in mind, a few suggestions, allowing quantitative analysis to choose from among various possibilities, will be developed in the next sections.

In section 2, the influence of market size will be anlysed with emphasis on imports equations for intermediary products and machinery and equipment, i.e. the two major commodity groups of manufactures. An attempt will be made to simulate the continuous process of substitution between domestic production and imports which proceed both with changing industrial structures and with the growth of market size taken as the key variable, as well as the new complementary imports which emerge in the same process. The same variable, market size, will be used to measure the impact of integrated versus fragmented markets on intra-regional trade. Last but not least, an attempt will be made to measure the impact of protectionism on the level of imports for some commodities.

In section 3, a comparison will be made on two alternative sub-models governing the competition among exporters, or in practical terms, the substitution between trade shares for each commodity in each importing region. The first, the semi-aggregated model, takes prices as explanatory variables, as well as the size of the importing market. It will appear as a fair instrument to predict shares of natural resources goods, but, as could be expected, rather poor for manufactures. In the latter case, a gravitational model of the type experienced in the past by Tinbergen and Linnemann will be preferred. This model, which can be considered as based on a generalisation of delta coefficients, will be shown to capture relatively well long-term moves such as those observed for Japanese and East Asian exports to developed markets or growing intra-regional trade in several regions for several categories of manufactures.

2. Import functions: complementarity and substitution processes

Before considering the specifications of import functions, a general remark should be made to explain their role in the UNITAD system. In a nutshell, domestic output is derived from a system of simultaneous equations which can be summarized as follows:

(1) $[VA(i)] = [I-\hat{i}'A]\ [I-A]^{-1}\ [FD(i)]$

(2) $[FD(i)] = (DD(i)] + [X(i)] - [M(i)]$

(3) $[M(i)] = f_i[VA(j), \text{GDP or MVA}, Z(i),]$

in which [VA(i)], [FD(i)], [DD(i)], [X(i)], [M(i)] stand for the vectors (by production sector) of value-added, final demand, domestic demand, exports and imports respectively (the index of the region has been omitted since this system refers to any one given region).

Equation (1) derives, through the usual inversion of the Leontief matrix of technical coefficients (A), the value-added vector from the final demand vector. As shown in equation (2) the final demand vector includes, by definition, the import vector with a negative sign. Equation (3) is a simplified import equation, in which the dependent variable, the import of commodity group i, is a function of an activity variable (value-added of sector j), the market size denoted by GDP or manufacture value-added (MVA) and other variables Z(i), which can be ignored at this stage.

The system includes two loops. Firstly, due to the negative sign of M(i) in equation (2), the higher (the lower) the imports of commodity group i, the lower (the higher) final demand and therefore domestic output of sector i; this negative loop therefore simulates a substitution process between imports and domestic output. More precisely, the substitution is between net imports (M(i) - X(i)) and domestic output, and it is important to note that this net vector actually refers to trade of the region with the other regions, since intra-regional trade, whether or not included in both M(i) and X(i), is cancelled out by the substraction.

A second loop, triggered by the two explanatory variables of M(i), makes imports dependent on the output mix derived from equation (1). The activity variable, VA(j), which must have a positive sign to be meaningful, has a positive effecton the level of imports (i), in other words it simulates a complementary import process. The market size variable, GDP or MVA (manufacturing value-added), which must have a negative sign to be meaningful, determines a negative loop, i.e. a substitution process: the higher (the lower) the market size of the region, the lower (the higher) the level of imports.

Since these two explanatory variables are usually found to be co-linear in time series, the coefficient of the market size variable was derived from a cross-country regression and then imposed on time-series regressions for each region. The use of cross-country analysis is especially justified here, since the market size effect can only appear as a structural change over the long run. Import equations for intermediary products will be considered first, followed by imports of machinery and equipment. A general presentation of import equations will be made thereafter.

(i) Imports of intermediary products

The cross-country analysis yielded the following equations[1/]

Equation N°	Sample	Equation	R^2
(4)	All countries	$IP = K_1 - 0.022\ GDP + 0.113\ MVA$	0.89
(5)	(64 observations)	$IP = K_2 + 0.029\ MVA$	

Equation (4) shows that, ceteris paribus, countries with a high GDP tend to have lower import requirements of intermediary products. Taking GDP as a market size indicator, the question therefore is: why should market size decrease import requirements? Three possible justifications can be given. Firstly, the basic product sector included both mining and primary processing of basic products. It may therefore be that GDP is correlated with mining value-added, which can be interpreted by saying that countries with a large mining sector import less intermediary products. Such a correlation was actually found to be the case so that a negative coefficient for mining, with MVA as the activity variable was obtained in another equation instead of equation (5). The second reason is the existence of economies of scale of the primary processing sector, which was evidenced in the analysis of the productivity functions (see part II,B). But plant size and domestic market size are not the same concept, and market size will only capture the impact of economies of scale, at the plant level, insofar as the two variables are correlated. This was actually found to hold true in the analysis of productivity functions, where a correlation coefficient of 0.6 was found between the two variables. The main and last argument, however, is much more decisive. As shown by Young (1928) quoted by Rayment (1982), a large market size induces a process of industrial differentiation and therefore the growth of domestic market size can be seen as the principal type of change associated with the growth of the sector. This was actually evidenced in the analysis of productivity functions (see part II,B) but to a much lesser extent for the primary processing sector than for equipment and machinery (see below in the text). At this juncture, we may note the two main conclusions, i.e.

1/ The complete set of cross-country times series regressions can be found in a paper "The Interplay of Trade & Development", by A. Duval, M. Gilli and J. Royer, July 1980, presented to the ACC Task Force on Long-Term Development Objectives.

that the impact of the mining sector should be separated and that there are good theoretical background for keeping GDP as a market size indicator with a negative coefficient.

The next step in the analysis consisted in working out time-series regressions for each region, imposing the negative coefficient found for GDP (-0.02) in the cross-country analysis, in order to avoid the problem posed by the co-linearity between GDP and MVA in time series. Similarly, a coefficient (-0.40) derived from cross-country regressions was imposed on mining value-added. The results are given in the following table:

Table 2

Imports of intermediary products (time-series regressions)

Region	Regressions(6) with -0.02 GDP					Regressions(7) with -0.40 mining				
	Constant	GDP	MVA	R^2	DW	Constant	Mining	MVA	R^2	DW
LA	187*	-0.02	0.202	0.95	2.2	662	-0.4	0.175	0.92	2.4
TA	690	-0.02	0.585	0.93	1.4	313	-0.4	0.835	0.97	2.2
NE	-1294	-0.02	0.922	0.93	0.8	-1277	-0.4	1.365	0.98	1.4
IN	1701	-0.02	0.100	0.79	1.9	...	...	...	...	...
AS	989	-0.02	0.515	0.94	1.5	732	-0.4	0.497	0.93	1.4

Note: *Coefficient not significant at the 0.95 level.

A glance at these regressions shows that the two specifications are equally good for Latin America (LA) and East and South-East Asia (AS), but that, in the case of Sub-Saharan Africa (TA) and West Asia and North Africa (NE), regressions (7) on the right side of the table have both a better R^2 and a better Durbin-Watson coefficients than regressions (6) on the left side. For South Asia (IN) no good regression was found for the regressions with mining value-added.1/ An interesting comparison can be made between the two regressions for each region. If postulating the inequality: IP derived from regression (6) < IP derived from regression (7), it is possible to compute the MVA/GDP ratio, i.e. the share of manufacturing value-added with a mining value-added/GDP ratio derived from observations (or from projections). The result shows that regressions (6) with a negative GDP coefficient give lower imports of intermediary products than regressions

1/ As a result of a strong protection of the domestic market, the imports of intermediary products were almost kept constant in that region during the observation period (1963-75).

(7) with a negative mining coefficient, for a manufacturing value-added ratio satisfying the following conditions:

LA : MVA/GDP < 37% NE : MVA/GDP > 4.2%

TA : MVA/GDP > 8.9% AS : MVA/GDP < 44%

These values are such that, in any future projection, regressions (6) with GDP as a market size indicator will yield a lower import level than regressions (7) with a negative mining coefficient, and this holds true for all regions. This th refore confirms the conclusions of the theoretical discussion on market size as a major factor for the growth of the primary processing sector. As an illustration, taking the assumptions of scenario IDS2, (see part III) th differences in the level of 1990 imports given by the two sets of regressions are the following:

Table 3

Imports of intermediary products in 1990

Trade flows in millions of 1970 US dollars

	Regressions (6) Negative GDP coefficient	Regressions (7) Negative mining coefficient	Import elasticities to GDP Regressions (6)	Regressions (7)	1963-75
LA	17158	18788	1.1	1.2	1.3
TA	5594	6665	1.0	1.25	1.6
NE	25386	44082	1.2	1.75	1.8
AS	23344	26011	1.5	1.6	1.3

Except for West Asia, and North Africa[1/], the results of the two equations are not very far, but the absolute figures or the import elasticities derived from regressions (6) all have the expected downward bias.

It should be recalled at this juncture that the time series regressions have a different geographical basis than the cross-country regressions. Since the GDP coefficient was derived from a comparison between countries, the time series regression gives the level of imports from outside the region, excluding intra-trade flows. Furthermore, in regressions (6), GDP variable refers to the region as a whole, and implicitly assumes a regional integration of the sector. In contrast, regressions (7) with a negative mining coefficient imply a fragmented market for the primary processing sector, and an integrated market for the mining sector, which does not seem a strong hypothesis. If used for projection purposes, a comparison between the two equations therefore offers a means of comparing

1/ The left side figure for the region NE which is much lower than the right side figure, draws attentionto the bad Dubin-Watson coefficient of the equation. The obvious explanation is that the high GDP figure is due to a high level of oil extraction and not to the process of industrialization. Another equation should therefore be used for that region, with, for example, the ratio MVA/GDP as a size indicator.

the impact on imports of intermediary products from outside each region of an integrated versus a fragmented market for primary processing activities. Assuming no trade creation, a possible value for intra-trade flows would then be the difference between the import values of the two equations.

(ii) Imports of machinery and equipment (EQ)

Cross-country regressions yielded the following results for developing regions:

Equation (8) Sample: DG $\quad Ln\ EQ = K_8 + 0.043\ Ln\ GFCF \qquad R^2 = 0.76$

Equation (9) (36 observations) $Ln\ EQ = K_9 - 0.8\ Ln\ GDP + 1.4\ Ln\ GFCF \qquad R^2 = 0.00$

In these equations, the activity variable is Gross Fixed Capital Formation (GFCF), which, through the productivity functions, is determined by the output mix. GDP, with a negative sign, emerges again as a market size variable which, ceteris paribus, decreases import requirements.

As will be seen in part II,B, the analysis of productivity functions fully confirms the importance of the market size in the sector. The theoretical fundation, based on Allyn Young's analysis of externalities, is formulated by Rayment (1982) as follows:

"Young (1928) saw the process of industrial differentiation as the principal type of change associated with economic growth: "notable as has been the increase in the complexity of the apparatus of living, as shown by the increase in the variety of goods offered in consumers' markets, the increase in the diversification of intermediate products and of industries manufacturing special products or groups of products has gone even farther." The crucial point concerning the division of labour is that it reduces complex processes into simpler ones which can then be performed by machines (or by more specialized machines), but Young emphasises two features: first, that the principal economies of scale are derived from roundabout methods of production for which large production is more important than large-scale production, in the sense of being carried out by large firms or industries; and, secondly, that the economies of roundabout methods of production depend even more than others on the extent of the market."

Other arguments can be derived from micro-economic studies. It is noteworthy that almost all European regional "poles" of mechanical and engineering industries of the post war period already existed in the early stages of industrialization. A few enterprise enquiries conducted by the author of this note demonstrated the importance of frequent and easy communications between firms contributing different components of the same end-use product. The market size effect, at that time, could therefore be interpreted in terms of "regional" (sub-national) market. Another finding was the importance of R-D expenditures as a major cause of industrial differentiation in the sector. The end-product plant, when requiring a new component or a new adjustment of an existing component, is dependent on the capacity of t... sub-contracting firm or affiliate to design the new component. A good example is the importance attached today by the automobile industry to R-D capacity in electronics to promote the new generation of electronically controlled engines.

Telecommunications development in the postwar period have made it possible to extend former "regional" (sub-national) poles to form a nationwide or continentwide or even worldwide network. As was seen, however, in the early part of this note, this development took place more intensely within continental regions (between USA and Canada, within EEC, within Eastern Europe) than across regions, and the determining factor was the move from sub-national to continental market size. This extension of the process of industrial differentiation across frontiers seems to be the main growth factor for inter-industry trade. Even though a similar development started slowly in developing regions, as seen in Laird's article, it leaves hope for a future development of a South-South inter-industry trade in the future[1/], as a function of market size at the sub-regional or regional level. It therefore suggests the use of the regional GDP as a market size variable in import equations. Time series regressions should be instrumental in testing this hypothesis. The following results obtain:

Table 4

Imports of machinery and equipment (time-series)

Region	Equations (10) with -0.8 LnGDP					Equations (11) with -0.2 LnPOP				
	Constant	LnGDP	LnGFCF	R^2	DW	Constant	LnPOP	LnGFCF	R^2	DW
LA	4.14	-0.8	1.37	0.98	1.6	0.389	-0.2	0.89	0.96	1.6
TA	2.10	-0.8	1.65	0.98	2.0	-2.034	-0.2	1.23	0.98	1.9
NE	1.60	-0.8	1.69	0.99	2.2	-2.478	-0.2	1.26	0.98	1.4
IN	...	...	...	...	...	...	...	...	...	...
AS	2.70	-0.8	1.58	0.98	1.1	-0.844	-0.2	1.12	0.98	1.6

1/ The inter-industry trade between a developing country and a developed country has altogether another profile. As was recalled in the introduction, the technology and the market of the components made in the developing country are under strict control of the contractor in the developed country. It may create employment but will do little in the development of an autonomous capital good industry.

On the basis of the statistical tests, regressions (10), with a negative GDP coefficient, are excellent for Latin America (LA), Sub-Saharan Africa (TA) and West Asia and North Africa (NE). The Durbin-Watson coefficient for East Asia (AS) is in the grey area (1.1) as to the possibility of auto-correlation of residuals. No meaningful regression was found for South Asia (IN) since the import substitution policy of India, during the observation period, resulted in an absolute decrease of imports. On the left side of the table, a negative term, equal to -0.2 LnPOP, found in a cross-country regression, was introduced to capture the growth of the market size due to the mere increase of the population. All these regressions have good R^2 but the Durbin-Watson coefficient of West Asia and North Africa (WE) is less satisfactory (1.4). In the other regions, that coefficient, although acceptable, is lower than in regressions (10).

A comparison of these equations leads to the conclusion that regressions (10) consistently give lower import requirements than regressions (11). This can be seen for Latin America, by derivating both equations and postulating the inequality:

$$-0.8\ \dot{\overline{GDP}} + 1.37\ \dot{\overline{GFCF}} < -0.2\ \dot{\overline{POP}} + 0.89\ \dot{\overline{GFCG}}$$

Where $\dot{X}$ denotes the compound growth rate of variable X. This can be written as:

$e(GFCF/GDP) < 1.67 - 0.42 \ (\dot{\overline{POP}}/\dot{\overline{GDP}})$

$e(GFCF/GDP) < 1.48$ taking values of $\dot{\overline{POP}}$ and $\dot{\overline{GDP}}$ from the observation period where e refers to the elasticity of GFCF growth relative to GDP growth. The computations for all regions give the following results:

LA: $e < 1.48$ NE: $e < 1.67$

TA: $e < 1.63$ AS: $e < 1.78$

The observed elasticities for the period 1963-75 for these regions meet the conditions for LA (1.4) and AS (1.65) but not for TA (1.8) and NE (1.7). However, it stands to reason that such high elasticities cannot be maintained indefinitely since the GFCF/GDP ratio, which was 22.4% in 1975 in TA, and 20.7% in NE, is bound to level off in the future in the 25-30 per cent bracket. For 1990, therefore, regressions (10) ought to give lower estimates than regression (11), with the possible exception of Sub-Saharan Africa. Actual comparisons for scenario IDS2 are as follows:

Table 5

1990 Imports of machinery and equipment
Trade flows in millions of 1970 US dollars

	Regressions (10)	Regressions (11)	Import elasticities to GDP Regressions (10)	Regressions (11)	1963-75
LA	19346	23595	0.7	0.9	1.1
TA	14780	14967	1.6	1.6	2.3
NE	28834	38748	0.8	1.1	2.3
AS	27210	33177	1.4	1.6	1.6

As can be seen, the test is successful in all regions including Sub-Saharan Africa; the difference between the values of the dependent variables of the two regressions appear much more pronounced than was the case for intermediary products. The same difference can be observed between the two elasticities of imports to GDP. This can be seen as an illustration of the sensitiveness of of the growth of the sector to market size1/.

As was argued for imports of intermediary products, the two equations give us a possibility of simulating the impact of regional integration of the sector2/. Again, it should be noted that regressions (10) will give an estimate of extra-trade flows (trade with other regions) in an assumption of regional integration of the sector. Intra-trade flows can be computed as the difference between the values of the two regressions, assuming no trade creation.

(iii) General presentation of import equations

The specifications used in the model are given for developing regions3/ in table 6 for non-agricultural raw materials (RM), energy materials (EN) and intermediary products (IP), and table 7 for consumer non-durables (ND), equipment and machinery (EQ) and consumer durables (CD)4/. A few explanations are in order to understand these tables.

As was shown in the detailed analysis made for intermediary products and equipment and machinery, the two main explanatory variables are an

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1/ To note that the high import values of region NE, in regressions (11), is somewhat suspicious on account of the low Durbin-Watson coefficient, but the elasticity of imports to GDP growth derived from this figure is still much lower than the observed elasticity for 1963-75.

2/ Actually the low Durbin-Watson coefficient for East and South-East Asia for regressions (10) is a hint that the growth of the sector was more attributable to inter-regional than regional integration. This ties in with the negative trend found for that region for the intra-regional delta coefficient of imports.

3/ Equation for developed regions are generally simple constant elasticity equations, with the activity variable (MVA, GFCF or GDP) as the explanatory variable.

4/ No import equations are given for agricultural goods since these imports are kept exogenous in most scenarios.

activity variable, with a positive sign, and a market size variable with a negative sign. In addition, two specifications were given, the first with GDP and the other with POP (population) as market size variables; the difference between the values of imports from the two equations is a major outcome of the model, since it provides an econometric measure of intra-regional trade (assuming no trade creation) on the assumption of integrated regional markets. In order not to keep the two sets of equations in the model, the value of variable POP which would give the same import level as the GDP variable is computed in each scenario. This not only simplifies the computer programme, but it allows the simulation of partial integration of the markets, simply by giving to variable POP intermediate values within the range given by the lower and upper limits of variable POP.

In fact, variable POP is not the total population of the region but a weighted average per country (using population figures as weights in order to give more weight to large countries). The lower and upper limits of variable POP are given hereunder for machinery and equipment (EQ):

Imports of machinery and equipment (EQ)
Lower limit (fragmented markets) and upper limits (integrated markets) of variable POP (millions of people), in 1990, scenario IDS2

Region	Lower	Upper	Total Population
LA	88	243	479
TA	38	263	448
NE	37	162	261
IN	..	...	...
AS	125	337	412
OA	1009	...	1158

While the two sets of equations, with GDP and POP, are given for imports (IP) and (EQ), tables 6 and 7 only contain one set with POP variable for the other commodity groups. Other market size variables (essentially mining value-added) and one other activity variable (GFCF) are included in a special column. In a few cases, a price variable (p/pm), defined as the ratio of import prices for the region to the average price for the world, is also mentioned. In general, this variable appeared in a number of equations but it hardly affected R^2 when it was significant; exceptions to this rule have been included in the table. This general finding is not surprising: in the long run, as was demonstrated in particular by Machlup

(1950), import elasticities to activity variables are much more stable than price elasticites. For developing countries, furthermore, the market size effect is by far the dominant explanatory variable after the activity variable.

Another variable denoted by Dut, is however noteworthy. It is meant to capture the effect of protectionist policies (both tariff and non-tariff protection) and, with a negative sign, it triggers an import substitution process. As can be seen from appendix 2, this variable appeared a number of times with the right sign in the cross-country analysis, and it was inserted, with the same coefficient, in the time-series regressions.

The level of variable Dut was the outcome of a tedious compilation made by GATT and UNCTAD experts. The rate of import duties levied on each group of commodities was first compiled for each country, which involved averaging rates of duties for the various sub-items of the group. An estimate was then established for non-tariff protection, classified in three categories: no protection, licensing, level close to absolute prohibition. Finally the tariff and non-tariff protection levels were cross-classified in a 3 x 4 matrix, each cell corresponding to a value of the Dut variable between 0 and 5 (see appendix 2). The degree of protection, through variable Dut, appears in all commodity groups, but is more important in consumer non-durables (DC's), equipment goods (Dg's and DD's) and consumer durables(DC's); in the latter groups, the coefficient of Dut, in the logarithmic equations, varies between -0.2 and -0.3, say around -0.25. The protection variable appears to be inversely correlated with the activity variable of developing countries for agricultural goods, raw materials and energy materials. The economic interpretation is interesting since it suggests that large countries tend to impose a substitution policy through protection policies in these sectors. In such cases, the model builder can only impute the substitution effect to one of the two variables, actually the activity variable, on the assumption that an adequate level of protection is imposed. It was impossible to measure the effect of protectionist policies for consumer non-durables in developed countries. This may be explained in two ways: the level of protection was reported as identical in EEC countries, which may be an idealistic view of reality; but a more subtle argument may challenge further attempts: non-tariff protection, in this sector, is said by Helleiner (1979) to take the form of restrictive marketing practices which would limit the amount and the choice of commodities originating from developing countries on sale on the market of developed countries.

To illustrate the impact of protection policies in the equations, it is sufficient to observe that the import level of manufactures of the same region can go down to 37 per cent of what it was with no protection when the protection level increases from 1 to 5.

The main conclusions to be derived from this analysis of import functions can be summarized by emphasizing the importance given in import equations to three substitution processes, i.e.:

- those induced by tariff and non-tariff protection;
- those made possible by the growth of the relevant domestic sectors as a result of national development policies;
- those governed by the enlargement of market size through collective self-reliance policies, at regional or sub-regional level.

The last two processes are fundamentally the same but are captured by giving two alternative values to the market size indicator, i.e. variable POP.

Table 6

Regressions used for imports of developing markets

Region	Log or Linear	Constant	Dut	LnPOP	MVA	GDP	Other variables	R^2	DW
		Non-agricultural raw materials (RM)							
LA	Log	-1.98			1.52		-1.0 Ln Mining VA	0.97	1.8
TA	Log	-8.11			2.48		-1.0 Ln Mining VA	0.83	1.9
NE	Log	-6.43		-0.3	1.32			0.78	1.4
IN	Log	0			1.13		-1.0 Ln Mining VA	0.60	1.5
AS	Log	0			0.91		-0.3 Ln Basic ProductVA		
							-1.35 Ln p/pm	0.76	1.5
OA	Log	-8.0			1.12			0.65	1.7
		Energy materials (EN)							
LA	Lin	201		-63	0.045		-2068 p/pm	0.92	2.06
TA	Lin			-63	0.098			0.76	2.6
NE	Lin	571			0.209		-0.13 Mining VA	0.70	0.6
IN	Lin	700		-63	0.018			...	...
AS	Lin	-1549		-63	0.121			0.84	1.6
OA	Lin	Exogenous						...	...
		Intermediary Products (IP) Set 1							
LA	Lin	183*			0.202	-0.02		0.95	2.2
TA	Lin	690			0.585	-0.02		0.93	1.4
NE	Lin	-1294			0.922	-0.02		0.93	0.8
IN	Lin	1701			0.100	-0.02		0.79	1.9
AS	Lin	989			0.515	-0.02		0.94	1.5
OA	Lin	...			...	...		...	...
		Intermediary Products (IP) Set 2							
LA	Log	-2.70		-0.30	1.206			0.95	2.1
TA	Log	-9.04		-0.40	1.781		-0.1 Ln Mining VA	0.96	1.7
NE	Log	-3.77		-0.30	1.500			0.95	1.1
IN	...	...		...	...			...	...
AS	Log	2.07		-0.30	0.893			0.97	1.5
OA	Log	-2.7			0.949			0.79	0.5

Note: A star (*) denotes a coefficient not significant at the 0.95 level.

Table 7

Regressions used for developing countries (continued)

Region	Log or Linear	Constant	DUT	LnPOP	MVA	GDP	Other variables	R^2	DW
		Consumer non-durables (ND)							
LA	Log	-4.1	-0.2	-0.4		1.21	-0.1 Ln Mining VA	0.93	1.8
TA	Log	-3.7	-0.2	-0.4		1.24	-0.1 Ln Mining VA	0.88	1.6
NE	Log	-4.8	-0.2	-0.4		1.33	-0.1 Ln Mining VA	0.88	0.5
IN	Log	0.54	-0.2	-0.6		0.80		...	...
AS	Log	0.63	-0.2	-0.4		0.86	-0.1 Ln Mining VA	0.74	1.9
OA	Log	-0.24		-0.6		0.60		...	...
		Equipment & machinery (EQ) Set 1							
LA	Log	4.14				-0.8	1.37 Ln GFCF	0.98	1.6
TA	Log	2.10				-0.8	1.65 Ln GFCF	0.98	2.0
NE	Log	1.60				-0.8	1.69 Ln GFCF	0.99	2.2
IN	...	...				...	...	...	...
AS	Log	2.70				-0.8	1.58 Ln GFCF	0.98	1.1
OA	Log	...				...	...	...	...
		Equipment & machinery Set 2							
LA	Log	0.738	-0.12	-0.20			0.89 Ln GFCF	0.96	1.6
TA	Log	-1.670	-0.12	-0.20			1.23 Ln GFCF	0.98	1.9
NE	Log	-2.216	-0.12	-0.20			1.26 Ln GFCF	0.98	1.4
IN	Log	0	-0.12	-0.20			0.90 Ln GFCF	...	...
AS	Log	-0.504	-0.12	-0.20			1.12 Ln GFCF	0.98	1.6
OA	Log	-1.17	-0.12	-0.20			0.93 Ln GFCF	0.65	1.3
		Consumer durables (CD)							
LA	Log	-1.17	-0.20	-0.3	0.968			0.96	1.9
TA	Log	0.60	-0.20	-0.3	0.875			0.58	0.8
NE	Log	-3.58	-0.20	-0.3	1.355			0.94	2.1
IN	Log	0.90	-0.20	-0.3	0.800			...	...
AS	Log	0.76	-0.20	-0.3	0.958			0.94	2.1
OA	Log	-1.15	-0.20		0.700			...	...

Note: A star (*) denotes a coefficient not significant at the 0.95 level.

3. Trade matrices and trade shares: the competition between exporters

The trade interaction between the eleven regional models is obtained through seven trade matrices. Regional models generate eight import figures by production sectors. Imports of services are merely totalled and the world total is distributed to exporting regions according to a given structure (pool system). Imports of goods, after conversion into the trade classification, provide margins for the seven trade matrices (one for each good basket). In any matrix, the 11 x 11 import shares generate export flows for each region. If shares were kept constant the model would be purely demand oriented, since exports growth would be entirely governed by the growth of the importing regions in each specific basket of goods. As was already noted, in this connexion, the growth of imports is a function of domestic policies governing protectionism, regional integration as well as of the output mix as determined by domestic policies (technology, income distribution).

Import prices (by basket of goods) are generated by export prices (and the transposed matrix of shares), which are determined by two factors: firstly, the price of domestic final demand and an exogenous price differential. The former is a cost-price generated by the I/O table from the prices of value-added by sector, which are themselves dependent on exogenous assumptions made on the shares of primary factors (capital, labour), and an inflation trend. The latter, i.e. the price differential, is meant to simulate a tension on demand or an oligopolistic policy[1/]. In the present version, such differential prices are different from zero only for agricultural goods, raw materials and energy. The model can, therefore, simulate exogenous changes in the world prices on the trade balance, the terms of trade, etc.

The competition between exporters (reflected by substitution between trade shares) introduces a crucial element in the determination of exports. As already stated two sub-models (the gravitational and the semi-aggregated models) were tested to make these shares endogenous, but the final decision was to use these models with caution outside the system, as a guidance to determine trade shares. Before examining these sub-models, it can be observed that in a simulation model like the UNITAD system, trade shares can be used to simulate trade policies, so that, irrespective of the merit

1/ The resulting income accrues to the Government, in the present version. It can easily be channelled to other agents (households, enterprises) by changing a vector of parameters.

of a sub-model, it seems legitimate to treat trade shares not as endogenous, but as policy parameters. Simulations will actually be carried out with trade shares fairly different from their trend values, in scenarios imposing various trade configurations, e.g. increased penetration of DG's on the market of DD's, or collective self-reliance policies.

The gravitational model is well-known in the economic literature 1/. Any bilateral flow for a specific commodity depends on three variables 2/:

(a) total imports (all origins) of the importing region;

(b) total exports of the exporting region;

(c) an "economic distance", estimated by the model, but which can be parametrized, which is influenced not only by transport conditions but by a host of institutional and sectoral characteristics.

The justification of the model lies both in the observation that the share of exporters depend on the competitiveness of the exporter (the theory of virtuous circle), the growth of the importing market and economic and institutional factors embodied in the economic distance. Admittedly, the model is fairly mechanical, in that it can generate exponential changes in partners shares while, in reality, adverse foces are bound to slow down and eventually limit the growth of the share of any exporter. Exogenous lower and upper limits have, therefore, been put on the shares generated by the model. Hence, it was felt preferable to leave it outside the system and to take "cum grano salis" the trends in manufacture shares derived from it. Tables 8 and 9 illustrate the shares which have been moved upward in the trend scenario, based on tendencies found in the gravitational model in a 1975-1990 projection.

1/ Similar models have been suggested by authors such as H. Theil, W. Leontief, J. Tinbergen. See also UN ECE Economic Bulletin Vol.24/2, "Trade Network Projections and international consistency tests", New York, 1973.

2/ The analytical expression of the model is as follows:

$$S_{ij} = \frac{a_{ij}\, x_i^{b_{ij}} M_j^{c_{ij}}}{\sum_i a_{ij}\, x_i^{b_{ij}} M_j^{c_{ij}}}$$

with S_{ij} = share of region i in imports of region j

X_i = total export of region i (all destinations)

M_j = total imports of region j (all origins)

The a_{ij}'s, b_{ij}'s, c_{ij}'s were estimated so as to minimize the sum of a weighted square of the differences between the observed and the calculated shares for the period 1963-75. The weights were taken as the inverse of the observed shares, so as to give more importance to small shares.

For $b_{ij} = c_{ij} = 1$, it can be seen that $x_{ij} = a_{ij}\, x_i\, M_j$, hence a_{ij} is equal to $\text{delta}_{ij} * 1/x_{..}$, with $x_{..}$ being total world trade. The model used in UNITAD is therefore based on a generalisation of delta coefficients.

Intra-regional shares (underlined in the table) are increasing for the following commodities:

Intermediary products : Western Europe, Tropical Africa;

Consumer non-durables : Western Europe, Latin America, Sub-Saharan Africa, Indian Sub-Continent;

Equipment & machinery : Latin America, Sub-Saharan Africa, West Asia and North Africa, Indian Sub-Continent;

Consumer durables : Eastern Europe, Latin America, Indian Sub-Continent.

This list does not coincide with that of increasing delta coefficients in table 1, but this is not surprising since the two indicators are not the same. It is,however, interesting to note that intra-regional shares for equipment and machinery are increasing in four developing regions but not in East Asia where the delta coefficient was found to decrease in the period 1963-1975.

The penetration of Japan into the other ten importing regions is increasing in five markets for intermediary products, two for non-durable foods, seven markets for equipment and machinery, and four market for consumer durables. The penetration is particularly high in North America (EQ), Western Europe (EQ), the"Other Developed"regions (IP, EQ, CD), Latin America (IP, EQ), West Asia and North Africa (IP, EQ), East and South-East Asia (ND, EQ), and CPE Asia (IP, EQ). East-Asian penetration is also noteworthy into North America (ND,EQ, CD), Japan (IP, ND), West Asia and North Africa (ND), Indian Sub-Continent (IP, ND), CPE Asia (ND).

These comments eloquently illustrate the capacity of the model to capture export-push effects in these two regions, especially in the case of equipment goods exports from Japan, and of consumer non-durable exports from East Asia.

The semi-aggregated model1/, which is also used as a guidance to project the exogenous shares, is based on an extension of the linear expenditure system used by R. Stone in projecting private consumption in his long-term growth model. The explanatory variables for any bilateral flows are the total imports of the importing countries and the prices (here the unit values). The original linear model has been modified so as to introduce a logistic curve for the share of each exporter (estimated by econometric methods). This model therefore has two advantages, i.e. to estimate the influence of prices in the competition between exporters, and to introduce the idea of a ceiling (an asymptotic share) for any share (see appendix 3 for the full specification).

It was hoped originally that the model could be used to illustrate what was called the "Tinbergen theory of diminishing elasticities" by B. Herman2/. Four decades ago, Tinbergen introduced the concept of elasticity competition, i.e the

1/ Acknowledgement should be addressed to Dr. J.J. Smolla, Department of Econometries from Geneva University, who designed and computed the model, and to Dr. B. Herman, Netherland Economic Institute, who kindly discussed the first results with the UNITAD team.

2/ See B. Herman "Market penetration: a formal analysis", mimeo - Netherland Economic Institute.

Table 8

INCREASING SHARES FOR MANUFACTURES IN THE TREND SCENARIO 1975-1990

(1) 1974 share and (2) 1990 shares in percentage points

Increasing Import shares in Developed markets*
(data derived from the gravitational model)

Basket of Goods	Importing Markets														
	North America Exporting Regions			Western Europe Exporting Regions			Eastern Europe Exporting Regions			Japan Exporting Regions			Other DD Exporting Regions		
		(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)
Intermediary Products (IP)	WE	30.0	36.0	WE	79.2	84.0	AS	0.3	3.0	NE	3.6	10.8	JP	19.8	25.7
	OA	0.1	1.0	EE	3.3	3.6				AS	14.7	23.5			
				JP	2.2	2.9									
Non-Durable Goods (ND)	OD	0.2	0.3	WE	81.2	85.3	NE	2.8	11.2	AS	37.4	56.1	NA	18.6	37.2
	LA	5.5	11.0	EE	3.1	4.0	IN	2.0	2.2				LA	1.0	10.0
	AS	23.2	30.2	IN	0.6	1.2	AS	0.3	3.0				IN	1.2	1.8
Equipment & machinery (EQ)	JP	13.9	27.8	JP	5.1	9.2	IN	0.1	0.8	WE	26.6	27.9	EE	0.2	0.3
	LA	1.0	5.0							EE	0.7	4.2	JP	15.2	38.0
	AS	3.4	8.5							OD	0.9	6.3	IN	0.1	0.6
										LA	1.1	11.0			
Consumer Durables (CD)	OD	2.2	4.4	JP	5.7	13.7	NA	0.9	1.4	OD	1.8	2.7	JP	18.9	37.8
	LA	3.4	9.5	LA	0.7	1.0	EE	16.1	32.2	LA	3.6	10.8	LA	0.3	2.4
	NE	0.1	0.3	AS	2.3	3.5	JP	2.4	7.2	TA	0.1	0.2	IN	0.4	1.6
	AS	10.1	18.0				LA	0.1	0.5	IN	1.1	3.3	AS	5.6	6.7
							NE	0.6	6.0	OA	2:6	7.8			
							IN	0.3	3.0						
							AS	0.1	0.6						

* See symbols for regions in Table 9. Note: intra-trade shares are underlined.

Table 9

Increasing Import shares in Developing markets (1) = 1974 (2) = 1990
(data derived from the gravitational model)

Basket of Goods	Importing Markets																	
	Latin America Exporting Regions			Tropical Africa Exporting Regions			West Asia and North Africa Exporting Regions			Indian Sub-Continent Exporting Regions			East and South East Asia Exporting Regions			Other Asia (CPE) Exporting Regions		
		(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)		(1)	(2)
Intermediary Products (IP)	JP	13.8	27.6	EE	2.3	4.6	EE	6.5	9.1	EE	33.3	38.3	OD	4.4	7.0	JP	45.8	57.3
				LA	1.1	7.7	JP	18.9	28.3	OD	1.9	3.0	LA	0.4	4.0	OD	1.4	4.2
				TA	8.7	12.2	OD	0.8	1.6	LA	0.8	1.4						
				OA	0.8	3.2	LA	0.2	0.4	NE	2.2	2.9						
										AS	3.8	9.5						
Non-Durable Goods (CD)	LA	22.2	44.4	LA	0.2	2.0	JP	8.4	9.2	OD	0.2	0.5	JP	16.3	29.3	EE	48.5	53.3
	OA	0.2	0.8	TA	3.2	5.8	LA	0.1	1.0	LA	0.1	1.0	OD	4.3	7.5	AS	4.1	12.4
				OA	4.4	13.2	TA	0.1	0.2	IN	7.4	16.3	LA	0.5	5.0			
							IN	1.6	4.0	AS	4.2	16.8						
							AS	6.3	12.6									
							OA	3.8	9.5									
Equipment & machinery (EQ)	JP	14.4	28.8	EE	1.3	5.2	EE	12.8	19.2	EE	25.3	50.0	NA	30.9	32.4	JP	25.7	48.8
	LA	6.1	11.0	LA	0.4	4.0	JP	7.3	14.6	LA	0.1	0.4	WE	0.7	2.1			
				TA	0.5	0.7	LA	0.2	1.8	NE	0.1	0.6	JP	33.6	38.6			
				OA	0.3	0.8	NE	1.3	3.9	IN	7.0	7.7	OD	2.2	4.1			
													LA	0.2	2.0			
													IN	0.3	1.8			
Consumer Durables (CD)	EE	28.5	34.2	OD	31.4	43.6	JP	15.8	23.7	IN	37.8	52.9	EE	2.4	7.2	EE	21.1	31.2
	JP	16.9	17.2	LA	0.2	2.0	LA	0.3	3.0	LA	0.1	1.0	OD	3.4	10.2			
	LA	7.5	13.5	NE	0.1	0.4							LA	0.2	1.6			
	IN	0.1	0.3															

Symbols for Regions:

NA = North America
WE = Western Europe
EE = CPE, Europe
JP = Japan
OD = Other Developed

LA = Latin America
TA = Tropical Africa
NE = West Asia and North Africa
IN = Indian Sub-Continent
AS = East and South East Asia
OA = CPE, Asia

Note: Intra-trade shares are underlined.

penetration (change in market share) which accompanies a one per cent reduction of relative prices. The law of diminishing elasticities as expressed by B.Herman predicts that "if a small supplier lowers his prices, he will attract not only new buyers, but also some of his competitors customers". But if the largest supplier "tends to monopoly, he may well enlarge the market but the share he holds will be less and less affected by price change". This was actually tested by Herman on 258 five digit commodities, in which diminishing elasticities were found for about two third.

Unfortunately, the tests conducted on the semi-aggregated model proved disappointing in several respects. Although the fit is generally good, allowance has to be made for two defects, i.e. the position of the asymptot has little to do with diminishing price elasticities, and more generally, at the level of aggregation of the UNITAD system, the model is relatively insensitive to price changes. It has however the merit of being relatively stable, as compared to the gravitational model, and it gives a first impression on price substitution. This can be illustrated by conducting two simulations of the semi-aggregated model. In the first, (S_1), 1990 prices offered by developed suppliers are twice their 1975 level, while the price offered by developing suppliers is kept constant at the 1975 level. In the second (S_2), the price changes are inverted for the groups, so that developed suppliers have a comparative advantage. The following table compares two past shares (1964 and 1974), the projected 1990 shares of the gravitational model and the two responses (S_1 and S_2) of semi-aggregated model:

Table 10 Export shares of developing regions in trend simulations (World=100)

Volume shares in per cent

Commodity Group	1964	1974	GRAV 1990	S_1 a/	S_2 b/
1. Agricultural products c/	36.8	31.5	26.3	32.2	28.3
2. Raw materials	28.3	32.2	24.3	40.9	27.7
3. Energy materials	60.6	65.5	75.8	65.4	67.3
4. Intermediary products	10.8	10.0	12.3	11.5	9.9
5. Non-durables	12.9	16.1	26.8	35.3	19.
6. Equipment goods	0.9	2.5	7.5	4.9	4.5
7. Durables	9.4	8.9	17.7	18.0	12.4
Totals c/					
Primary goods (1 to 3)	36.9	35.5	46.3	48.0	43.0
Manufactures (4 to 7)	6.8	7.3	12.5	13.3	9.0

a/ Comparative advantage to DC's
b/ Comparative advantage to DD's
c/ Also includes processed food

As can be seen from table 10 simulation S_1, in which DG's have a comparative advantage, yields figures above the gravitational model for agricultural products, raw materials, consumer non-durables and durables.

On the other hand, the volume shares are, even in the most favourable simulation, inferior to those of the gravitational model for energy materials, intermediary products and equipment goods, and are almost insensitive to prices, so that, if the volume share is kept constant, the current value share has a positive price elasticity close to 1. This might be plausible for energy materials and perhaps equipment goods but much less for intermediary products. All in all, the semi-aggregated model was used to generate (outside the model) exogenous shares for primary goods for the trend scenario, and their price elasticities could be used with caution in the system itself in a future version.

A last remark should be made on trade shares for primary goods. It stands to reason that supply considerations should be introduced in any projection for the long or very long-term future. Since no supply mechanism is built in the model for raw and energy materials, trade shares have to be exogenously manipulated, using factual supply information, again a justification for keeping shares exogenous.

The results of the introduction of the projected shares in the different scenarios are commented in part III. It may be sufficient to say that, when comparing the impact of 1974 and trend shares, the balance of goods and services, in current values, seriously deteriorates for North America and slightly for Western Europe, drastically improves for Japan, and moves upwards for Latin America, West Asia and North Africa, India and East Asia; the other regions are not very much affected.

Perhaps this study should end with a note of humility. The choices made in the UNITAD model, original as they may appear in some respect, are likely to be considered as crude by many readers, and leave room for some arbitrariness (such as the controls put to the outcome of the gravitational model). However, in mapping strategic choices for the long road to industrialization, a large-scale map showing the end goal is likely to be more useful than a detailed map for the first day of the journey, especially if there is no guarantee that the present itinerary does not lead to a deadlock.

APPENDIX 1
to
Trade Sub-System

Bibliographical references

Chenery, H.B. (1960) 'Patterns of Industrial Growth', American Economic Review, Vol 50, No. 4, September 1960.

Fels, G. (1972) 'The choice of Industry mix in the Division of Labour between Developed and Developing Countries', Weltwirtschaftliches Archiv; 108, 1972.

Herman, B. (1978) Market penetration: a formal analysis mimeo. Netherland Economic Institute.

Hirsch, S. (1975) 'The Product Cycle Model of International Trade - A multi-country cross-section analysis', Oxford Bulletin of Economics and Statistics, 37, (1975).

Keesing, D.S. (1968) Population and Industrial Development: Some evidence from trade patterns. Am.ECO. Review June 1968.

Kravis, I. and Lipsey, R. (1971) Price Competitiveness in World Trade: Studies in International Economic Relations, No. 6, National Bureau of Economic Research, New York, 1968.

Laird, S. (1981) 'Intra-Industry trade and the expansion, diversification and integration of the trade of the developing countries', Trade and Development, an UNCTAD Review.

Lary, Hal B. (1968) Imports of Manufactures from Less Developed Countries, National Bureau of Economic Research, New York, 1968.

Leontief, W. (1956) 'Factor proportions and the structure of American Trade; further theoretical and empirical analysis'. Review of Economics and Statistics 38, 1956.

Linder, S.B. (1961) An Essay on Trade and Transformation Almqvist and Wicksell, Stockholm, 1961.

Linnemann, H. (1966) An Economic Study of International Trade Flows, Amsterdam, 1966.

Helleiner, G. K. 'Structural Aspects of Third World Trade: some trends and some prospects', The Journal of Development Studies, April 1979.

Maizels, A. (1963) Industrial Growth and World Trade, Cambridge University Press, 1963.

Machlup, F. (1950) 'Elasticity pessimism in international trade', Economia internazionale.

Mistral, J. (1976) Croissances nationales, accumulation du capital et concurrence international mimeo - Ministère des Finances, Paris, 1976.

Ohlin, B. (1963) Interregional and International Trade, Harvard University Press, 1933.

Rayment P.B.W. (1979) 'Intra-Industry Specialization and the Foreign Trade of Industrial Countries', in Controlling Industrial Economies, Mac Millan, 1982.

Samuelson, P.A. (1948) 'International trade and the equalisation of factor prices', The Economic Journal, 58, 1948.

Smith, Adam (1970) — The Wealth of Nations, Penguin Books, 1970.

Tinbergen, J. (1941) — "Unstable and Indifferent Equilibria in Economic Systems" ISI Review - 1941.

Tuong, H.D. and Yeats, A.J. (1980) — On Factor proportions as a guide to the Future Composition of Developing Country Exports, Journal of Development Economics, Vol. 7.

UNCTAD, (1978a) — The role of transnational corporations in the marketing and distribution of exports and imports of developing countries (TD/B/C.2/197) Geneva, March 1978.

UNCTAD, (1978b) — Recent trends and development in trade in manufactures and semi-manufactures of developing countries and territories: 1977 Review, Geneva. (TD/B/C.2/190), March 1978.

UNCTAD, (1978c) — Growing protectionism and the standstill on trade barriers against imports from Developing Countries, (TD/B/C.2/194), Geneva, March 1978.

UNCTAD, (1981) — Marketing and distribution arrangements in respect of export and import transactions: structure of international trading channels (UNCTAD/ST/MD/25).

UNECE, (1973) — "Trade network Projections and international consistency tests" in ECE Economic Bulletin Vol. 24/2, 1973.

Vernon, R. (1970) — The technology factor in International Trade, NBER, New York, 1970.

Tariff and Non-Tariff Protection: Dummy Variable DUT and Population figures used in the regressions

I. For Developed Countries

Definition of DUT Variable

Tariff level	Non-Tariff Protection: No barrier	Licensing	Prohibition
≤ 5 %	1	2	5
5 to 15 %	2	3	5
> 15 %	3	4	5

(Figures indicate the magnitude of DUT Variable)

	Countries	AC	RM	EN	IP	ND	EQ	CD	Pop x 10^{-6} 1974-75
NA	United States	2	1	1	2	4	2	2	211.1
	Canada	3	1	1	2	4	2	3	22.3
WE	Cyprus	4	1	1	2	3	3	3	0.7
	Denmark	3	1	1	3	3	3	2	5.0
	F.R. Germany	3	1	1	3	3	3	2	61.5
	Finland	3	1	1	3	3	3	2	4.7
	Greece	3	1	1	3	3	3	2	8.9
	Israel	3	1	1	3	3	3	2	3.3
	Norway	3	1	1	3	3	3	2	4.0
	Portugal	3	1	1	3	3	3	2	8.7
	Spain	3	1	1	3	3	3	2	34.9
	Sweden	2	1	1	3	3	1	2	8.2
	Turkey	3	1	1	3	3	3	2	38.4
	United Kingdom	3	1	1	3	3	3	2	56.1
JP	Japan	4	1	1	2	3	3	4	108.7
OD	Australia	3	1	1	3	4	3	4	13.3
	South Africa	3	1	2	3	4	3	4	23.7

(Level of DUT Variable: AC to CD; Import categories across, Countries down)

AC: Agricultural Products
RM: Raw Materials
EN: Energy Materials
IP: Intermediary Products
ND: Consumer Non-Durables
EQ: Equipment Goods
CD: Consumer Durables

(For precise definitions in terms of SITC, see Annex 2)

Tariff and Non-Tariff Protection: Dummy Variable DUT and Population figures used in the regressions

II. For Developing Countries

Definition of DUT Variable

Tariff level	Non-Tariff Protection		
	No barrier	Licensing	Prohibition
≤ 25 %	1	2	5
25 to 75%	2	3	5
> 75 %	3	4	5

(Figures indicate the magnitude of DUT Variable)

Countries \ Import categories		Level of DUT Variable: AG	RM	EN	IP	NP	EQ	CD	Pop x 10^{-6} 1974-75
LA	Bolivia	2	2	2	2	2	2	3	5.2
	Brazil	3	3	2	3	4	3	3	105.2
	Columbia	3	2	2	3	3	3	3	24.7
	Ecuador	4	2	2	3	3	2	4	6.8
	Guatemala	3	2	2	3	3	3	3	58.7
	Panama	1	1	1	1	1	1	1	1.6
	Peru	4	4	4	4	4	4	4	14.7
	Venezuela	4	2	3	4	3	2	3	11.7
TA	Ethiopia	4	3	3	3	3	3	3	27.0
	Ghana	3	3	3	3	4	3	3	9.5
	Mozambique	4	3	3	3	3	3	3	8.9
	Nigeria	3	3	2	3	3	3	3	60.4
	Egypt	3	2	2	3	4	3	3	36.2
	Iraq	2	2	2	2	2	2	2	10.5
	Tunisia	3	2	2	2	2	2	3	5.5
ASIA	India	5	4	3	4	5	4	5	591.0
	Pakistan	5	3	3	5	5	4	5	67.3
	Korea	3	2	2	5	4	2	3	33.7
	Hong Kong	2	2	2	2	2	2	2	4.1
	Indonesia	3	2	2	3	3	3	4	130.8
	Philippines	3	2	2	3	3	3	4	42.3
	Singapore	3	2	2	3	3	3	4	2.2

Countries:
LA: Latin America
TA: Tropical and North Africa, with Irak
ASIA: South and East Asia

Import Categories: See definitions preceding page and Annex 2.

APPENDIX 3

to

Trade Sub-System

The Semi - Aggregated Trade Model

Let

- $W_i = m_i \sum_i m_i = m_i/M$ (current prices)

denote the share of exporter i in market j, time t (no subscripts j or t are needed here), with m and M both expressed in current prices.

- p_i, the export price of country i in market j.

- $A = \sum_i a_i \; p_i$ is a price index, with $\sum_i a_i = 1$, the a_i's can be interpreted as a vector of hypothetical shares estimated by the model.

- b_i, another set of hypothetical shares with $\sum_i b_i = 1$

The model reads:

(1) $$w_i = \frac{a_i \; p_i}{A} S + b_i (1-S)$$

With S, a parameter estimated by the model which varies between 0 and 1. Two specifications were actually tested:

(i) $S_1 = 1-e^{\frac{-M/A}{\nu}}$ and (ii) $S_2 = e^{\frac{-\mu}{M/A}}$; with μ , ν as two parameters estimated by the model.

In both cases:

$$\lim_{M \to \infty} S(M) = 1 \quad \lim_{M \to 0} S(M) = 0$$

It can be seen that, if S is inserted in equation (1), the current price share will change

from b_i when M = 0 to $\frac{a_i \; p_i}{A}$ when $\frac{M}{A} \to \infty$

In other words, the model introduces the a_i's as asymptotic shares for a given price system p_i's.

B. The technology sub-system

Technology, in the broad sense, is mainly embodied in two parts of the model, i.e.:

- the eight by eight input-output matrices of the different regions;
- the productivity functions of twelve sectors.

1. The input coefficients

Over the past twenty-five years considerable research has been conducted concerning the time behaviour of input coefficients (or technical coefficients). The following conclusions seem to be generally agreed upon:

- In the advanced industrialized countries, with a very complete technological structure, changes in technical coefficients at a high aggregation level take place very slowly. Several authors like A. Carter in the United States and Tilanus in the Netherlands have widely demonstrated that over a five to ten year period changes of the coefficients are small and do not affect very substantially the relation between final demand and output. If one is interested in the relative accuracy of the output response to final demand, it is relevant to refer to the research work of Koopmans and others using the I/O model and activities analysis, with different aggregation levels. The conclusion is that for long term models the use of more aggregated tables may be recommended as they will have a higher degree of inertia without losing much precision at the output level. One implication is that, at a higher level of aggregation, technical coefficients should be interpreted, not as reflecting a "technology" (as in the Leontief original terminology) but as technology mixes influenced by the output mix within each broad sector. The inertia of these coefficients, over a period of ten years, is therefore related to the slow changes in output mixes as well as to the slow diffusion of new technologies.

- This, it is clear, may not apply to developing countries where the output mix can undergo drastic changes in a period of five to ten years. Furthermore, if the analysis is intended over a period of ten years or more, both in industrializing and in advanced industrialized countries, there is a possibility if not a likelihood, of important changes in the input structure induced by the continuous erosion of techniques due to technical progress and/or to a change of relative prices (thus a substitution process in the input structure).

(i) Input coefficients, developed regions

In the UNITAD Project, no sophisticated attempt was made so far to project the input structure of the five developed regions. This can be justified by the preceding arguments: any serious inquiry on new technologies, using the ex-ante method based on information from enterprises, is costly, as compared to the fact that, with a few changes, highly aggregated (8 sectors) tables can be used for a 1990 projection. However, available tables all reflect technologies and output-mixes of the pre-oil crisis period and this deserves some attention. Information was therefore requested from consultants 1/ on changes which could be observed in developed market economies of Europe and North America, especially the United States where long time series of detailed input structures are available 2/.

The main results of this analysis for developed countries can be summarized as follows:

(a) In the agricultural sector, the sum of energy inputs remains fairly constant in spite of a slow substitution between electricity and oil products. The input of fertilizers seems fairly stable in physical terms (but not in value terms) in Europe, and is fastly increasing in the USA. Inputs of processed food or feed are slowly increasing in both regions, as well as inputs of services. The most spectacular change remains the well-known trend towards more intermediary inputs and a lower contribution from primary inputs (labour and capital). The value added coefficient is decreasing in both regions by approximately ten per cent over a fifteen-year period. All these changes were

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1/ Acknowledgements are due to Prof. E. Fontela (Geneva University) and Dr. J. Skolka (Vienna) for the main findings in paragraphs 35 to 37.

2/ Tables were available for years 1947, 1958, 1963 and 1967 for the USA, for 1959, 1965, 1970 to 1978 for France, and for 1959 and 1970 for a number of European countries.

therefore taken into account when projecting coefficients from 1975 to 1990.

(b) In the agro-food processing sector of two European countries, petroleum inputs are declining since 1973-74 most probably on account of energy savings measures, with little indication of a substitution process with other energy inputs. The energy input is therefore declining, other inputs are stable. The major features in the USA are a remarkable stability of the more important coefficients (agriculture, agro-food, services and value-added), with a slight increase of basic products at the expense of agricultural inputs.

(c) In the energy sector, a rapid substitution is taking place from petroleum to coal, and primary sources (nuclear plants), but, interestingly, these internal changes within the sector have had so far a small impact on coefficients at the 8 sector aggregation level. Since, however, major changes are expected in the mix of energy sub-sectors, a projected vector of input coefficients for 1990 was computed on the basis of the expected mix of sub-sectors in 1990, on the assumption that technologies of sub-sectors would remain stable over time at that aggregation level.

(d) As to the basic product sector, the overall energy coefficient seems hardly affected by the observed decrease of coal and petroleum and the increase of electricity and gas. This would mean a substantial increase of the energy coefficients in value term, (since the real term value of this coefficient amounts to 7-8 per cent, i.e. a high proportion of total cost). In the final version, a small decline of the energy input coefficient was however included in all developed countries, to make room for the slow renewal of investment in the sector over the 1980's. Other trends seem to differ in the USA and in Europe: in the former country, the diagonal coefficient decreases and the services input increases, while in Western Europe, the intra-industry input coefficient increases at the expense of the services and value-added coefficients.

(e) In the light industry sector, the small energy coefficient (below 2 per cent) is continously declining since 1974 in all sub-sectors, thus suggesting that the energy crisis has induced serious efforts of energy saving. By comparison, one may wonder why this was not as spectacular for the heavy industry (basic products) as for light industry. The answer may be that (i) energy savings were continuously under review in the former sector pre- and post-energy crisis, while it was neglected in the light industry sector before the crisis and (ii) the output-mix and the technology of heavy industry can only move slowly due to the magnitude of the investments required.

(f) Hardly any change attributable to the energy crisis can be observed at the 8 sector level for the remaining sectors: capital goods, construction and services. A slight decline of the energy input was however introduced as in the basic products sector. Technological trends initiated before the crisis proceed without change (in particular the trend towards automation, the increased importance of repairs and the intra-consumption of the services sector).

The conclusion for developed countries seems therefore confirmed: at the highly aggregated level of the UNITAD tables, except for energy inputs, few changes are needed to make the 1970 tables valid for 1990, at least in a trend scenario. The changes in energy inputs have been introduced on the basis of a IIASA study which provided an overall check for the overall sum of these inputs 1/.

(ii) Input coefficients, developing regions

In contrast, an unprecedented attempt was made in the UNITAD project, in close co-operation with UNIDO, to bring some light in the controversial issue of the projection of input-output matrices in the process of industrialization of developing countries. The most common assumption found in large models of this type is that the technology and output-mix embodied in input coefficients are comparable across countries and can be related to macroeconomic variables through multiple regression analysis. On the strength of UNIDO's extensive collection of input-output tables, this track was thoroughly investigated for a sample of 30 countries, using the following explanatory variables:

(a) the level of economic development measured by per capita gross domestic product;

(b) the size of country measured by the size of population;

(c) population density, measured by number of inhabitants per square kilometer.

1/ IIASA "Energy in a Finite World: A Global System Analysis", 1981 Ballinger, Cambridge (USA). See analysis of the IDS scenarios.

The result, however, was negative[1]. In an attempt to check the influence of the quality of original data on these results, the analysis was repeated with 34 selected country tables but the overall negative conclusion stood.

Another approach was also explored, i.e. taking as explanatory variables of the regressions, the shares of industries (at the 24 sector level), in the sectoral input of each aggregate sector (at the 8 sector level). The idea was to check whether industrial specialization (at the 24 sector level) was responsible for the spread of technical coefficients at the 8 sector level. Some impact of output mix was actually found in 40 (out of 64) input coefficients, but with a poor explanatory power of most equations (R^2 between 20 and 30 per cent). On the basis of such meagre results, the question was therefore whether the model builders should ignore the unexplained part of the variance, i.e. 70-80 per cent, thus treating it as a noise (like in many former global models) - or whether missing factors, to be identified, accounted for this large part of the variance.

A major step forward, in this connection, was achieved by using a graphical display of the data - the main component analysis - sector by sector[2]. The interesting result was that some 80 to 90 per cent of the variance of the input coefficients for a sample of 42 countries could be identified in the graphs. The first visual inspection confirmed the suspicion that input coefficients are influenced by other factors than the economic variables selected in the regression analysis. Specifically, in most diagrams, one could detect clusterings of countries by regional affinities - as opposed to GNP per capita - and, within such clusterings, an influence of economic variables. In the best cases (energy, light industry, capital goods industry) the analysis was able to interpret the diagram in terms of output-mix, thus suggesting the interesting assumption that technology patterns in individual industries would tend

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1/ Regression equations with an R^2 as low as (or higher than) 30 per cent were only found for 11 out of 64 independent coefficients.

2/ The analysis consisted in computing the 8 eigen vectors of the correlation matrix of the input coefficients of each sector; each eigen value corresponds to the share of the variance explained by the eigen vector. It was found that 80 or 90 per cent of the variance was spread on two, sometimes three eigen vectors out of eight. The graphs were obtained by taking pairs of eigen vectors as axes.

to be similar within regions[1]. In other cases, the influence of the tax system or simply statistical "artefacts" (such as biased coefficients[2]) were brought up by the analysis.

Some methodological conclusions follow:

(a) Input coefficients were found to differ widely, by country, for the same sector, depending on regional similarities[1] or output-mix so that any "deterministic" method to project the matrix of input coefficients should be prohibited. Instead, soft modelling techniques such as the main component analysis, should be used.

(b) The level of aggregation has a strong influence on the whole issue. The negative aspect is that, at the 8 sector level, the influence of the output-mix is blurred in many sectors. The advantage, though, is that some rough projection can be made for the decade 1990 to 2000 or a more distant future, with adequate changes reflecting output-mix. This justifies the level of aggregation of 8 sectors for a long-term model and conversely points to the considerable uncertainty introduced by a detailed input-output table.

In practice, technologies embedded in the technical coefficients of developing countries should be projected to reflect policy decisions taken by national decision-makers (enterprises and government) and also factors governing the international division of labour.

In general, however, failing information on such factors, the matrix of input coefficients for industrial sectors was endogenously determined to simulate a move towards "modern" technologies borrowed from industrialized countries, while keeping some of the specific regional features found in the base year table. To do this, the 1990 table of each region, for each manufacturing sector, was computed as a weighted average of the base year "technology" and the "technology" of a specific industrialized country selected on the basis of the two countries' position in the main component analysis. The weighting coefficient was made a function of the ratio of the capital/labour coefficients of the sector in the two countries.

1/ The reasons for regional similarities are yet to be explored. One may think of the size distribution of enterprises and all "traditional" features of small scale industries. In other cases, the modern sector is similar, due to same factor proportions, demand mix, output mix, etc.

2/ There is a strong suspicion that many such biasses were introduced by a blind RAS treatment.

In the energy sector, the 1990 vector was computed on the basis of the expected mix of sub-sectors, as was done in developed countries.

In agriculture, construction and services, an ad-hoc treatment was adopted, making the technology in agriculture fully endogenous according to the value of parameters in the productivity equations and, for the other two sectors, using empirical cross-country comparisons within each region. In this way, care was taken not to destroy the strong specific regional characteristics observed in the main component analysis[1/].

2. The productivity functions

Productivity functions, relating investment demand and employment requirements to output, were obtained by multiple cross-country regression analysis. The dependent variable is productivity (gross value added at constant prices per worker) and the exogenous explanatory variables: capital per worker, value added coefficient (ratio of value added to gross output), average size of plant, size of market. Before presenting the results, a few words should be said on sources and problems.

The main source of data[2/] was the United Nations Yearbook of industrial statistics (YIS) based on annual surveys conducted in countries at the enterprise level. Information coming from reporting enterprises for 40 ISIC three digit sectors, included: production (groos-output and value added), employment, compensation of employees, gross fixed capital formation by utilizing sector and size of establishment. These data were processed for a sample of thirty three countries for the years 1967-76, and some

1/ This analysis summarizes and updates a number of internal papers, to be consolidated in further publications:

- The UNIDO contributions on technology characteristics on regional models in the UNITAD Project (Y. Cho and J. Royer), June 1980, submitted to the ACC technical working group.
- Trend projections of input coefficients for the UNITAD Regional Tables (G. Margreiter and J. Skolka), June 1980.
- The main component analysis (B. Dissmann, A. Duval, J. Royer and M. Weisser), July 1980.
- Construction of the base year matrices for the regions of the UNITAD Project (V. Gregor, C. Margreiter, M. Mauler, M. Oeltl and L.N. Rastogi), June 1980.

2/ The only partial exception refers to socialist countries were national data on capital stock and other variables were used.

55 indicators derived from original data were computed for each of the 40 sectors, by country[1]. Two limitations of the data should be mentioned, beyond their unknown degree of reliability; firstly, the scope of the surveys, in each country, refers to a minimum size of establishments varying from 5 to 20 workers. Depending on the cut-off point, information on small scale plants is missing, thus introducing a bias which can be measured, for example, on employment figures for the manufacturing sector. The following table gives an idea of the magnitude of the bias in six of the UNITAD regions:

Table 1

Employment (million workers) in Manufacturing, 1975

Region	ILO[2] source	YIS source	Ratio YIS/ILO
North America	20.326	18.993	0.94
Western Europe	42.472	36.275	0.85
Japan	13.460	11.337	0.84
Other Developed	2.802	2.797	0.99
Latin America	11.960	10.530	0.88
East Asia	8.480	6.303	0.74

The YIS source, weak as it may be for the six regions of the table (employment bias between 1 and 26 per cent) appears to be the almost unique source for Africa and West Asia. Employment for the base year had therefore to be guessed for these regions, by cutting down the YIS productivity by a more or less arbitrary figure. For the Indian Sub-Continent, the situation is reversed, the YIS data were not acceptable and the ILO employment figure was taken as a basis. All in all, the production functions derived from the YIS source were adjusted to take account of the cut-off bias by a multiplier within the range of the ratio quoted in the table. The underlying assumption is that the bias affects the level, not the growth of productivity, which may be a strong assumption.

1/ Altogether, this required the manipulation of more than 70.000 data. See internal note "An analysis of technology indicators", October 1979, by J. Requena and J. Royer.

2/ ILO source is based on Employment and Industrial surveys. ILO publication also uses YIS estimates but such figures were not retained for the above comparison.

The second limitation of the YIS source is the absence of data on capital stock. Following several authors, an attempt was made to compute a proxy for this variable. Electricity consumption per unit of output was tested and rejected and instead, the sum of gross capital formation for five years (normalized for ten years) was retained 1/. A simple model 2/, making assumptions on the life of equipment in each sector, yielded estimates of the capital stock, on the basis of the above proxy. Comparisons with two countries, North America and Corea, showed that both this proxy and the sum of gross investment for ten years were reasonably correlated with the capital stock derived from national sources (rank correlation 0.99 among sectors). Two alternatives were therefore available in the model, as proxies for capital per worker (K/L), i.e. CAPLE (gross investment over ten years per worker) and PKL (capital stock per worker estimate derived from the former). In spite of theoretical advantages of PKL, CAPLE was retained for the sake of simplicity, pending further studies on the complex link between PKL and the "true" capital stock per worker. One additional remark should be made: there is no proportionality between CAPLE and the true "K/L" especially where comparing developed and developing countries; in fact, for countries with very high rates of manufacturing growth during the observation period, like Corea, more capital was accumulated during the decade 1967-76 than during any preceding period, so that CAPLE is not far from K/L. This does not hold true for developed countries, where gross investment includes a high replacement component.

The general form of the productivity function is:

$$LP = f(Caple, Ivy, Tle, Du, t)$$

where LP stands for the value-added per worker

Caple = for a capital labour indicator (see text)

Ivy = for the value added coefficient (ratio value-added to gross output)

Tle = for the average size of plants (workers per plant)

Du = for a variable on market size (see text)

t = for time

Du, is a decreasing function of total GNP, meant to measure the influence of total market size (admittedly the domestic market only)

1/ See in particular ECE study on "Structure and change in the Manufacturing sector".

2/ Writing $I_t = (r + \lambda)\ k_{t-1}$, where I_t stands for gross investment for year t, r the exponential rate of growth of capital stock per annum, λ the replacement rate, and K_{t-1} the capital stock at the end of year t-1.

since its value was calibrated according to GNP in 1970 prices, so as to divide countries basically into four groups: North America (Du=-1), other DD's (Du=0), large DG's (Du=1), i.e., GNP higher than 1970 US$ 7.5 billion, small DG's (Du=2), GNP lower than 1970 US$ 7.5 billion. However, the definition of Du varies with the sector (see detailed analysis). A better indicator should be found in sectors where this variable happens to explain a large share of productivity. This will be attempted in the future.

The multiple cross-country analysis is summarized below for each sector separately. The variables have been entered in double logarithmic (Ln) form, except Du and t, so that the relation between productivity (LP) and capital-labour ratio (Caple) is comparable to a Cobb-Douglas function. However, the coefficient of Caple is likely to differ from that obtained with a direct estimate of the capital stock, since there is no proportionality between Caple and K/L. It should also be noted that the coefficient of the average plant size (Tle) introduces a further influence of labour, i.e., with a positive sign it denotes economies of scale, and with a negative sign dis-economies of scale, with the special meaning given here to scale (manpower).

(i) Agro-food processing industries

A general remark is that good estimates emerged from the analysis for developed countries separately (DD's) and for the whole sample of developing and developed countries (DG's) but not for developing countries alone (DG's). The explanation which suggests itself for the latter finding is that this sector includes a number of traditional industries which differ widely, in developing countries, from country to country. Two samples of countries were therefore tested, with or without the non-conformist developing countries. The results are shown in table 2:

Table 2: 1967-1976 Productivity functions, agro-food processing industries

Sample	DU	Ln Caple	Ln Ivy	Ln Tle	Constant	R^2	DF
(1) DD	-0.26 (-3.9)	0.54 (3.9)	0.93 (2.6)	...	5.27 (3.9)	0.83	18
(2) DD + DG (complete*)	-0.22 (-5.8)	0.41 (5.3)	...	0.25 (4.5)	4.35 (5.4)	0.77	38
(3) DD + DG (selected DG's*)	-0.25 (-6.5)	0.65 (7.1)	0.78 (4.1)	...	4.02 (4.8)	0.84	28

* See text. Note: Student-t variables are shown in parentheses.

In equation (1), variable Du is taken as -1.5 for North-American countries, and 0 for other developed countries, except Spain (1) and Greece (2). It is partially correlated with Caple (r=-0.5) but it appears significant in the equation (t=-3.9), which seems to justify its inclusion. It may be taken as illustrating the strong influence of the North-American market size in explaining productivity.

Variable ivy, in this equation, is more difficult to justify. The straightforward explanation (it can be written as the complement to 1. of the proportion of material inputs in gross output) seems to stand, i.e. that the larger the proportion of material inputs, for a given capital intensive coefficient, the lower the productivity. Two remarks should however be added. The first is that a number of modern food processing industries have both a highly capital intensive technology and a high proportion of material inputs. The fact that variable ivy is significant is therefore an evidence of the composite character of the industry, as is well known, and of the difference in output-mix among sub-sectors from country to country. Spurious correlation between the productivity and the value-added coefficient cannot, however, be discarded since the two variables have some direct correlation (0.6).

The average trends of the exogenous variables in the sample have been analysed, with the following results: no increase was found for the value-added coefficient, while variable caple increases exponentially.

Equation (2), covering the whole sample DD + DG's is interesting since a good correlation ($R^2 = 0.77$) is obtained if the manpower size of enterprises is added to caple as an explanatory variable. Variable DU was taken as -1.5 and 0 for DD's, 1 and 2 for DG's according to size of GNP. Its coefficient is highly significant. That of caple is smaller than in the other equations, while that of plant size is highly significant. This equation could therefore be used to illustrate the impact of employment of a deliberate policy of small scale industries in rural areas, such as that followed by some governments, since plant size has a negative employment effect.

Equation (3), in contrast, illustrates the technology of "modern" agro-food processing industries. The sample of developing countries has been restricted to a selection of countries with a capital intensive coefficient above a given level. The coefficients, it will be noted, are very close to that found for developed countries alone, but are more significant (variables t higher). R^2 is slightly higher (84%), in spite of the inclusion of 10 more observations from developing countries.

(ii) Oil extraction, coal extraction, other mining

Equations for the three sector are of the same type and refer to developed and developing countries (DD + DG's). However, no variable DU was included for oil extraction, while for coal and other mining, DU only takes two values, -1 for North America and 0 for all other countries. Moreover two specifications are available for "other mining". Results are given in table 3:

Table 3: Oil extraction, coal extraction, and other mining. Productivity equations

Sample	DU	ln CAPLE	ln Ivy	LnTle	Constant	R^2	DF
(1) Oil DD + DG	...	0.59 (...)	...	...	1.2 (...)	0.74	10
(2) Coal DD + DG	-1.29 (-3.9)	0.55 (5.4)	...	...	3.04 (3.3)	0.83	15
(3) Other Mining DD + DG	-1.38 (-3.7)	0.65 (6.6)	1.26 (3.7)	...	3.03 (3.4)	0.77	16
(4) " "	-1.11 (-2.6)	0.50 (3.9)	...	-0.36 (-2.7)	5.43 (3.7)	0.71	16

Note: Student-t variables are shown between parentheses.

A stricking feature is that, in spite of the fact that these equations were derived from small country samples (especially oil extraction), with a different country-mix, the capital-labour coefficient (caple) lies in a relatively narrow bracket (0.55 - 0.65), except in the last equation where manpower size of enterprise is entered.

The inclusion of the value-added coefficient (ivy) in equation (3) is fully justified here, since spurious correlation seems excluded (direct correlation with productivity is 0.4). This variable, on the other hand, is correlated (-0.7) with manpower size, hence the negative coefficient of variable Tle in equation (4). In practice, however, equation (3) will be used since it is difficult to predict the behaviour of manpower size in the mining sector. This correlation conveys a straightforward interpretation of the influence of the value-added coefficient.

The values of the exogenous variables in the future are computed in different ways:

For oil, an assumption is made on the future mix of inland and off-shore oil deposits in each region, and the value for caple is taken as weighted average of the two categories.

For coal, an exponential trend was found for caple, with an exponent higher than 1.

For other mining, exponential trends are also used for projecting caple and ivy, with a high exponent for the former and a low one for the latter. There seems to be a strong trend towards an increase of the value-added coefficient in the future, but any evidence from external sources could also be used instead.

(iii) Utilities

The DU variable for this sector was taken somewhat arbitrarily as ranging from -1 (North America) to 0 (all developed countries), 2 (all developing countries except India) and 4 (India). Interestingly, this cast appears to give a good correlation between DU and caple (-0.8). Thus, two equations were tested, with and without DU (see table 4).

Table 4: Productivity functions for utilities

Sample	DU	Ln CAPLE	Ln ivy	Constant	R^2	DF
(1) DD + DG	-0.32 (-4)	0.60 (5)	1.60 (4.7)	3.76 (3)	0.89	24
(2) DD + DG	...	0.94 (46)	1.91 (5)	0	0.82	26

Note: Student-t variables are shown in parentheses.

The correlation between DU and Caple results in lowering strongly the coefficient of Caple when the two variables are taken (equation 1). The high coefficient found in the second equation (0.94) can usefully be compared with the 0.55 - 0.65 range found for mining. The value-added variable (ivy) has almost no direct correlation with productivity so that spurious correlation is excluded. Once more, the variable is found to be significant in a sector with a very diverse mix of sub-sectors, ranging from thermic power plants (coal, oil) to non-thermic plants (hydro-electric, nuclear). There is some correlation between the two explanatory variables ivy and Caple (-0.6) but they appear to be both significant in the equations.

An interesting feature is that a good correlation seems to exist between the value of caple and the ratio of non-thermic to total energy production by contry. This therefore offers a means of making projections of this variable, deriving the future mix of non-thermic and thermic plants from national energy plans (as already known for 1990).

As to variable ivy, there is a slight increasing trend in developed countries, but no satisfactory solution was found how to project it for developing regions, except for a slightly increasing trend. Fortunately, the share of this explanatory variable in the productivity is small, as compared to that of caple.

(iv) Oil refineries

Variable DU was taken as -1 for North America, 0 for other developed countries and 1 for all developing countries. This variable happens to be well correlated with caple (-0.75): refineries are less capital intensive in developing than in developed countries.

Another finding is that the coefficient of the time variable (0.20) is significant: there is therefore a term for neutral technical progress in the equation (see table 5).

Table 5: Productivity function for oil refineries

Sample	DU	Ln Caple	Time	Constant	R^2	DF
Refineries	-0.40 (-5.3)	0.25 (3.9)	0.20 (2.7)	6.75 (9)	0.91	14

Note: Student-t variables are shown in parentheses.

To note the high value of the constant, which explains a large part of the productivity. This is reassuring since there can hardly be low productivity technologies in this sector.

(v) Primary processing of basic products

This sector includes all steel and metal processing industries, chemical industries and building material industries. They were regrouped according to their highly capital intensive characteristics in developed countries, an assumption which is therefore put to a test in these equations.

Two equations, denoted (1) for developed countries (DD's), and (2) for all countries (DD + DG's) were obtained with caple and ivy as explanatory variables, with good R^2 (0.72 and 0.74 respectively). The coefficients of caple are similar (0.66 and 0.69 respectively). The value-added coefficient has a low direct correlation with productivity (0.4). There is no spurious correlation, but the influence of the proportion of material inputs on productivity reflects the composite character of the sector, as in the case of the food-processing industry.

An interesting feature is that the time coefficient is significant in equation (1) for developed countries, where no time trend was found for exogenous variable caple. The opposite holds true for equation (2), when taking up developing countries; here, caple is found to increase both with market size and with time:

$$\ln \text{Caple}_2 = \underset{(2.5)}{-0.89}\ \text{DU} + \underset{(15)}{1.22} \ln \text{Caple}_1 \qquad R^2 = 0.59$$

where Caple_2 and caple_1 stand for two consecutive five-year periods and DU takes the value -1 (North America), 0 (DD's), 1 (large DG's), and 2 (small DG's).

On the other hand, time is not significant for that equation, which points to a larger influence of embodied technical progress than of neutral technical progress, in developing countries.

Equation (3), for DD + DG's, shows a positive influence of plant size (variable Tle) on productivity (economies of scale).

Equation (4), again for the whole sample, includes variable DU, as defined for equation (2). There is a good correlation between market size and capital intensiveness, so that the coefficient of caple, in this equation, is much lower than in the preceding equation. Interestingly, a time trend appears significant when adding up variable DU, which is compatible with the preceding findings. R^2 is very high (0.86).

For trend projection purposes, it can be noted that in developing countries, variables ivy and Tle have a high exponential trend, while this is only observed for variable ivy in developed countries.

Table 6: Productivity functions for primary processing of basic products

Sample	DU	Ln Caple	Ln ivy	Ln Tle	t	Constant	R^2	DF
(1) DD only	...	0.66 (4.9)	1.54 (4.9)	...	0.19 (2.1)	3.6 (2.6)	0.72	14
(2) DD + DG	...	0.68 (8.9)	0.97 (4.6)	...	-	3.36 (4.5)	0.74	33
(3) DD + DG	...	0.63 (8.3)	0.85 (4.2)	0.24 (2.2)	-	2.7 (3.6)	0.76	32
(4) DD + DG	0.27 (-5.3)	0.28 (3.1)	0.65 (4.0)	...	0.16 (2.4)	6.65 (7.8)	0.86	31

Note: Student-t variables are shown in parentheses.

To sum up, a number of noteworthy findings emerge from this analysis: the role of technical progress, the capital intensiveness of the sector and its composite character, and finally the economies of scale.

(v.) Light industry

No fully satisfactory relations were obtained for that sector. The excellent R^2 found for developing countries (0.88 - 0.90) and for the whole sample (0.91) are suspicious, since the value-added coefficient (variable ivy) appears to have a high direct correlation (0.8 - 0.9) with the dependent variable, productivity. Spurious correlation is therefore possible. This suspicion is strengthened by two facts, i.e. for developed countries alone, where the direct correlation is weaker (0.6), coefficient R^2 goes down to 0.44; again, one can see that the Student-t variable for variably ivy is higher than for any other variable (see table 2.7).

As can be expected large plants in terms of manpower have a lower productivity than small plants (the same was found in the mining sector).

The trends observed for the exogenous variables are worth being noted: high exponential trends for caple, found both in developed and developing countries,are the only common feature. Instead, manpower size of enterprises are growing exponentially in developing countries but are constant in developed countries. The value added coefficient, likewise, is increasing in developing countries, while found highly variable, with almost no trend, in developed countries.

Table 7: Productivity functions for light industries

Sample	DU	Ln Caple	Ln ivy	Ln Tle	Constant	R^2	DF
(1) DD	...	0.42 (2.1)	2.31 (2.6)	...	6.97 (3.5)	0.44	15
(2) DG	...	0.49 (3.8)	1.26 (9.1)	...	5.06 (4.6)	0.88	19
(3) DG	-0.24 (-2.1)	0.54 (4.9)	1.19 (10.6)	-0.24 (-2.7)	5.9 (6)	0.92	17
(4) DD + DG	-0.26 (-5.1)	0.54 (10.0)	1.21 (5.6)	...	5.0 (5.8)	0.91	36

Note: Student-t variables are shown in parentheses.

To note that equation (3) (possibly adjusted to exclude variably ivy) can be used to simulate employment-oriented policies with large plants in terms of manpower.

(vii)Capital goods

Equation (1) found for developed countries (see table 8) shows the importance of market size to explain the technology of this sector in developed countries. The productivity is explained, with an excellent R^2 (0.88) by two variables i.e. the market size DU (-1 for North America, +1 all other countries), and the neutral technical progress. Student-t variable for DU takes a high value (11), and the constant, a higher value (51). These findings, as well as the high level of the constant (8.8) all confirm expectations.

A better relation (equation (2)), for the same group, brings down the student-t variable of the constant, with two more variables, i.e. the value-added coefficient and the manpower size of plant. To note that the former variable (ivy), clear from any suspicion of spurious correlation (no direct correlation with the dependent variable), can be said to capture the composite aspect of the sector, and that the latter variable (Tle) has a negative coefficient (diseconomies of scale), a feature compatible with what is known of the industry.

For developing countries, as can be seen from equation (3), weak correlations were found (R^2 = 0.45), with, however, a significant time trend (neutral technical progress).

For the sample as whole two good relations (equations (4) and (5)) can be found, one with value-added, another with the capital-labour coefficient (the two variables appear to be co-linear). As for developed countries, the market size plays a major role (DU = -1 for North America, 0 for developed countries, 1 for large and 2 for small developing countries), with a Student-t variable equal to 11. No spurious correlation is to be feared with the value-added coefficient (no direct correlation with the dependent variable), and its explanatory power again shows that the proportion of material input is an interesting variable in a composite sector. A noteworthy finding is that the coefficient of neutral technical progress is significant in both equations. Finally, the constant term, with a (too) high Student-t value, bears witness that the sector has a high productivity in all countries. Its level, around 10, is the highest found in all sectors.

Table 8: Productivity functions for the capital goods sector

Sample	DU	Ln Caple	Ln ivy	Ln Tle	t	Constant	R^2	DF
(1) DD	-0.45 (-11)	...	...	...	0.16 (2.3)	8.8 (51)	0.88	15
(2) DD	-0.47 (-12)	...	0.81 (2.11)	-0.24 (-3)		10.9 (19)	0.90	15
(3) DG	-0.22 (-2.2)	...	1.50 (3.1)	...	0.19 (2.0)	9.41 (18)	0.45	10
(4) DD + DG	-0.48 (-11)	0.12 (4.6)	...	...	0.15 (2.1)	7.7 (26)	0.85	29
(5) DD + DG	-0.49 (-11)	...	1.41 (4.2)	...	0.20 (2.6)	9.8 (31)	0.84	28

Note: Student-t variables are shown in parentheses.

3. Conclusion

One methodology lesson and important policy conclusions can be derived from this analysis.

The methodological conclusion is that the figures derived from the YIS source happen to give a convincing and coherent picture of the technology, in spite of the lacunae mentioned in the introduction: results expected from direct knowledge of the different sectors were confirmed to a reasonable degree in the econometric analysis.

There remains a major policy issue: To what extent can the I/C tables and the productivity functions permit the simulation of technologies deviating from North-imported technology? The overall impression given by this study is somewhat balanced: in the analysis of I/O tables, input coefficients vectors found in the agriculture, service and construction sectors appeared to have specific profiles by region. For these sectors, labour and investment requirements are obtained separately (complementary factors) in the UNITAD system, using observed labour and capital-output coefficients. It would be easy, in these sectors, to simulate labour-intensive techniques, by deriving observed values from successful experiments in specific regions.

In the manufacturing sectors, the analysis of productivity functions conveys a general impression that capital-labour substitution is regulated by the same economic equations in all countries, whether developed or not. This, it is probable, is partially built in the sample of enterprises retained in the statistical source, which excludes very small scale enterprises. Two remarks should however be made. Firstly, the exogenous variables, especially the capital-labour coefficients, can be chosen so as to lower productivity, insofar as observations (derived from existing small-scale enterprises in regions) yield such exogenous values. Second, the manpower size of enterprises explicitly enters in the equations of three sectors, agri-food processing, mining, and light industry, thus making it possible to simulate a deliberate policy of development of labour intensive industries (e.g. small-scale enterprises in primary processing, agro-food industries)

To go any further in the simulation of such policies, would require changes in the technology sub-system. One such change has been introduced in the model for Centrally Planned Economies, Asia, where urban and rural industries have been separated. One may assume, for low income regions such as Tropical Africa or South Asia, that the development of a modern industry sector in urban areas might take place parallel to the establishment of a low productivity industry sector in the rural side, at least for food processing and light industry, with a slow move of the "rural" technology towards the "urban" technology to simulate a progressive integration of the whole economy. Such a policy is probably justified in large continents with fragmented markets due to high transport cost. There, a small scale rural industry could give income and employment to a number of people without being endangered, on account of market fragmentation, by the high productivity urban sector.

The limits of such a paradigm for rural development are well known. The market of a remote rural region is never fully cut off from the urban sector for all categories of goods: light plastic materials, for example, can support high transportation costs. Moreover, as the transport infrastructure improves, market fragmentation decreases. These arguments have their value, but do not defeat the basic philosophy of the paradigm, which can be articulated around two statements: (i) no rural development can take place without full participation of all concerned, which justifies long-term investments and training processes in all fields of activities (and not merely to make agriculture more efficient). This is an essential requirement for a successful progressive integration of the rural sectors in the national economy. (ii) Such an integration, in turn, may take anything between 30 to 50 years, i.e. two or three generations, in some areas of Africa South of Sahara or the Indian Sub-Continent where costly transport and telecommunications infrastructures are to be considerably extended. Such a time lag both justifies and demands the development of the rural sector "per se". A final remark is that the same paradigm can apply as well to the development of remote and backward regions in developed as well as in developing countries, where both the urban and the rural sector lag behind the "poles" of advanced regions. In other words, what is suggested here is merely a pari-passu extension to rural development - the main areas of mass poverty of the third world - of a well established experience gained in regional development of the developed world.

PART III: A SAMPLE OF OVERALL RESULTS

The model has been used to assess a range of future situations at the regional level in 1990, consistent with three alternative sets of exogenous assumptions, broadly identified as scenarios, i.e. a "trend scenario" published in the 1980 report, and two scenarios on the theme of the Third United Nations Development Decade. Most certainly, the results should not be identified as forecasts, not even of a very broad nature. They are conditional projections providing a set of consistent results for the target year given the projected values of the exogenous variables. Whether they are optimistic or pessimistic, plausible or implausible, desirable or not, will largely depend on the accuracy of the exogenous predictions as well as on the specification of the model itself. It should be observed, however, that few, if any, long-term models can claim to give "accurate" magnitudes. The interest of such models lies essentially in their capacity to compare in relative terms the results of different scenarios based on contrasted assumptions. This is attempted in this part, where the first section refers to two scenarios related to the International Development Strategy (designated IDS 1 and 2 respectively) applied to the Third Development Decade. For each scenario, attention will be drawn to a precise definition of assumptions, followed by a broad analysis of main results and, when relevant, a comparison with the trend scenario. Finally, in section B, some policy conclusions are drawn.

A. Two scenarios related to the International Development Strategy

1. Basic assumptions

These scenarios are meant to test the consistency of quantitative targets and statements included in the text of the International Development Strategy (IDS) for the Third United Nations Development Decade adopted by the General Assembly in December 1980. This document addresses a number of international and domestic issues and policies, leaving it to governments and international institutions to achieve a balance between many, possibly conflicting, orientations. This justifies the attempt made here to explore two alternative sets of assumptions, embodied in two scenarios, designated IDS1 and IDS2 respectively, which differ essentially by their trade policies and their agricultural policies.

A common assumption for the two scenarios, as derived from the text of the IDS, refers to growth rates of developing countries, i.e. to achieve in the 1980s a sustained 7 per cent annual growth rate for developing regions as a whole. Thus, the annual GNP growth targets for 1980-1990 were chosen so as to reach 7% for Latin America, 5.5% for Tropical Africa, 9.3% for West Asia, 5.6% for South Asia, 6.8% for East Asia and 6% for CPE, Asia. For developed market economy countries an average rate of 3.3%, very close to the rates tested in the trend scenario, was selected as against 4% for CPE, Europe, thus yielding an overall 3.5% growth rate for the North as a whole. The corresponding 1975-1990 growth rates will be quoted in table 1.C together with observed figures (1963-75) and trend scenario (T scenario).

Since the scenarios are meant to illustrate favourable conditions for the growth of the South, common optimistic assumptions were made concerning financial flows: ODA was assumed to reach the 0.7% target in the case of developed market economy regions, and 2.5% of GNP in the case of West Asia. The annual rate of growth of non-concessional capital flows is the same as in the trend scenario (12% per annum), but softer terms and conditions are assumed.

A minor difference refers to the energy price indices, which were set in both scenarios at a much higher level than in the trend scenario: 3.8 times the 1970 real price in IDS1 and 4.1 times in IDS2, i.e. an average annual increase of between 2 per cent and 2.5 per cent in real terms during the decade.

There are two major differences between the two IDS scenarios: the regional import substitution policies for capital goods and the growth of agricultural production. Using the market size variable, import functions of scenario IDS1 have been specified[1/] so as to simulate systematic regional policies allowing capital goods industries to develop in each region on the regional market as a whole. In scenario IDS2, instead, conservative trends for import substitution policies govern import functions for machinery and equipment[2/], so that assumptions of restrictive business practices and fragmented regional markets can be said to prevail.

1/ See part II, A on the trade sub-system.

2/ The elasticity of imports with respect to GDP growth rates is very close to observed values (endogenously computed).

On the agricultural side, both scenarios meet the IDS minimum target of a 4% growth rate in terms of gross output for developing countries as a whole (equivalent to 3.2-3.4% in terms of value added), but the growth rate for IDS1 (4% in terms of value added) is set much higher than for IDS2 (3.4% in terms of value added). No institutional change is made in the agricultural sector, so that unemployment implications, if any, can only be attributed to growth.

To sum up, scenario IDS1 simulates conditions more favourable to the success of the Strategy than scenario IDS2, in that the former illustrates a beginning of a South-South economic co-operation process (as in the trend scenario) as well as a vigorous development of the agricultural sector (in contrast with the trend scenario), whereas conservative assumptions on these two issues are made in scenario IDS2.

2. The energy balance

Special attention was given in both scenarios to the recommendations made in the IDS concerning energy conservation and the development of energy resources. Reductions in energy inputs in developed countries were assumed to reach high levels, ranging from 65 per cent to 80 per cent. These reductions were derived from a study by the International Institute for Applied Systems and Analysis (IASSA) for market economies and from an ECE study for the centrally planned economies of Europe (CPE, Europe). Next, the 1990 supply capacity of the energy sector, subdivided into the four sub-sectors already mentioned, was computed outside the model for each region from an ECE study[1]. In order to make the endogenous energy production of the model smaller than or equal to this maximum capacity, the trade shares for the energy sectors and the coefficients of energy import equations were parametrized. In this way, in all regions except three, energy imports were made to equalize the difference between demand requirements and the maximum supply capacity. The exceptions are, besides CPE, Asia, the two main oil producing regions, i.e. CPE, Europe where the energy output happened to be below the maximum capacity, and West Asia, where the output level was allowed to be fixed endogenously to generate exports commensurate to the requirements of oil importing regions.

An examination of the results for the world energy balance of scenario IDS1, keeping in mind the assumptions made, leads to the following conclusions:

1/ These levels are close to those included in World Development Report, 1981 (Washington DC, 1981) table 4.1.

- The "required" energy output for West Asia (which can be translated in terms of oil and gas) exceeds the assumed "capacity" of that region (1.6 billion tons of oil equivalent) by 18-65%, depending on the trade share of CPE, Europe. This excess can be reduced to 10% if the figures for primary sources of electricity (hydro and nuclear electricity together) are revised upward according to the latest estimates made in the three major oil importing regions (North America, Western Europe and Japan). Altogether, the model conveys the conclusion that a 7% growth rate of developing regions would generate conflicting claims on scarce oil and gas resources even on the generous assumptions made for energy conservation in the North.

- The resulting tension on the oil and gas markets could only be eased, <u>ceteris paribus</u>, if the expansion of coal and primary sources of electricity in the North during the decade exceeded the requirements as recently estimated by the governments concerned, so as to release additional oil and gas supplies for the South. Alternatively, industrialized countries might finance new energy sources, including oil exploration, in developing countries. This would obviously call for an unprecedented negotiation at the world level based on the fulfilment of two conditions: a consensus to guarantee sufficient oil and gas resources for the growth of the South and an investment effort based on a long term planning of energy resources for the world at large.

- The scenario can also be interpreted as an indication of the trade reorientation needed to achieve a better energy balance in the future: an increase in energy trade within CPE, Europe; the same within North America; a substantial decrease of the West Asian share (oil) in Western Europe and Japan, and a corresponding increase of the shares of CPE, Europe (coal, gas), North America (coal) and the OD region (coal, gas) in the imports of Western Europe and Japan.

Two attempts were made to test the sensitivity of the conclusions on the assumptions made:

- The first consisted of constructing a variant with a low growth assumption for the North, which will be fully reported in section 7. This showed that a 1% decline in the growth rate of the North decreased the world energy output by 0.7% (0.8 for the North and 0.3 for the South), thus restoring the world energy balance at the maximum capacity level.

- The second consisted of increasing the real price of energy (with no other change) by 10% compared to the IDS1 level[1/]. The increase proved

1/ This can be done in the model by manipulating the incremental international price for energy.

almost sufficient to restore the world energy balance at the maximum capacity level. This result should, however, be considered as very tentative, since the model seems to overestimate the response of demand to a price increase.

It may nevertheless be concluded that, with a 7% growth rate for the South and a 3.5% growth rate in the North for the decade, the energy market would be extremely tight, generating tensions comparable to those observed in 1979-1980.

3. The sectoral structure and the trade dependency

The sectoral structure, for the South as a whole (DGM regions) seems at first glance relatively stable in volume (1970 prices). Two different breakdowns are shown in Table L1 together with 1963, 1970 and 1975 observed structures, and the trend scenario (denoted T).

The first result to be commented is the relatively stable proportion found for the manufacturing sector in 1990, i.e. 22.2% of GDP for scenarios T and IDS2, and 20.8% for IDS1 (as compared to 16.1, 18.1 and 19.4 in 1963, 1970 and 1975 respectively). However, this apparent stability is strongly dependent, in reality, on the assumptions made for the energy and agricultural sectors. The growth of the manufacturing sector is obtained, in scenarios T and IDS2 at the expense of the constrained growth of agriculture and partly, in the two IDS scenarios, at the expense of the constrained energy sector (see breakdown A). This, in turn, is related to the technology imposed exogenously for these last two sectors.

Another interesting feature relates to the difference found for the capital goods sectors in the two IDS scenarios, i.e. 4.9% (IDS1) versus 4.2% (IDS2). The higher growth rate found in IDS1 can be directly traced to the assumption made in this scenario on the high proportion of intraregional trade of equipment goods among developing regions. As far as embodied technology is concerned, this growth of the capital good sector can be clearly interpreted in terms of a reduction of technological dependence. The beneficial effects on the balance of goods and services will be reviewed in a further paragraph.

As against these differences, it is worth noting that the relative importance of the basic product sectors (mineral mining and primary processing) is very similar (around 9.3%) in the three scenarios in spite of highly differing assumptions. This can be ascribed to a number of offsetting different uses (fertilizers used by the agricultural sector, primary metallurgy by industrial sectors and construction). Another general

Table 1.0 Annual Growth Rates Assumptions for each Scenario[a] (1975-90)

	1963-75 (actual)		1975-90 T		1975-90 IDS1		1975-90 IDS2	
Developing regions	GDP	Agri	GDP	Agri	GDP	Agri	GDP	Agri
LA/Latin America	6.1	3.2	5.5	3.0	6.3	5.2	6.3	4.1
TA/Tropical Africa	4.5	1.6	3.7	2.6	4.8	3.2	4.8	2.6
NE/West Asia[1]	7.0	1.7	5.9	3.0	7.8	5.3	7.8	3.0
IN/South Asia[1]	3.6	2.4	3.5	2.5	5.0	3.1	5.0	3.1
AS/East Asia[1]	7.2	3.6	6.0	4.1	7.0	3.8	7.0	4.0
Total DGM	5.7	2.6	5.2	2.9	6.3	4.0	6.3	3.4
OA/C.P. Asia[1]	6.0	3.5	6.0	3.5	6.0	3.5	6.0	3.5
Developed regions								
NA/North America	3.7	1.0	2.6	...[b]	2.9	...[b]	2.9	...[b]
WE/Western Europe	4.5	1.7	3.0	...[b]	2.9	...[b]	2.9	...[b]
JP/Japan	8.9	2.8	4.9	...[b]	5.9	...[b]	5.9	...[b]
OD/Other Developed	5.0	4.1	3.5	...[b]	4.5	...[b]	4.5	...[b]
Total DDM	4.5	1.7	3.0	...[b]	3.3	...[b]	3.3	...[b]
EE/C.P.Europe	6.7	1.6	4.0	...[b]	4.0	...[b]	4.0	...[b]

a/ Average rates for the decade 1980-90 are given in the text. The table is meant to facilitate a comparison between 1975-90 rates and the observation period (1963-75).

b/ Endogenous in the model.

1/ In the text, the names of the regions are shortened as in the table. Initials are also used, as follows:

	Full Name	Text	Tables
Developing regions:	Latin America	Same	LA
	Tropical Africa	Same	TA
	North Africa & West Asia	West Asia	NE
	Indian Sub-Continent	South Asia	IN
	East & South-East Asia	East Asia	AS
	CPE, Asia	Other Asia	OA
	Developing Market Regions	DGM	DDM
Developed regions:	North America	Same	NA
	Market Economies, Europe	Western Europe	WE
	Japan	Same	JP
	Other Developed	OD Region	OD
	CPE, Europe	Eastern Europe	EE
	Developed Market Regions	DDM	DDM

Table 1.1 Sectoral Structures (DGM as a whole)

In percent of GDP

	1963	1970	1975	1990 T	1990 IDS1	1990 IDS2
	----------	actual	----------			
Breakdown A						
Agriculture	31.0	25.3	21.8	15.8	15.8	14.5
Food Industry	...	4.4	4.0	3.5	2.8	3.5
Energy	...	7.2	6.7	6.3	5.9	5.7
Basic Products	...	5.7	6.0	9.1	9.3	9.4
Light Industry	...	5.9	6.1	6.1	5.5	5.8
Capital Goods	...	2.7	3.5	4.5	4.9	4.2
Construction	5.3	5.4	6.0	7.1	7.9	7.7
Services	42.3	43.4	45.9	47.6	47.9	49.2
GDP	100.0	100.0	100.0	100.0	100.0	100.0
Breakdown B						
Agriculture	31.0	25.3	21.8	15.8	15.8	14.5
Utilities	1.1	1.5	1.7	2.5	2.3	2.3
Manufacturing	16.1	18.1	19.4	22.2	20.8	22.2
Mining	4.2	6.2	5.2	4.8	5.3	4.1
Construction	5.3	5.4	6.0	7.1	7.9	7.7
Services	42.3	43.4	45.9	47.6	47.9	49.2
GDP	100.0	100.0	100.0	100.0	100.0	100.0
Final Demand						
Capital formation	15.0	17.6	21.3	25.0	27.2	26.5
Net exports (volume)	+0.3	-0.1	-6.0	-5.5	-2.2	-11.6

feature is the relative decline of the light industry sector in the two high growth scenarios, IDS1 and IDS2 (5.5 and 5.8 respectively), as compared to 1975 and the trend scenario (6.1%). Clearly the major beneficiaries of a high growth process are the primary processing and the capital good activities, which together account for 14.2% and 13.6% of GDP in IDS1 and IDS2, respectively, as compared to the observed figures of 8.4% in 1970, 9.5% in 1975. This can be explained by the fact, already noted in the trend scenario, that the two sectors are mutually supporting: the basic product sector is highly capital-intensive and its growth provides an outlay to the capital good sector, which in turn consumes (in the I/O table) much of the output of the primary sector. As already seen in the trend scenario, both sectors play (in the model as in the real world) a crucial role in the process of industrialization.

In this connection, it is interesting to compare the trade dependence for the largest part of the manufacturing sector, i.e. basic products, light industry and capital good industry, in the different scenarios. In Table 2, the trade self-sufficiency ratio is defined as the ratio of domestic gross output divided by the sum total of supply, i.e. domestic gross output plus imports from outside the region[1/].

Table 2. Self-sufficiency ratios for manufacturing sectors[a/]

(in value terms)

Regions	1970 Actual	1990 T	1990 IDS1	1990 IDS2
LA	84.7	86.8	86.3	83.4
TA	63.6	59.1	58.6	60.9
NE	62.4	58.2	70.1	52.4
IN	87.4	84.4	87.8	86.8
AS	66.0	65.7	69.4	60.5
Average[b/]	73.8	71.7	77.4	67.7

a/ For definition, see text.

b/ Harmonic average of LA, NE, IN, AS.

As could be expected, in four out of five regions the self-sufficiency ratios fall down sharply from scenario IDS1 to IDS2. Leaving aside Tropical

1/ This ratio is computed in value term, although in volume term, a close but somewhat higher self-sufficiency ratio is generally found on account of higher import prices.

Africa, with an industrial base too small to gain full benefit of intra-regional co-operation, the average figures for the four regions are striking: self-sufficiency increases only in scenario IDS1 (77.4), compared to the observation period (73.8). It decreases in the trend scenario (71.7), where assumptions are similar to those of IDS1 but where overall growth is lower, and it decreases even further for IDS2 (67.7) on account of the trade policy. The overall philosophy of these noteworthy results can be summarized as follows: fragmented regional markets generate an increased dependence from the North, whereas as shown by scenario IDS1, collective self-reliance at the regional level in the capital goods sector decreases the overall dependence in manufactures.

It may also be noted in Table 2 that Latin America and South Asia are by far more self-sufficient than other regions in the observation period and all three scenarios (ratios above 80%). As against this, the vulnerability of East Asia, which is developing on the world market, is conspicuous (66% in the observation period and scenario T, around 70% in IDS1 and 60% in IDS2).

4. The balance of goods and services

Another way of looking at the same issue is to analyze the balance of goods and services. The comparison will be restricted to the two IDS scenarios.

In Table 3, the major common feature of both scenarios is the heavy weight of energy balances in developed market economies (DDM) (respectively $581 and $606 billion, i.e. about 4.6 per cent of their GNP), the major part of which is transferred to the West Asian and North African region (respectively $388 and $400 billion, 3.1 per cent of the GNP of DDM). Another important part of the balance is transferred in both scenarios to Eastern Europe ($117 and $129 billion respectively, i.e. about 1 per cent of the GNP of DDM), on the assumption that that region could supply important amounts of oil, coal and gas. In contrast with developed market economies, the energy trade of developing market regions appears at first glance reassuring. West Asia, as already seen, accumulates large surpluses, while Latin America, Tropical Africa and East Asia exhibit modest positive balances; South Asia alone has a small negative balance in both scenarios. This optimistic picture, however, merely reflects the geographic distribution of oil deposits in the South and conceals the large deficits of developing oil-importing countries, i.e. the majority of Latin American, Tropical African and East Asian countries. The positive balance of the South displayed in both scenarios bears witness, nevertheless, to the potential benefit to be derived from a South-South policy of solidarity between oil importing and exporting countries. Such an assumption, it should be observed, seems more compatible with scenario IDS1 than with scenario IDS2, which is dominated by North-South linkages.

Sharp differences between the two scenarios are found for the other two commodity groups, i.e. agricultural goods and manufactures. It should be recalled that in the two scenarios, the rate of growth of agricultural production is exogenously given, with a view to testing the impact on the trade balance. For developing countries as a whole, the balance of agricultural goods is almost in equilibrium for scenario IDS1, with a 4 per cent annual growth rate of agricultural production in terms of value added (i.e. about 4.8 per cent in terms of gross output), and is heavily negative (-$129 billion, i.e. 3.1 per cent of their GNP) in scenario IDS2, with a 3.4 per cent annual growth rate of agriculture (about 4 per cent in terms of gross output).

These results confirm the importance of the agricultural growth target in the IDS, which is exactly reached in the second scenario and should therefore be considered as a minimum, although it appears relatively ambitious as compared with the past (2.6 per cent annual growth rate in terms of value added). Moreover, the table shows that the deficit of the South in scenario IDS2 is entirely attributable to two regions, i.e. Tropical Africa (in which a 2.6 per cent annual growth rate was assumed, as compared to 1.6 per cent in the past) and West Asia (in which a 3 per cent annual growth rate was assumed, against a past trend of 1.7 per cent).

The balances of manufactures, as it can be seen from the table, are consistently negative for all developing regions (with the exception of South Asia which reaches equilibrium in IDS2), but the magnitude of the deficit in IDS1 is on an average 70 per cent of its value in IDS2 ($324 billion compared to $484 billion, i.e. respectively 7.7 per cent and 11.5 per cent of the GNP of developing market economies). The comparison, therefore, suggests that developing regions could cut down by 30 per cent their deficit in manufactures trade by a better integration of their capital goods industries within regions.

Table 3

Net exports in billions of 1990 dollars

Regions	Agricultural goods	Energy materials	Manufactures & ores	Total, including services: Billion dollars	Total, including services: % GNP of region	Total, including services: %GNP-DDM
LA, IDS1	21	45	-56	-13	-1.0	-0.10
2	14	39	-76	-49	-3.8	-0.37
TA, IDS1	-1	19	-58	-44	-11.4	-0.34
2	-45	14	-54	-92	-24.9	-0.70
NE, IDS1	-1	388	-179	183	11.1	+1.40
2	-127	400	-294	-46	-2.7	-0.35
IN, IDS1	-2	-5	-2	-12	-3.1	-0.09
2	9	-15	0	-8	-2.0	-0.06
AS, IDS1	-3	15	-29	-15	-3.1	-0.11
2	+20	36	-60	-6	-1.3	-0.05
All DGM						
IDS 1	14	462	-324	less NE: -84; with NE: +99	less NE: -3.3; with NE: +2.4	-0.64; +0.76
2	-129	474	-484	-201	-4.8	-1.54
All DDM						
IDS 1	-24	-581	349	-218	-1.7	-1.7
2	107	-606	495	46	0.4	0.4
Eastern Europe						
IDS 1	-7	117	-5	113	2.2	..
2	2	129	8	147	2.9	..

This result, though, does not apply equally to all regions. Leaving aside South Asia (where no intraregional integration was assumed in this exercise for methodological reasons)[1/], no benefit from integration appears to materialize for Tropical Africa, where the industrial base is too small to have a significant effect in the decade, so that three regions seem to contribute to the overall gain, i.e. in increasing proportions, Latin America, West Asia, and East Asia. In the latter region, the deficit in manufactures is reduced by about 50 per cent between the two scenarios (-$29 billion compared to -$60 billion), a remarkable achievement, which can be traced up to the past behaviour of the region, as simulated in scenario IDS2, when declining trends were observed in the intraregional trade for equipment goods. The reversal of this trend, in recent years, seems to suggest that businessmen for East Asia have received economic signals pointing to the same direction as the conclusions reached in this exercise. In Latin America and West Asia, where long-established policies have tended to encourage intraregional co-operation in manufactures, past indicators of economic integration[2/], relating to the trade of equipment goods, used to suggest up to 1975 a relatively stable level among Latin American countries and increasing trends among Arab countries. The comparison between the two scenarios would tend to prove that further integration of equipment goods would bring about in 1990 a decrease in the deficit for all manufactures of 27 per cent and 40 per cent in Latin America and West Asia respectively.

The overall balances of goods and services (adding up services to the three categories of goods reviewed above) should now be briefly considered. For developing regions as a whole, there is an overall surplus in scenario IDS1 of $99 billion, 2.4 per cent of their GNP) on account of the surplus in West Asia. Excluding West Asia, the deficit reaches 84 billion, i.e. 3.3 per cent of the GNP of the four regions concerned. In scenario IDS2, the whole area is in the red, with an aggregate deficit of $201 billion,

1/ This will be attempted shortly in a new exercise.

2/ See delta coefficients in part II, A.

almost 5 per cent of their GNP. In the first scenario, the deficit of the four regions corresponds to a transfer amounting to 0.64 per cent of GNP of developed countries; in the second scenario, the deficit for the five regions exceeds 1.5 per cent of the GNP of developed countries. For the more "realistic" scenario in terms of present policies, i.e. scenario IDS2, the largest deficit is found for Tropical Africa, (11.1 per cent of its GNP, 0.7 per cent of the GNP of developed countries). Latin America and West Asia exhibit deficits in absolute terms about one half of that magnitude (3.8 per cent and 2.7 per cent of their respective GNPs, about 0.36 per cent of the GNP of developed countries), while South Asia and East Asia are closer to equilibrium (2 per cent and 1.3 per cent of their respective GNPs, about 0.05 per cent in terms of GDP of developed countries).

The reverse situation obtains for developed market economies, i.e. a large deficit for IDS1 (-1.7 per cent of their GNP) and a small surplus for IDS2 (0.4 per cent of their GNP); a glance at the breakdown of the balances for developed countries is enlightening: the energy bill, on the negative side, is about the same for both scenarios, but in IDS1, net exports of manufactures alone cover to 60 per cent of the bill and net exports of agricultural goods are negligible. In IDS2, instead, the energy bill is paid for as to five sixths by net exports of manufactures, and as to one sixth by net exports of agricultural goods. The surplus, in that case, is almost entirely attributable to the net export of services.

A last remark should be made: the overall balances for developing regions are extremely volatile from one scenario to the other, depending on the four characteristics evidenced in this exercise: the rate of growth of agricultural output, the real price of energy, the trade policies for manufactures, and obviously the relative growth rates of the South and the North. These factors are by no means the only determinants of the trade balance, but their contributions in this exercise cannot but lead to the conclusion of the great vulnerability of developing countries to the North-South linkage simulated here. The sensitivity analyses made on the UNITAD model give broad indications on some of the alternatives. For example, within the prevailing institutional framework of agriculture in developing countries, the balance of agricultural goods is not found in equilibrium for growth elasticities relative to GDP below 0.5 for Latin America, 0.65 for Tropical Africa, 0.7 for West Asia, 0.6 for South Asia, 0.55 in East Asia. The magnitude of the problem is clearly demonstrated by a comparison of these figures with observed elasticities in the last fifteen years in Tropical Africa (0.35) and West Asia (0.24). The present gap between past trends and required growth within the present framework would therefore seriously endanger the achievement of a 7 per cent overall growth rate, as shown by scenario IDS2.

5. The current payments and the debt problem in scenario IDS2

A word of caution is in order in interpreting the results of the model for current payments, in view of the simple treatment of capital transfers in the UNITAD model. Both the total amount of these transfers and its distribution among developing regions are exogenous figures, just like inflation trends. The merit of the model, it is hoped, is to assess the 7% growth target in relation to the unmanageable debt problem. Scenario IDS2, which simulates a continuation of the North-South linkage, will be used for the demonstration.

Starting with the current payment balance, Table 4 shows the balance of each developing region in relative terms on assumptions made in this scenario.

Table 4

Current balances of developing regions in 1990 (IDS2)

	Trade gap	Current payments balance (before ODA)	Payments balance (after ODA)	
	-------(% of GNP of DDM)	------------	------------	(% of GNP of each region)
Latin America	- 0.37	- 1.05	-1.00	-10.3
Tropical Africa	- 0.70	- 0.78	-0.19	- 6.7
West Asia	- 0.35	+ 0.64	+0.37	+ 2.9
South Asia	- 0.06	- 0.09	+0.16	+ 5.4
East Asia	- 0.05	- 0.33	-0.24	- 6.3

The analysis of the trade gaps (first column) already pointed to the critical situation of three regions, Latin America, Tropical Africa and West Asia, especially Tropical Africa. Adding up interest on outstanding debts, including remitted profits, interest on short term financing payments and migrant remittances, the second column reveals a fairly different ranking. The situation in Latin America seems by far the worst, with a payment gap exceeding 1% in terms of GNP of developed countries, followed by Tropical Africa (0.78%, not very different from the trade gap), and East Asia with a serious gap (0.33% compared to 0.05 as a trade gap). West Asia, this time, has a positive payment balance (+ 0.64), reflecting its position as a money lender 1/. South Asia's gap remains small, since no account was made here of the debts incurred in recent years.

If 83% of ODA is directed to South Asia and Tropical Africa, the balance becomes largely positive (5.4% of GNP) for the former, but negative for the latter (-6.7% of GNP). Even with a different ODA allocation as between the two regions (keeping South Asia just in equilibrium), the gap for Tropical Africa may become more manageable. However, no matter how the remainder of ODA is allocated, Latin America and East Asia remain with huge gaps (10.3% and 6.3% respectively in Table 5) which can be traced to the capital-service burden (6.8% of GNP for Latin America and 7.9% for East Asia). In both regions, a continuous growth of borrowing appears necessary in order to service the gigantic debt (including direct investment) which is almost multiplied by 10 as compared to its 1975 value. This strengthens the conclusion already reached in the trend scenario, i.e. the absolute need for these two fast industrializing regions to keep under control the growth of their outstanding debt and of direct foreign investment. It also provokes rather pessimistic views on the possibility of these regions to achieve the IDS growth targets on the basis of North-South linkages simulated here.

6. A comparison of employment figures

The model computes the labour demand by sector, with a proportion of labour assigned to the rural area. It then compares separately labour demand and supply between urban and rural areas. Exogenous supply figures are derived from the studies on rural/urban migrations made by the Population Branch at United Nations Headquarters. Needless to say, the absolute figures should only be taken *cum grano salis*, but it is hoped that the comparison among scenarios can give an idea of changes in relative terms. Table 5 summarizes the main findings (including the trend scenario, denoted T):

1/ It should be recalled that the region includes a number of capital exporting countries and that, as was the case for the base year, trade deficits can coexist with a large outflow of capital transfers.

Table 5

Labour gap figures in 1990 (millions of workers)

	Urban areas			Rural areas			Total		
	T	IDS1	IDS2	T	IDS1	IDS2	T	IDS1	IDS2
Latin America	59	56	54	-16	-27	-22	43	29	32
Tropical Africa	18	12	9	58	53	58	76	65	67
West Asia	4	-2	-6	13	6	13	17	4	7
South Asia	36	3	17	150	127	145	186	130	162
East Asia	15	9	12	53	52	52	68	61	64
All DCM	132	78	86	258	211	246	390	289	332

Urban employment is clearly related to the growth process: the two IDS scenarios yield labour gaps of the same magnitude, roughly 62 per cent of the trend scenario level for the South as a whole. This can be observed in all regions, including West Asia where negative figures mean that, with the assumed GDP growth rate (7.8 per cent), rural/urban migrations are too slow to feed labour demand in the urban areas. The immigration of workers in West Asia from other regions, as can be observed today, may be taken as an illustration of these tensions in the labour market in the gulf area.

The difference between the two IDS scenarios depends on the relative growth of capital-intensive versus labour-intensive industries, which itself is related, through the I/O table, to the structure of final demand and to the technology. Thus a drive towards capital-intensive sectors can be observed, from IDS2 to IDS1, in Latin America, Tropical Africa and West Asia, and the reverse prevails in South and in East Asia. Altogether, three regions suffer from significant urban unemployment both in the trend scenario and in scenario IDS2, the two scenarios dominated by conservative trends and policies, i.e. Latin America, South Asia and East Asia. Tentative as these figures may be, they convey an idea of the magnitude of the social problems.

Rural unemployment, under the assumptions made on the growth of the agricultural sector (which is preeminent in the demand for labour) and internal migrations, hardly decreases for the South as a whole. The difference is particularly small (less than 5 per cent) between the trend scenario and IDS2, just because the growth rates of agriculture have been taken as identical in three regions, i.e. Tropical Africa, West Asia and East Asia. A fifteen per cent decrease can be observed in scenario IDS1 for the opposite reason, i.e. a general rise in the growth rate of agricultural outputs. On an average, with all reservations due to the difficulty of quantifying such unemployment, the figures for the trend scenario represent between 30 and 35% of the working age population in rural areas - one worker in three. This may be taken as a warning signal drawing attention to the social cost of a low growth of rural output 1/. This calls for efficient policies to reduce this figure, e.g. a different technology with or without a change in the distribution of assets in the sector, and an increasing number of labour-intensive rural industries.

Altogether, total unemployment figures are extremely high in the three scenarios, although the total labour gap of the two IDS scenarios is significantly lower than in the trend scenario (by 15% in scenario IDS2, by 26% in scenario IDS1). It is difficult to check outside the urban area whether unemployment is increasing or decreasing in relative terms as compared to the base period. A 2.5% growth rate of employment seems however to be achieved in the industrial sector in scenario IDS1 and IDS2 if the results are compared to ILO figures for the base year. This, it should be noted, complies with one of the recommendations of the International Development Strategy, but it does not contribute much to the absorption of the unemployment inherited from the past, since this rate is in most regions lower than the population growth rate.

7. A variant of scenario IDS1 with low growth for the North

In scenario IDS1, large trade imbalances were found in developed market economies, about 1.7% of current GNP, essentially on account of their energy bill. These findings, therefore, invite an exploration of the implications of a lower growth rate for the North, 1.6%, i.e. one half of that previously assumed (other assumptions unchanged).

A brief review of the reaction of the UNITAD system can be summarized as follows:

1/ In Latin America, rural unemployment is negative, i.e. transferred to the urban area, it is significant in Tropical Africa and East Asia and it reaches peak levels in South Asia.

- As was already stated, the world energy balance is definitely restored.

- The trade balances of developed market economies improve substantially in all regions, with a small negative gap (-0.5% compared to -1.7%, relative to GNP) for the region as a whole. Eastern Europe loses two-thirds of its net surplus and approaches equilibrium.

- As to developing regions, the trade gaps which appeared to be moderate in the IDS1 scenario, exceed now 5% of GNP both in Latin America and East Asia. These two regions must now service not only their long-term debts (programme financing) but also large short-term balance of payments financing, so that the Latin American current payments gap increases by 50 per cent and the East Asian gap triples.

This is enough to illustrate both the sensitivity of the model and the sad conclusions which it leads to. Developing countries cannot sustain the 7 per cent IDS target on the assumptions of the low variant of the North. This is obvious for Latin America and East Asia, but the same conclusion may as well be extended to Tropical Africa and South Asia, since the doubling of the ODA required to make good their current gap is hardly plausible in a sluggish Northern economy. The South therefore appears extremely vulnerable to the growth of the North, with perhaps one qualification, i.e. South Asia, which appears less dependent on account of its relatively low participation in world trade and its low level of indebtedness.[1]

If the results of the low and high IDS1 variants are compared, developing regions seem to be squeezed between a high growth rate for the North, which brings unbearable tensions to the energy market, and a low growth alternative, in which their export earnings are shrinking. Results should obviously be worse for scenario IDS2 when a stronger North-South linkage prevails, so that the only way out for the South seems to be to generate a growth process less dependent on the world market. Other scenarios of economic co-operation among developing countries are therefore essential to explore plausible conditions to fulfill the International Development Strategy.

1/ This may no longer hold true in the future since the Indian government recently engaged in a new policy of borrowing to finance energy and other sectoral projects.

B. Some policy conclusions from the comprehensive scenarios

Based upon the detailed analysis of the explorations achieved so far, it seems useful to take a bird's-eye view of the main policy implications; the leading thread will be the analysis of the trade and payment balances, as well as the employment balance.

Three main issues will be considered, the growth of the agricultural sector, the world energy balance and the acceleration of industrialization either through South-South co-operation, or the enlargement of internal markets. Firstly, negative balances for agricultural goods are likely to become a crucial problem in two regions, Tropical Africa and West Asia (which includes here North Africa), unless active policies succeed in reverting the low growth trends observed in the past (1.6 per cent in Tropical Africa and around 2 per cent in West Asia). In other regions, like South Asia and East Asia, high average trends leave hopes for a balanced trade of agricultural products, but such averages may hide vulnerable balances for individual countries. In the past the first impact of an acceleration of the industrialization process was often a sudden rise in food imports to ease a demand pressure resulting from high income elasticities for food in the urban areas. The Ricardian law of comparative advantages cannot justify such a rise. The truth lies in the slow or inexistent adjustment process in the domestic supply of food for reasons which vary from country to country: it encompasses adverse domestic policies ranging from low internal prices for agricultural goods to institutional defects in the credit and marketing system or no adequate extension services, in other words, low priorities to the allocation of resources to the lengthy and costly adjustment of the agricultural sector. Distributive aspects also play a role, as will be seen below in the text.

The analysis of energy balances brings to the fore the relation between growth process and energy demand. The slack which can be observed today in the international oil market should not deceive policy makers on potential long term tensions. Actually, the UNITAD scenarios draw attention to possible conflicting claims of developing and developed countries for scarce resources like oil and gas. A 2 per cent annual growth of the capacity of the energy sector of developed market economies for the decade, such as is planned by governments with generous assumptions on conservation energy, would require an annual growth rate of the sector output between 5 per cent and 5.5 per cent in developing market economy countries to sustain a 7 per cent GNP growth rate in the 80's and satisfy as well energy import requirements of the North. This figure should be compared with an expected 4.5 growth rate of the capacity of the sector in developing market countries. A sustained 7% growth rate for developing countries, it may be said, appears highly improbable when looked at in 1982. However, a slightly higher growth of the North would bring out the same world energy tensions. It is also noteworthy that a great deal of uncertainty attaches to the real impact, in the long run, of energy conservation policies in the North which are an essential ingredient to fill the gap. Another problem is the financing of investment required in the South to achieve the expected 4.5 growth rate of energy supply capacity. This calls for urgent consideration and decisions at the international level, taking into account the long maturation delays, ranging from 5 to 10 years, required to raise the supply capacity: in the field of energy, the year 1990 is tomorrow.

There remains the fact that negative balances of commercial energy (ignoring, for that discussion, non-commercial energies affecting the life of more than half of mankind) are still found in 1990 for South Asia, if a 5% overall growth rate is to be achieved; in other regions, the reassuring positive balances found in the scenarios hide the abysmal deficits likely to appear in the majority of individual oil importing countries. There long-term adjustments processes are required, until the time when the necessary structural changes reach a cruising speed. No short term solutions can alleviate the deficit of oil developing importing countries (and prevent a long standing halt in their growth), short of an ambitious solidarity effort of all oil exporting countries, whether developed or developing, with an adequate support of international financing institutions. It is essential here to recall that weak economies are more vulnerable to a sudden shock than advanced industrialized countries and also require a more costly process of recovery in relative terms. In this field, a specific South-South solidarity scheme might well serve as a starting point for triggering the world community effort which is called for.

The third area in which the UNITAD scenarios bring out sharp conclusions is the trade of manufactures. In order to evaluate the impact of the message, it seems essential to follow step by step the main arguments.

(i) Following many authors, and in particular the conclusions of the "Interfutures team"1/, it is assumed that developed countries have now

1/ Published by OECD.

entered a new era of relatively slow progress of productivity and growth. These analyses, based on sociological, technico-scientific and political considerations, or a mix of these, refer to the long run beyond the stabilization schemes now under way. An essential issue is therefore the assessment of the implications of this radical change on the world trade equilibrium at large, and on developing countries in particular. The low exogenous growth rates assigned to market developed countries in the UNITAD scenarios, from 3 per cent to 3.3 per cent, as compared to the 4.5 per cent found in 1963-75, is meant to reveal these implications, even if they are considered over-pessimistic.

(ii) The second pillar of the demonstration is the time duration of the industrialization process in developing countries and its implications in terms of market power. There are obvious differences from one country to another but the magnitude of the problem can be perceived from a variety of indicators, such as the relative size of the manufacturing value-added, as a percentage of GDP, in the UNITAD scenarios for 1990: around 22% as an average for developing countries as a whole, compared with the pre-recession figures in developed countries: 25% for North America, 33% for Western Europe and 32% for Japan. Using the same yardstick, the road to industrialization will still be very long in 1990 for Tropical Africa (13%), South Asia (16%), West Asia (19%); Latin America (26%) and East Asia (27%) should aim at keeping at least the same ratio in further GDP growth.

(iii) The main lesson of the UNITAD scenarios is that, as long as regional markets remain fragmented, there will be a strong tendency towards increased trade dependency of the South in manufactures, but South-South economic co-operation appears to be a powerful means of reverting this tendency. In a nutshell, fragmented markets in the South will tend to decrease the self-sufficiency ratio for manufacturing from 74% in 1975 down to 68% in 1990, in spite of a growth rate of manufacturing valued added around 7% in the more optimistic scenario. In terms of trade balance, the same scenario indicates an overall deficit for manufactures as a whole (food excluded) amounting to 11.6 per cent of the GNP of the South in 1990 (10.2 per cent in 1975). The deficit in manufactures can be traced to their high import elasticities (food excluded), i.e. 1.35 per cent relative to GDP in volume terms (1.40 in current prices). Such is the hunger for manufactures imports in the course of the industrialization process that exports cannot catch up with them in a South-North oriented trade with a sluggish northern economy, in spite of the generous assumptions on the penetration of exports into developed markets[1]. On the other hand, integrated regional markets in the field of machinery and equipment alone (admittedly a large area) can reduce by 30% and probably more the overall trade deficit in manufactures, and increase the self-sufficiency rate in manufactures up to 77%. The merit of the UNITAD scenarios, if any, is to illustrate the enormous magnitude of potential gains to be expected from South-South co-operation, without neglecting, altogether, the policies to improve North-South balances of manufactures.

(iv) To achieve such results, it would not be sufficient for governments to establish free trade areas for machinery and equipment among neighbouring countries, but action would be required to curb restrictive trade practices of world oligopolies and ensure an equitable share of industrialization benefits between more industrialized and less industrialized countries of the same region. As was perceived by the 1975 UNIDO Lima Conference, the small share of manufacturing value-added of market developing countries in the world manufacturing value-added (8%[2] in the mid seventies, 12% in 1990 according to the UNITAD scenarios) can be interpreted in terms of a weak market power. Market integration provides the means to achieve the required market size, but it calls for specific policies to counterbalance the influence of oligopoles and monopoles dominating international trade and orienting the allocation of investment in major fields. To quote a recent UNCTAD publication[3] "possibly 30-40 per cent of all international trade is on an intra-firm or related-party basis [i.e. transnational private corporations], another 30 per cent is likely to constitute state trading, a further share of international trade is captive in nature...". Two conclusions emerge: "it is apparent that the concept of a freely competitive international trading market is illusory" and "the barriers to new entrants in the international trade market are formidable and could well be growing greater, especially as a result of concentration of market power...". In view of these impressive obstacles, rapid progress towards South-South co-operation appears as a major challenge for the world community at large, worth mobilizing the energies at the international, regional and subregional levels.

(v) The extension of the market for manufactures should not be sought only through co-operative arrangements among neighbouring countries but also inside each country through the harmonious development of urban and

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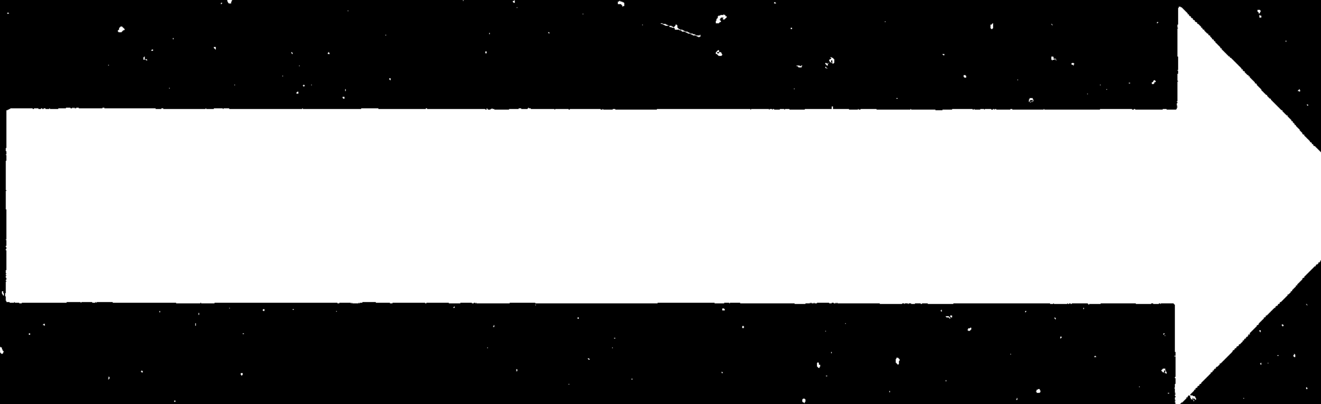
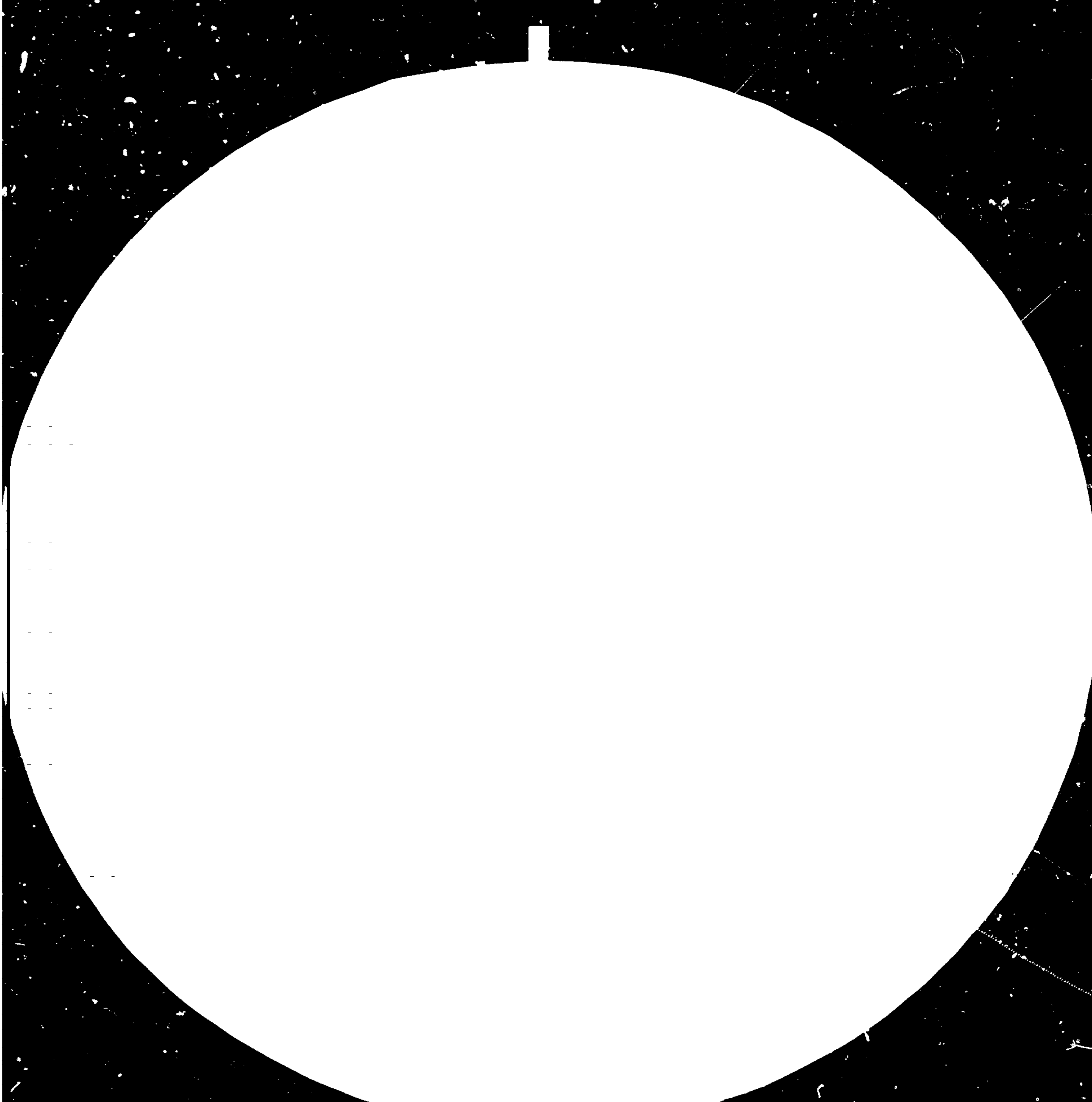
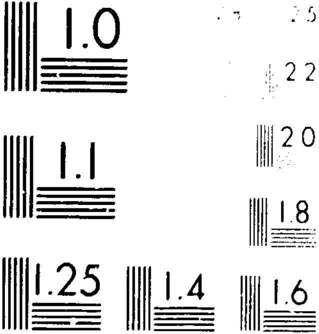
1/ The annual growth rate of exports of manufactures from the South appears to be 12.1 per cent in the scenario.

2/ 10.3 per cent in 1975 prices.

3/ UNCTAD/ST/MD25.






1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

rural areas. In this respect, the analysis of employment figures of the scenarios showed the small impact of overall GNP growth and of industrial growth on rural unemployment (which should actually be interpreted in terms of underemployment). The problem is acute in Tropical Africa, South Asia and East Asia, where 70% or more of the population is living in rural areas, and also in large parts of Latin America, North Africa and West Asia. This raises two related problems, i.e. the development of agriculture, already mentioned, and that of rural industries. It should be observed that the agricultural growth process was achieved in all scenarios without changes in land distribution nor in technology. In other words, the bulk of the additional output was produced by large farms or plantations with "modern technology", i.e. with a high capital-labour ratio, and costly inputs of fertilizers. The employment effect, as was seen, was naturally minor, leaving more than two hundred million people unemployed for the South as a whole. The struggle against poverty in rural areas as well as a sustained growth of internal markets therefore point to the same direction, i.e. special policies and programmes to raise the standard of living of small and medium farmers. This should be completed by the development of rural industry which can both improve the average productivity and income in rural areas and foster productivity progress in agriculture itself. Beyond the obvious social benefits of such policies, the experience of several countries is most convincing in demonstrating the long-term impact a balanced industrial development may have on further growth: in brief, a large food industry and consumption goods industry sector provide the market required to develop a number of capital goods and intermediary products, thus avoiding the difficult search for a sizeable export component for infant industries.

The international side of such domestic policies are multifold. One of them is that food aid, useful as it should be in emergency situations on the humanitarian side, calls for parallel and sustained international action to alleviate the financing burden of costly and time consuming plans for rural development. The integration of rural and urban economies, in turn, offers a large area for financial co-operation, especially with regard to costly infrastructure network. Perhaps the fast technology progress in decentralized energy sources (biomass, solar) or in modern telecommunication framework (satellite) would permit, if made available to developing countries, to delay, or even to avoid, the early development of some national wide infrastructure networks. More generally, the doubling of ODA to least developed countries, as recommended by the 1981 Paris Conference might act as a catalyst in accelerating the pace of rural development in this group of countries.

This brief review of major long-term development issues cannot be concluded without turning attention to the international financial problem, which appears both as an immediate and as a long-term challenge for the world community. It is not relevant here to elaborate on the magnitude of present indebtedness[1] which is outside the scope of this study. However, as was well perceived by the Brandt Commission, the present difficulties in the recycling of short-term balances of capital surplus countries call for an imaginative solution to take into account long-term development requirements. The simplified treatment of the debt problem in the UNITAD scenarios appears quite sufficient to demonstrate the pervasiveness of financial requirements of industrializing countries over the next decades and the need for the world financial system to find a response commensurate to the dimension of the development process, whether in the agricultural, the energy or the manufacturing sectors. The improvement of the monetary and financial world system cannot therefore but loom large in forthcoming negotiations on a North-South solidarity framework.

1/ According to the President of the IBRD: "In 1970, the debt owed to private lenders by developing countries amounted to only 45% of the total. By 1980, the percentage had burgeoned to 65%: $284 billion out of $?49 billion", 13 January 1982, Press Release.

PART IV: SUGGESTIONS FOR FURTHER WORK

In the preceding two chapters, an attempt has been made to convey a first ideaof the model and its scope for policy application. Given the obvious limits of space, both the description of the model and the results of the two scenarios have been kept to a strict minimum, while reference has been made to the relevant literature. However condensed previous discussion may have been, it should be sufficient to illustrate the merits and the limitations of such an exercise.

The project was reviewed and evaluated by an international forum of experts, convened by UNIDO in June 1981 on behalf of the sponsoring agencies, and some of their conclusions are of general interest.

In general, for example, it was acknowledged by the group of experts that the UNITAD system was an efficient tool for exploring institutional and structural transformations associated with the new international economic order and alternative development strategies. Comments were made on the nature and role of prices, the equilibrium mechanisms between the savings-investment and payment gaps, the treatment of technology and the import functions.

The time treatment in the economic dynamics of the system was criticized and it was recommended that more flexible time paths should be introduced in the equations involving stocks (essentially physical capital and financial capital flows), instead of the linear or exponential trends assumed so far.

Another criticism referred to the operation of the model as a man-machine system, with GDP fixed as a target. As shown in part I above, the manipulation of the system is admittedly a cumbersome procedure, which should be simplified and made more flexible. In particular, the experts recommended that the system should be completed so as to generate a growth rate, given the trade gap, or to generate the technology and trade parameters compatible with given growth rates and trade gaps.

Additional issues were suggested by some experts for future consideration, in particular the economic influence of transnational corporations (in so far as this can be done in a macro-economic model), the impact of disarmament policies and the environmental implications of new world industrial structures.

The sponsoring agencies, on the other hand, had in mind the exploration of a spectrum of issues within the system as it stood. A UNIDO project along those lines, it was noted, was actually under way. It included, essentially, two broad themes: economic co-operation among developing countries; and a growth process oriented more towards the internal market, with appropriate technologies in some sectors.

The system might then be used to explore conditions for a sustained growth of the South by any combination of those policies; a variety of scenarios might be generated, depending on the assumptions made regarding future trends in the developed countries and the decisions of the world community on the international environment. In that respect, leaving aside a continuation of the current trends, which, it was seen, would be conducive to increased misery and inequity and would seriously affect low-income regions, the following two main families of assumptions would be worth exploring:

(a) A progressive promotion of a new international division of labour, implying a strong adjustment on the part of industrialized countries, and in particular industrial redeployment, with a further liberalization of trade and adequate financial structures;

(b) A more imaginative world pattern, encouraging collective self-reliance among developing countries and calling at the same time for a deep restructuring of developed countries so as to reduce the waste of natural resources at the world level. Such an international order, more respectful of alternative development strategies, could be combined, in some regions, with internal policies along the lines of the "unified approach to economic and social development" suggested in the text of the International Development Strategy — in other words, oriented towards maximum employment and active participation of the whole population.

Lastly, the system could also be used to explore the future development of one specific region, in co-operation with the regional and subregional economic organizations concerned. In that case, the information supplied by the system on the world environment and the linkage between that specific region and other regions should be matched with disaggregated studies or models, among subregions or countries, conducted by the regional organizations concerned. Some projects of that type were actually suggested by the group of experts.

ANNEX 1. Classifications

ANNEX 1.1

1. Geographical breakdown (r space)

Developed regions (DD)	Developing regions (DG)
(1) (NA) North America	(6) (LA) Latin America
(2) (WE) Western Europe	(7) (TA) Africa (South Sahara)
(3) (EE) CPE, Europe	(8) (NE) North Africa and West Asia
(4) (JP) Japan	(9) (IN) Indian Subcontinent
(5) (OD) Other Develoepd	(10) (AS) East and Sotheast Asia
	(11) (OA) CPE, Asia

Regions are geographical entities. Turkey and Yugoslavia are included in European market economies (WE) as in ECE studies. The "Other Developed" regions include Australia, New Zealand and South Africa. The Pacific Islands, except Hawaii, are attached to East and South-East Asia, which also includes Thailand, Malaysia, Singapore, Indonesia and East-Asian countries.

ANNEX 1.2

Trade sectors (I^t space)

	SITC Number (Rev. 1)
1. Agricultural products	0, 1, 2 (excl. 251, 266, 27, 28), 4
2. Non-agricultural raw materials	27, 28 (excl. 286)
3. Energy	286, 3, 515, 688
4. Intermediate products	251, 266, 5 (excl. 515, 54, 55), 61, 621, 63, 541, 65, 66 (excl. 665, 666), 67, 68 (excl. 688), 691, 692, 693, 694, 698, 81
5. Consumer non-durables	54, 55, 62 (excl. 621), 642, 665, 666, 696, 84, 85, 89 (excl. 891, 896, 897)
6. Equipment	695, 71, 72 (excl. 724, 725), 73, 861
7. Consumer durables	667, 697, 724, 725, 82, 83, 86 (excl. 861), 891, 896, 897, 9

ANNEX 1.3

Producing sectors (I^p space)

(1) Agriculture (ISIC 1, 3132)
(2) Agri-food processing (ISIC 311/3/4)
(3) Energy (ISIC 210, 220, 353/4, 410/420)
(4) Basic products (ISIC 230, 290, 371/2, 341, 351/2, 361/2/9)
(5) Light industry (ISIC 321/2/3/4, 331/2, 342, 355/6, 381)
(6) Capital goods industry (ISIC 382/3/4/5, 390)
(7) Construction (ISIC 5)
(8) Services (ISIC 6, 7, 8, 9)

ANNEX 1.4

Utilizing sectors (I^u space)

(1) Agriculture (see $I^p(1)$)
(2) Agri-Food processing ($I^p(2)$)
(3) Oil extraction (ISIC 220)
(4) Utilities (ISIC 4)
(5) Coal mining (ISIC 210)
(6) Other mining (ISIC 230, 290)
(7) Oil refineries and coal products (ISIC 353/4)
(8) Primary processing (ISIC 371/2, 341, 351/2, 361/2/9)
(9) Light Industry (see $I^p(5)$)
(10) Capital good Industry (see $I^p(6)$)
(11) Construction (see $I^p(7)$)
(12) Services (see $I^p(8)$)

ANNEX 1.5

Private consumption categories (I^c space)

(for definition, see Yearbook of National Accounts)

(1) Food, Beverages, Tobacco
(2) Clothing and footwear
(3) Gross rent, fuel and power
(4) Furniture, furnishing and household equipment and operation
(5) Medical care and health
(6) Transport and Communication
(7) Recreation, entertainment, education and cultural services
(8) Miscellaneous goods and services

ANNEX 1 (contin ·d)

SUMMARY ANALYTICAL EXPRESSION OF THE UNITAD MODEL

Preamble: It is assumed here that only one classification is used for goods and services by production, utilisation, trade, consumption sectors.

1. Interregional equations

1.1 Trade commodities category

$$EX_T(11) = s_T * IM_T(11)$$

. EX_T (resp. IM_T) is the vector, the components of which are the exports (resp. imports) of category T for the 11 regions.

. s_T is the trade share matrix for category T.

$$PIM_T(11) = s_T' * PEX_T(11)$$

. PIM_T (resp. PEX_T) is the vector, the components of which are the prices of imports (resp. exports) of category T for the eleven regions.

. s_T' is the transposed matrix of s_T.

1.2 Capital flows

$$ODA(11) = [\sigma(11) * oda(11) - \widehat{oda}(11)] * GDPC(11)$$

. ODA(11) is the vector of the official development aids received (>0) or given (<0).

. $\sigma(11)$ is the column vector of percentages of the total ODA received.

. oda(11) ($\widehat{oda}(11)$) is the row vector (diagonal matrix) of the percentage of GDPC given as ODA.

. GDPC(11) is the column vector of the gross domestic product at current price.

$$MCAP(11) = [\mu(11) * xcap(11) - \widehat{xcap}(11)] i$$

. This is a symetric equation of the precedent one for the export, import of capital.

. i is a vector of 1.

. xcap(11) is the row vector of capital export by region.

ODEB(11)= f [odeb$_{-15}$(11), MCAP(11), mcap$_{-15}$(11)]

. ODEB is the vector of outstanding debt.

MINT(11)= f [ODEB(11), MCAP(11), BAGOSE(11)]

. MINT(11) is the vector of the interests paid (>0) or received (<0).

. BAGOSE is the trade balance of goods and services.

2. Regional equations

2.1 Employment and investment

LP(.) = f (ivy(.), caple(.), t, ...)

. LP(.) is the productivity vector by sector

. ivy(.) is the vector of the value-added coefficient.

. caple(.) is the vector of the capital-labour ratio.

. For agriculture, services and construction sectors, the treatment differs according to the region. The productivity is a function of employment gap.

LD(.) = VA(.) / LP(.)

. LD(.) is the employment by sector

. VA(.) is the value-added by sector

LSX(.) = wax * prx

. LSX(.) stands for labour supply of the Xth category (male urban, male rural, female urban, female rural).

. wax is the working age population of the Xth category.

. prx is the participation rate of the Xth category.

LABGAPX = LSX - LDX

. LABGAPX is the labour gap for category X.

. LDX is the distribution of LD(.) in the Xth category.

CAP(.) = caple(.) * LD(.)

. CAP(.) is the gross capital at the target year, which for agriculture could be increased to account for land extension cost and cropping intensity variation cost.

IR(.) = f (ir_{-15}(.) , CAP(.))

. IR(.) is the investment requirement vector.

. ir_{-15} is the same vector at the base year.

. This function has been developed under the hypothesis of an exponential variation of the investment requirements.

GCF(.) = bmi * IR(.)

. GCF is the vector of the gross capital function in the classification by production sectors.

. bmi is a transfer matrix.

2.2 Imports

M^t(.) = f (VA(.), GCF(.), MVA, GDP, Popmcy, dut)

. M^t(.) is the vector of imports by categories.

. MVA is the manufacturing value-added.

. Popmcy is a parameter which determines the degree of co-operation among countries inside the region.

. dut is a trade barrier coefficient.

2.3 Income distribution and private/public consumption

SAVING = f (NDIG, NDIHX, GDIE)

. SAVING is total savings (national concept).

. NDIG is total government income (national concept).

. NDIHX is household income by category (national concept)
. GDIE is enterprise income (national concept).

BAGOSE = EXPC(.) - IMPC(.)

. EXPC and IMPC are exports and imports at current prices.

SAVING = GFCC(.) + BAGOSE + net factor payment + ODA

. GFCC is the gross capital formation at current prices.

(NDIG, NDIHX, GDIE) = f (ALPHA, GDFC, ODA, MINT)

. ALPHA is an endogenous parameter which is determined by the precedent equations.

In conclusion, income distribution is fixed in such a way that the two equations defining savings are satisfied, and that there is equality between expenditures and resources.

$$GCCU = \alpha \, GDPC + \beta \, [Exp. \, rent]$$

. GCCU is total consumption of the government at current prices.

. Exp. rent is the income accruing from exogenous export price.

$$CPCUX = (a + b \, NDIHX / popx) * popx$$

. CPCUX is the total consumption of household of category X.

. popx is the total population of category X.

$$GC(.) = gc(.) * GCCU$$

. GC is the government consumption by sectors.

. gc(.) is the structure of this consumption by sector

$$CPC(.) = f \, (CPCUX, FDD(.))$$

. CPC(.) is the total household consumption by sector

. PDD(.) is the vector of domestic prices.

2.4 Price evaluations

$$PVA(.) = f \, (ALPHA, pw, pnw)$$

. PVA(.) is the value-added price vector.

. pw is the index of wage price.

. pnw is the index of non-wage price.

$$PGO(.) = (I - A')^{-1} * PVA(.) * (I - A')i$$

. PGO is gross output price vector dual of value-added price vector.

. i is column vector of 1.

. A is I/O coefficient matrix.

$$PDD(.) = PGO(.) + \frac{[PIMP(.) - PGO(.)] * IMP(.)}{GC(.) + CPC(.) + GFC(.) + EXP(.)}$$

This equation leads to the equalities between expenditures and resources at current and at fixed prices.

2.5 Input output results

$$FD(.) = GC(.) + CPC(.) + GFC(.) + EXP(.) - IMP(.)$$

. FD(.) is the final demand vector.

$$GO(.) = (I - A)^{-1} * FD(.)$$

. GO(.) is the gross output vector.

$$VA(.) = (I - A')\,i * GO(.)$$

2.6 I/O matrix generation

The input/output matrix which is in this model changes according to several rules:

$$A_1(.) = f\,(A_o(.),\ GDP,\ pop)$$

. $A_o(.)$ is the initial matrix

. $A_1(.)$ is the final I/O matrix.

. This regression equation defines the I/O coefficients in relation to GDP per capita.

$$A_2(.) = u\,A_1(.) + (1 - u)\,A_n(.)$$

. $u = f\,[caple(n) / caple(.)]$

. $A_2(.)$ is a weighted average of matrix $A_1(.)$ and a target matrix $A_n(.)$.

. The weight u is a function of the ratio of the two values of caple associated with matrices $A_n(.)$ and $A_1(.)$ respectively.
Thus $A_2(.)$ will tend towards $A_n(.)$ insofar as caple(.) is close to caple(n).

* * *

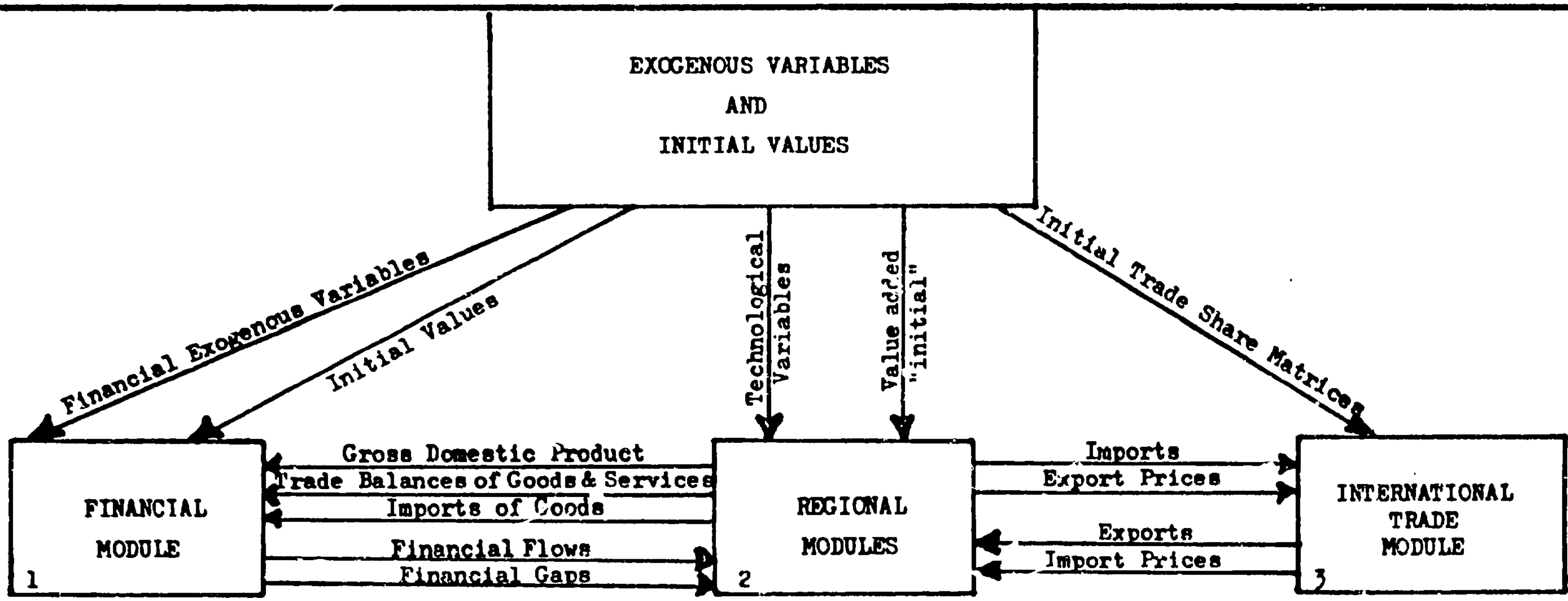
ANNEX 2

FLOWCHARTS FOR THE REGIONAL MODELS

(MARKET ECONOMIES)

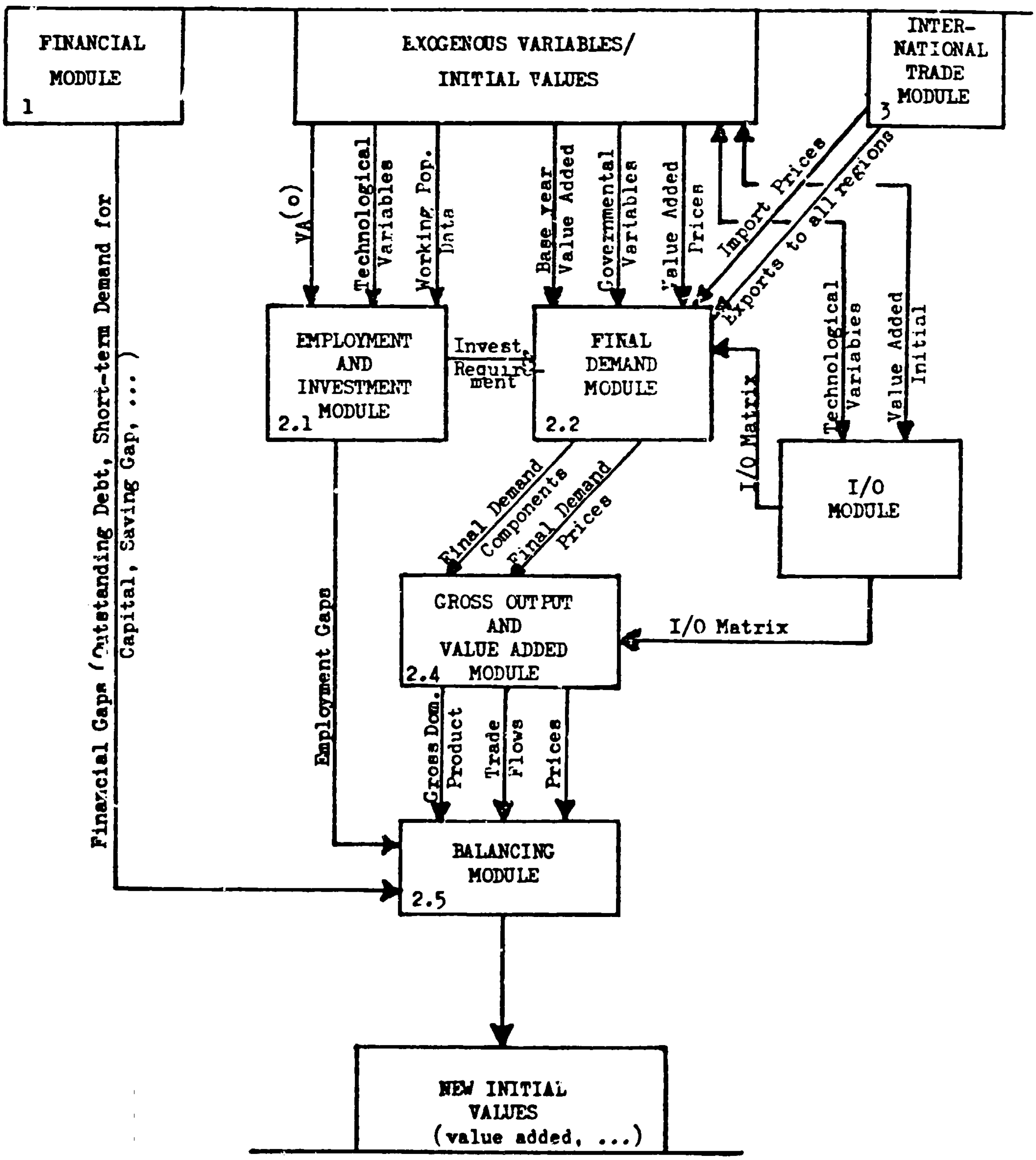
Contents

Flowchart I: THE GLOBAL MODEL

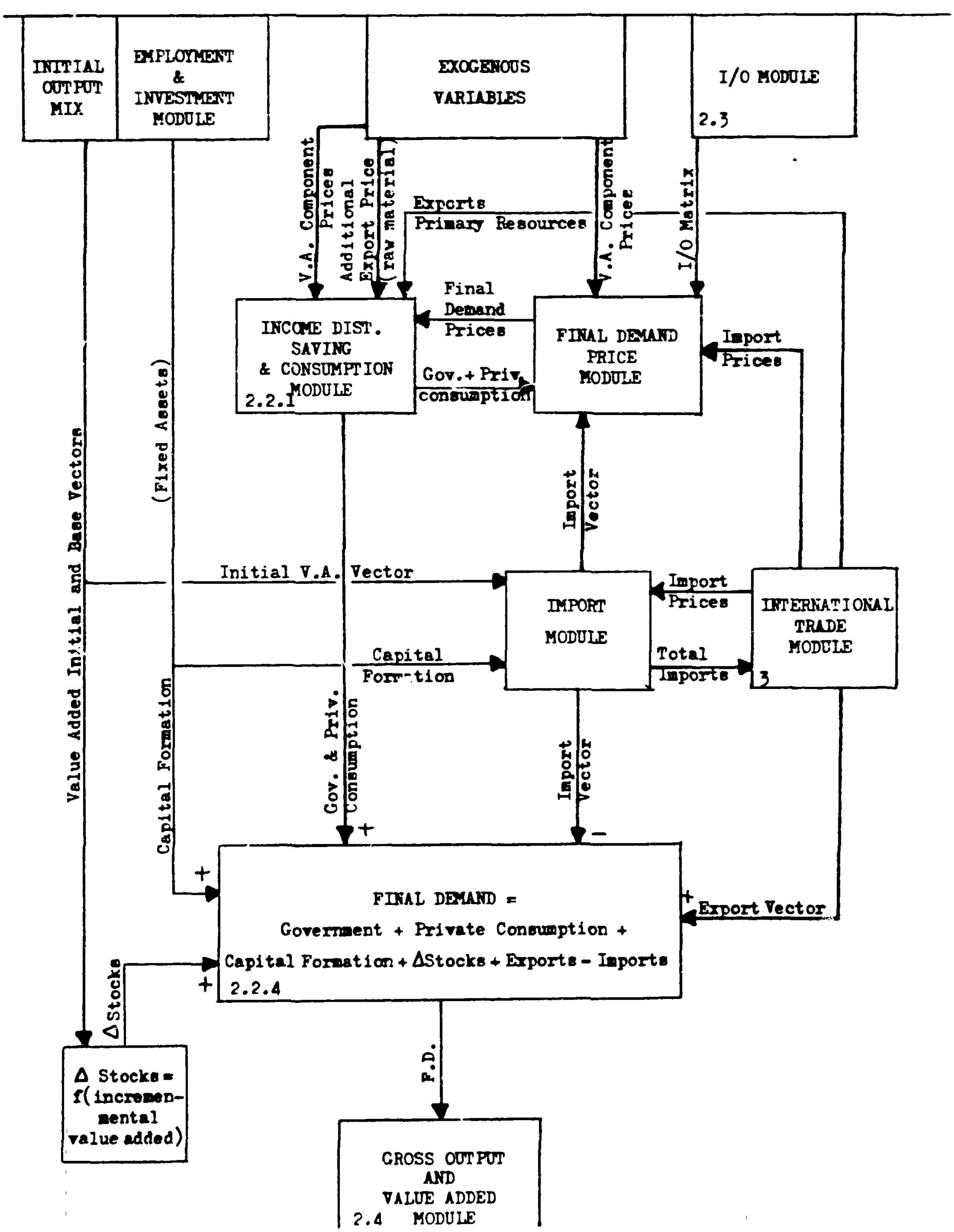


Flowchart I: THE GLOBAL MODEL

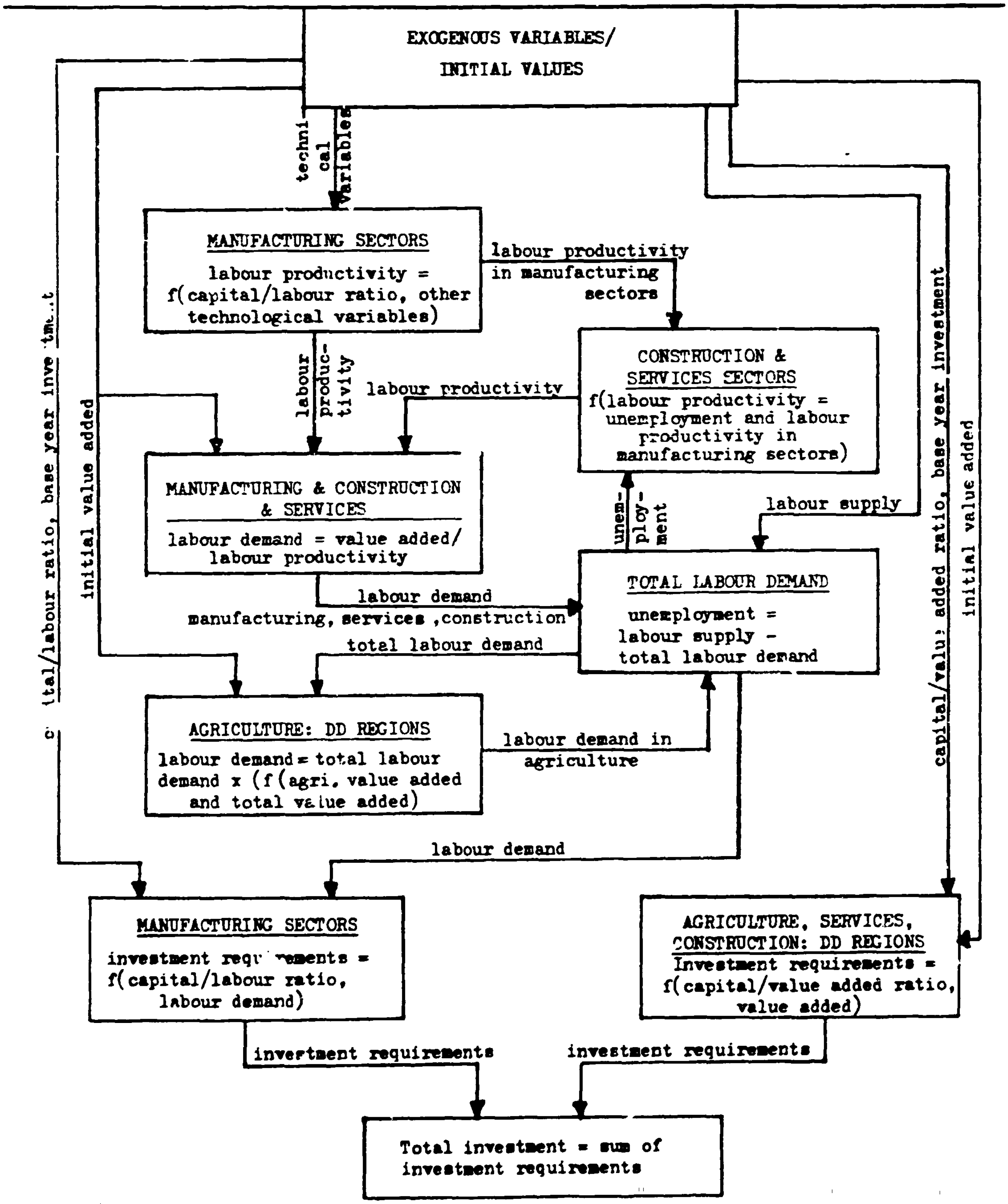
Flowchart II: REGIONAL MODEL



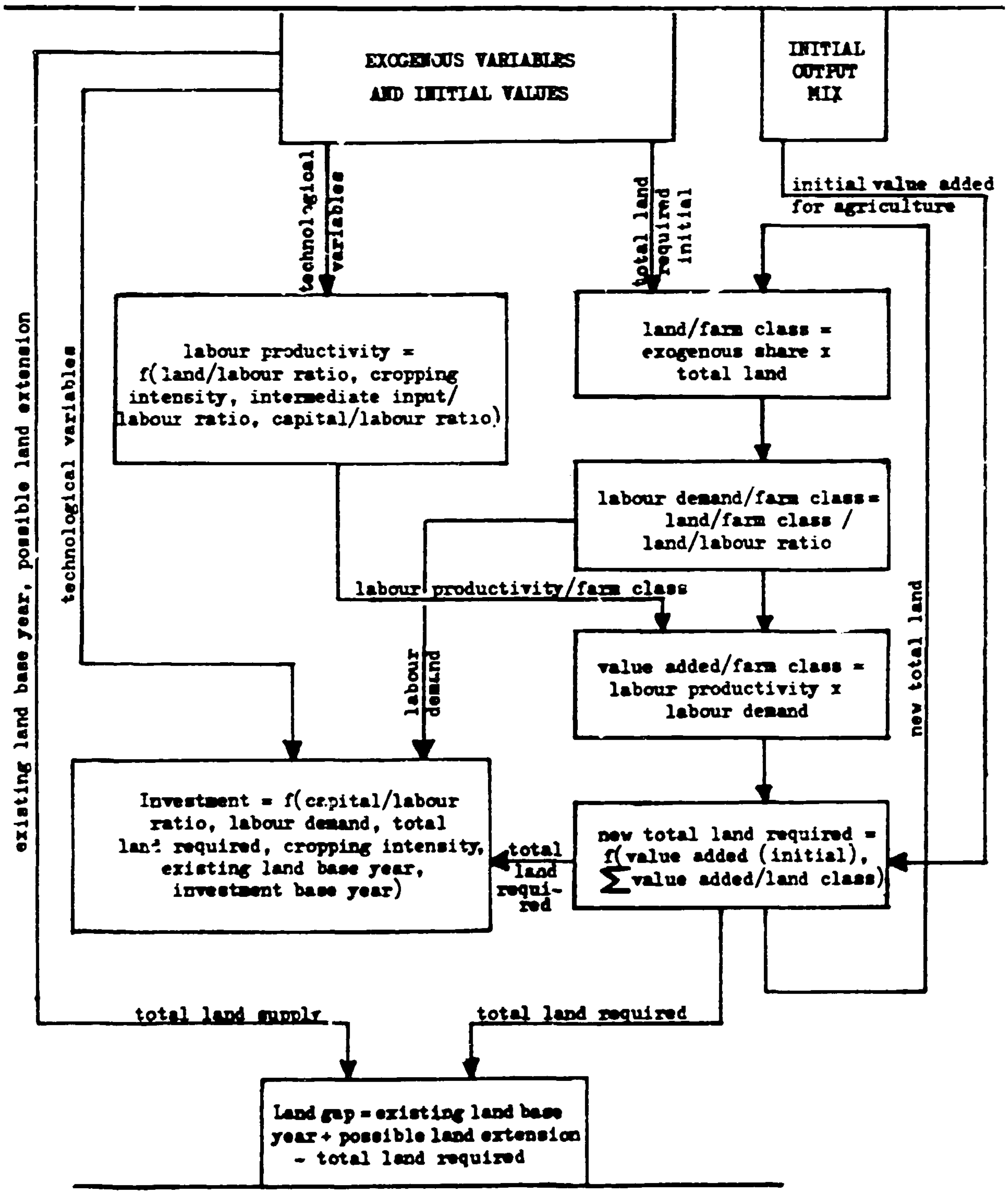
Flowchart III: FINAL DEMAND MODULE



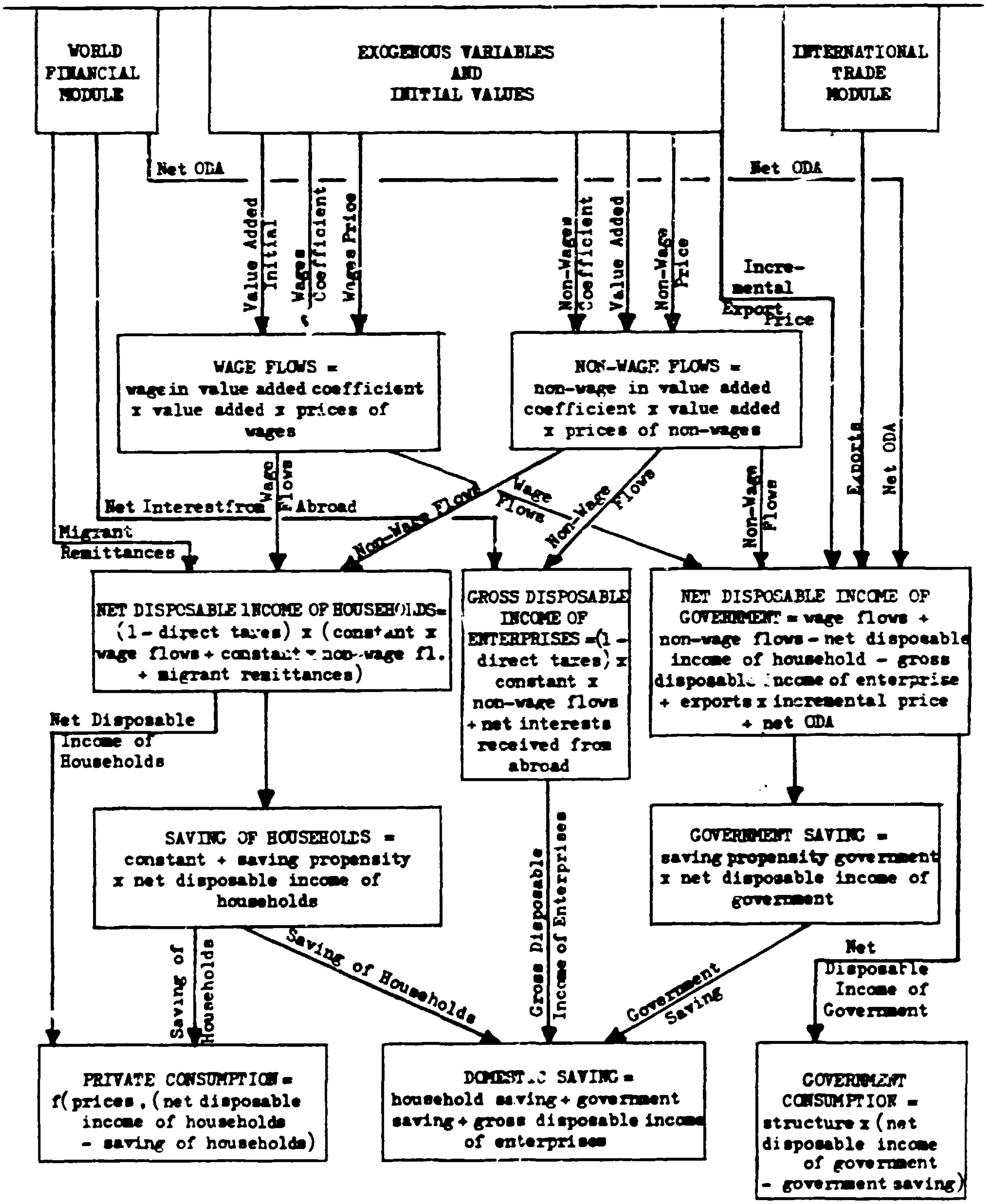
Flowchart IV: EMPLOYMENT AND INVESTMENT MODULE
(including AGRICULTURE for DD REGIONS only)



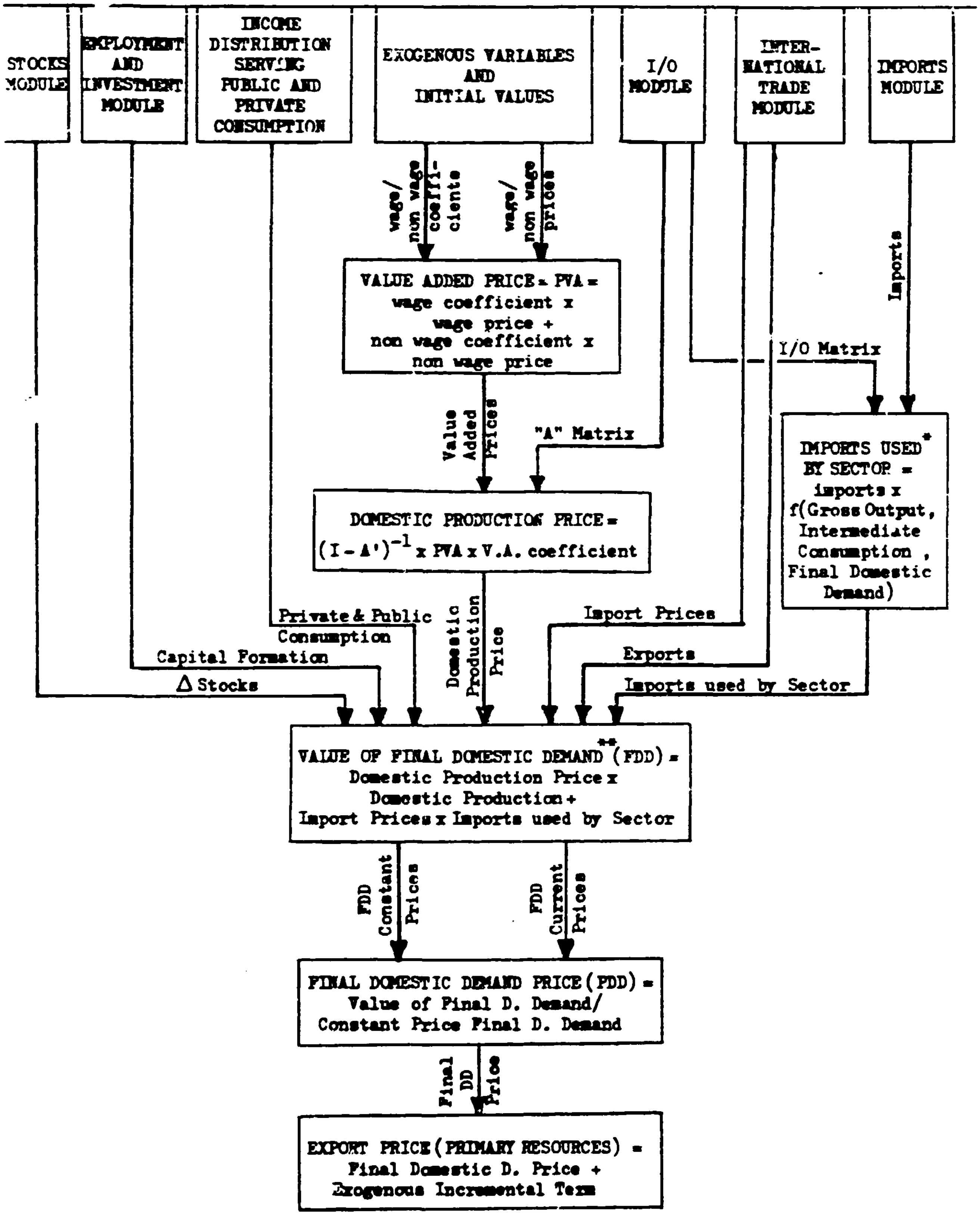
Flowchart V: AGRICULTURE MODULE: DC REGIONS



Flowchart VI: INCOME DISTRIBUTION, SAVING, PRIVATE AND PUBLIC CONSUMPTION MODULE



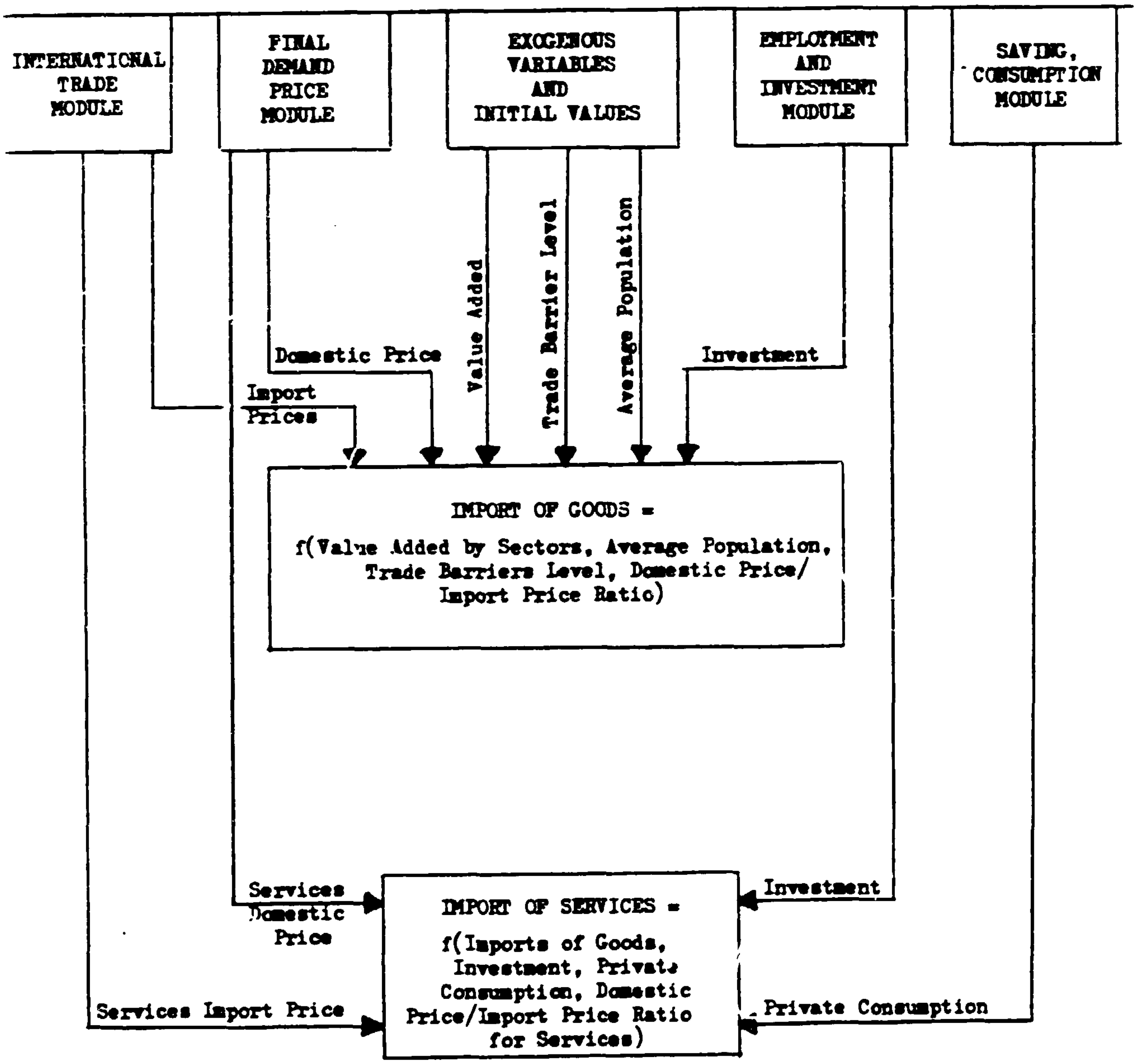
Flowchart VII: FINAL DEMAND PRICE MODULE



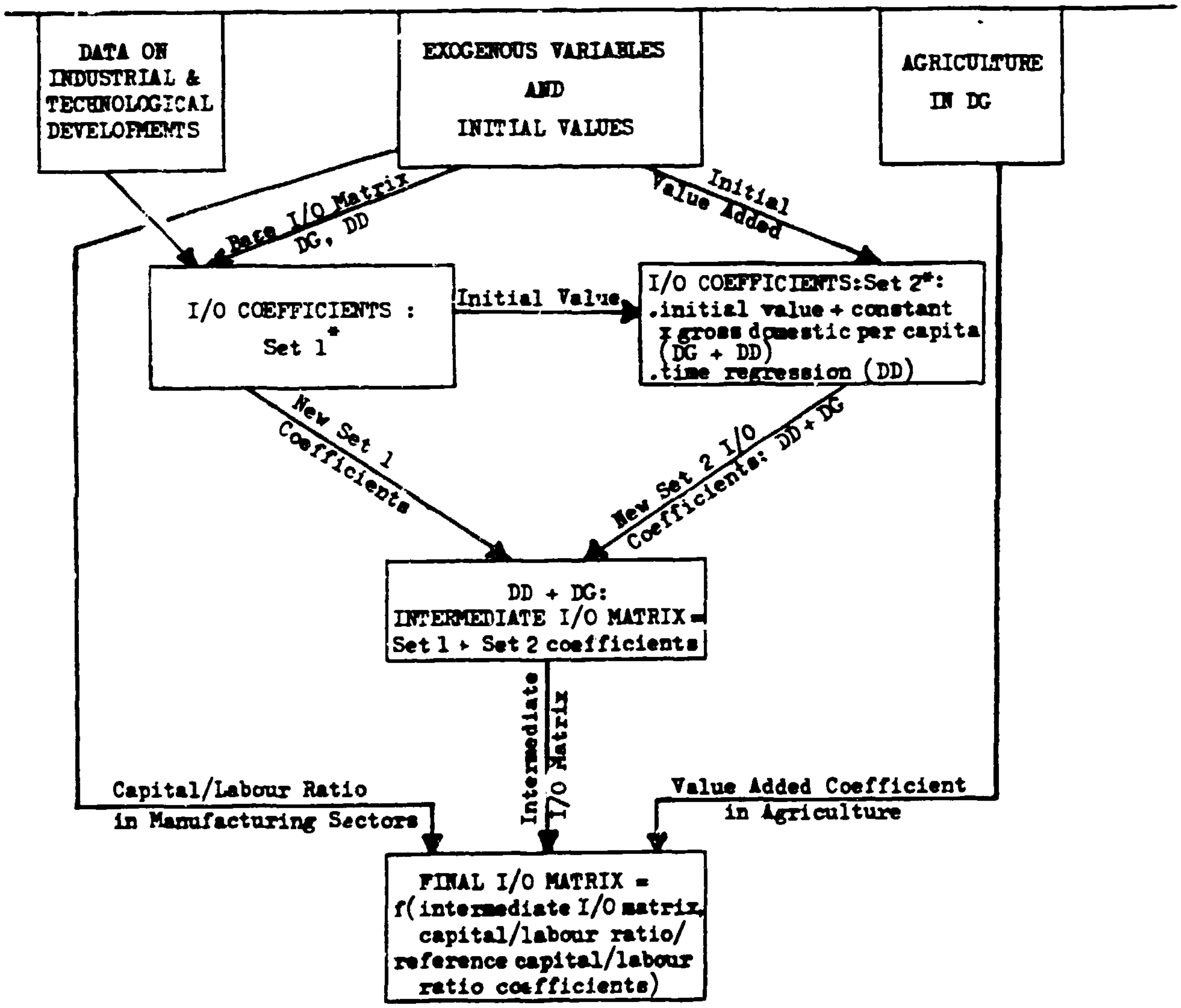
* 'Imports used by Sector' includes intermediate imported inputs of the corresponding column of the I/O matrix and excludes imported inputs of the corresponding row (except diagonal figure);

** 'Final Domestic Demand' (FDD) includes exports.

Flowchart VIII: IMPORT MODULE



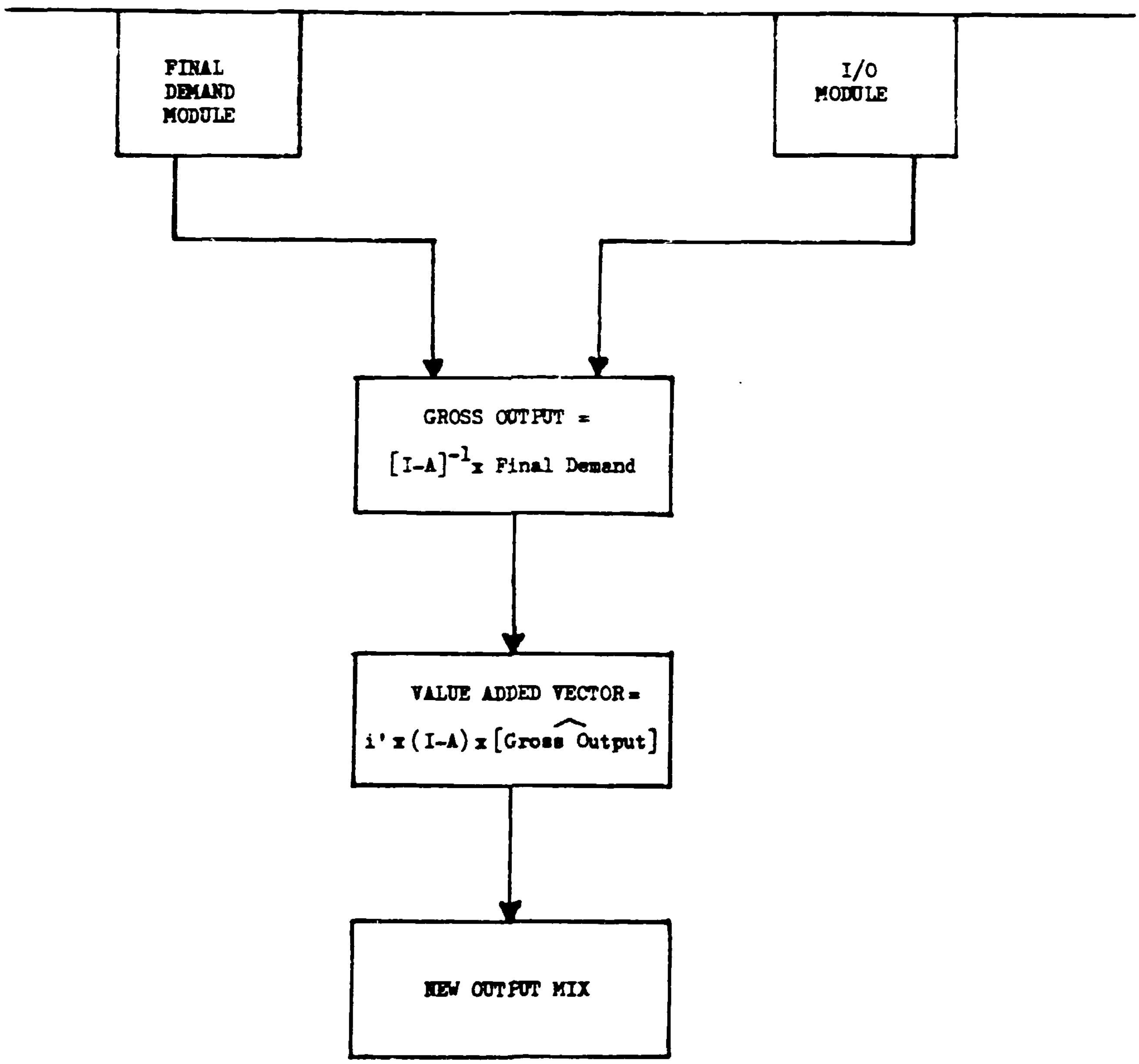
Flowchart IX: INPUT/OUTPUT MODULE (I/O MATRIX)



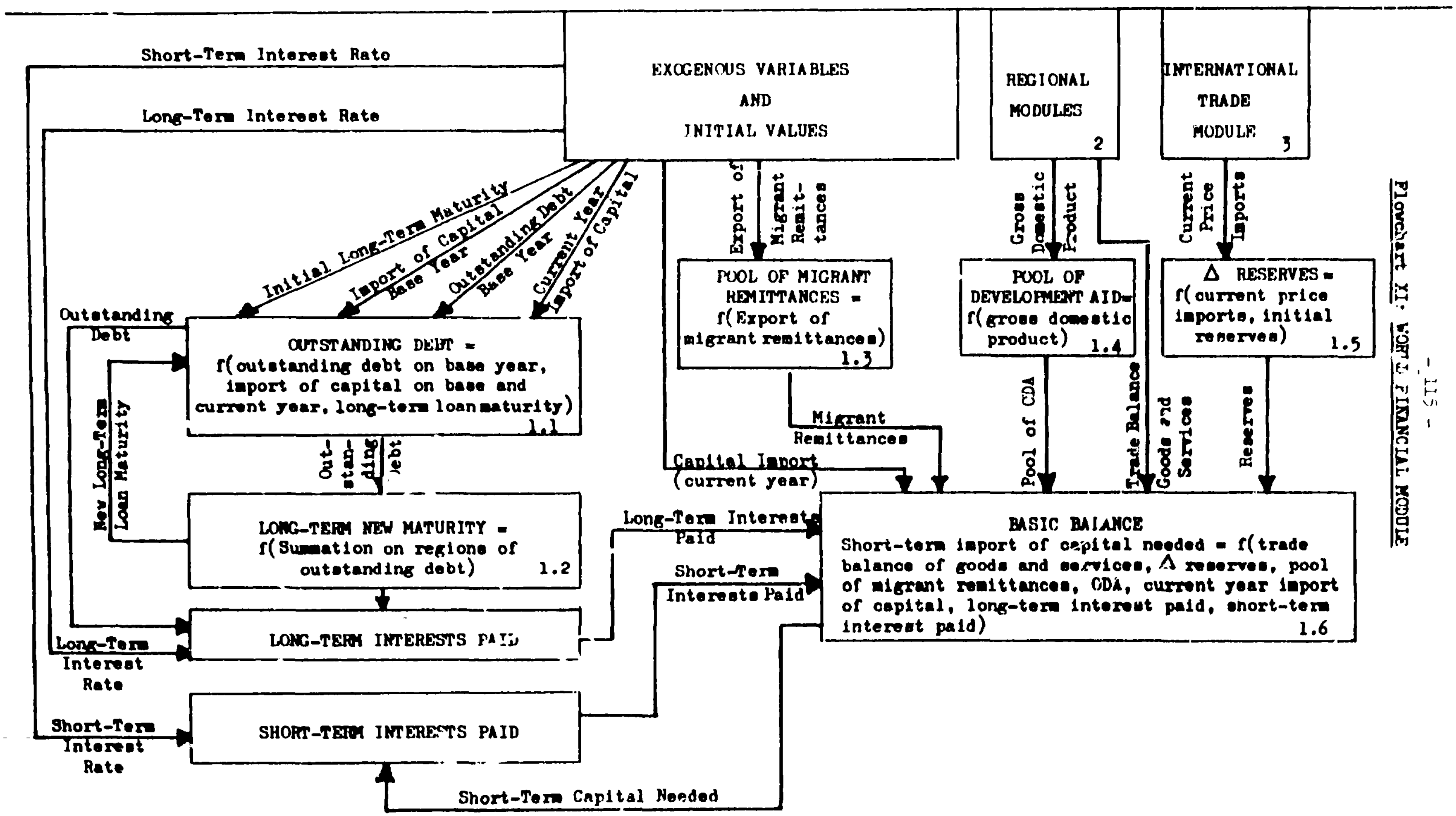
* set 1 of technological coefficients: no significant time or cross-country regressions are available;

* set 2 of technological coefficients: significant time or cross-country regressions are available.

<u>Flowchart V: GROSS OUTPUT MODULE</u>

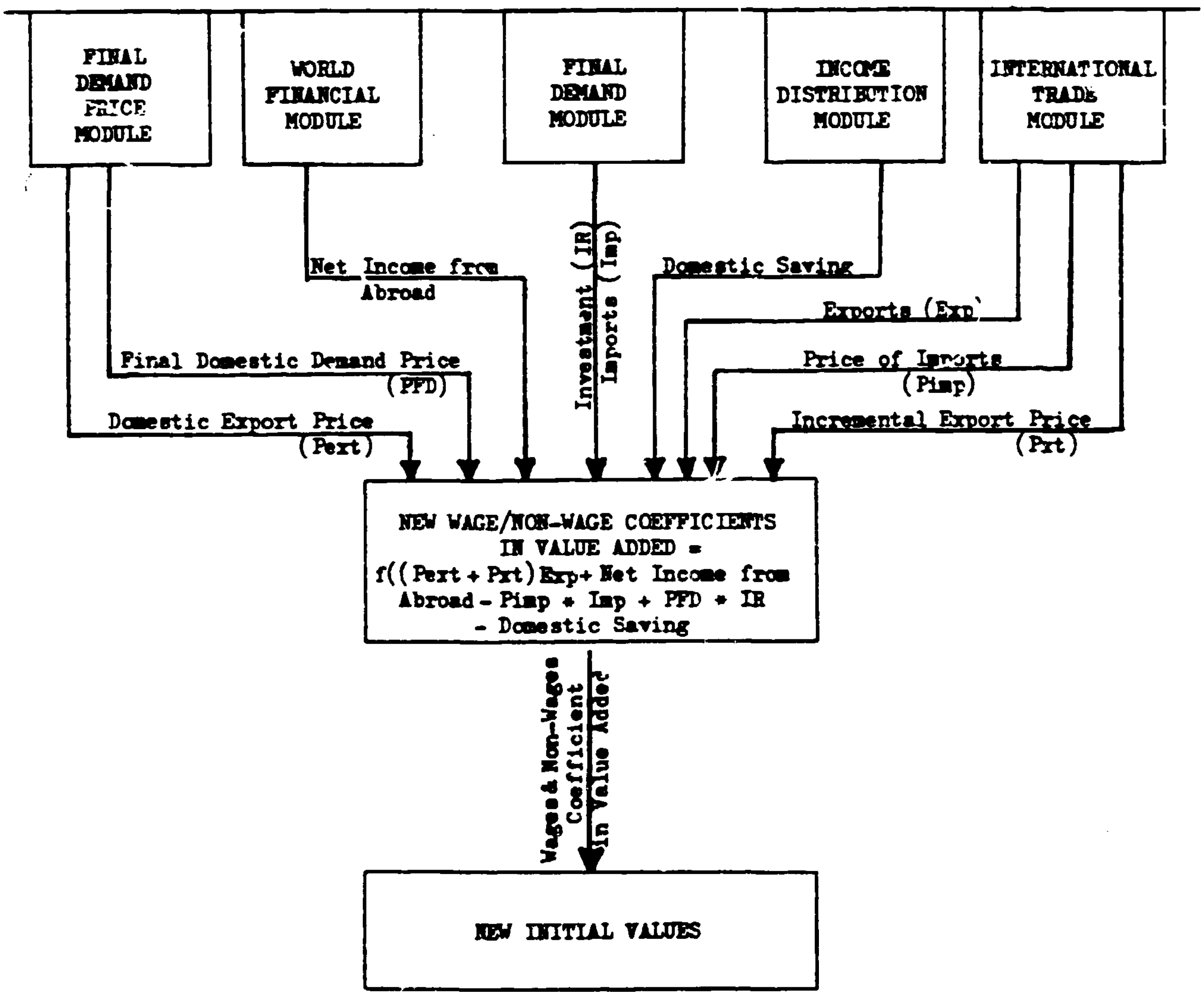


lowchart XI: WORLD FINANCIAL MODULE



Flowchart XI: WORLD FINANCIAL MODULE

Flowchart XII: BALANCING MODULE

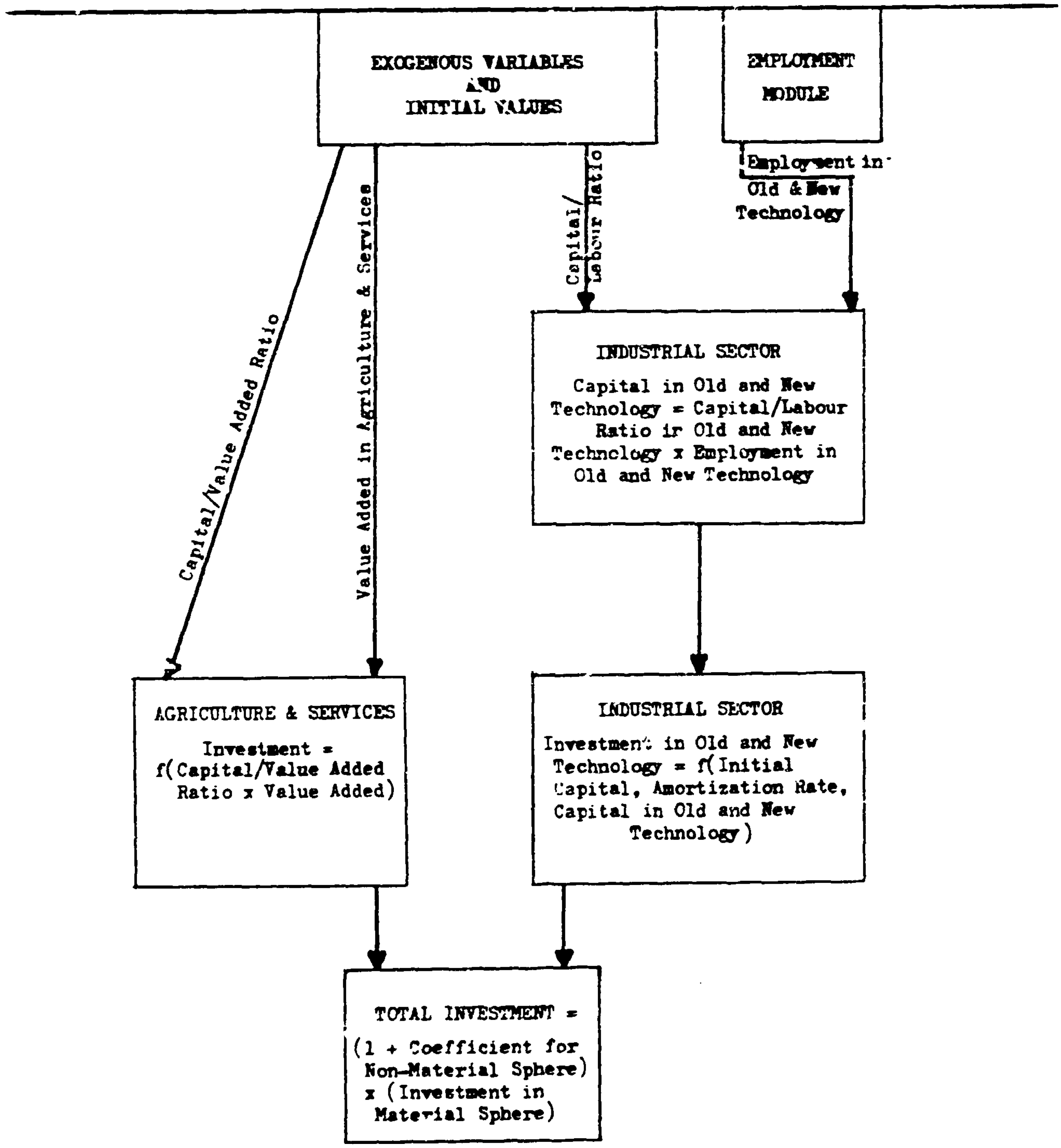


ANNEX 2
(continued)

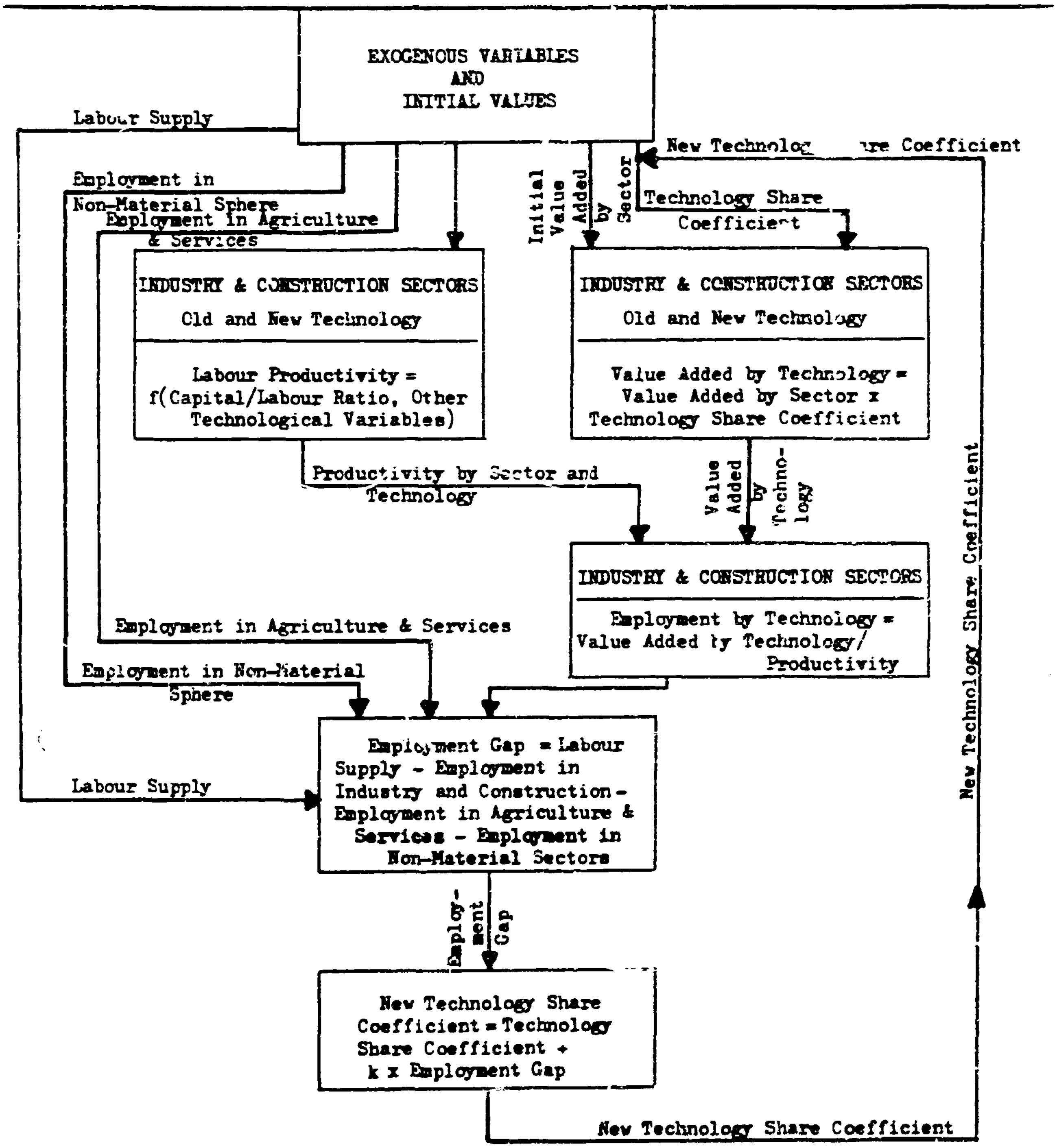
FLOWCHARTS FOR THE REGIONAL MODELS
(CENTRALLY PLANNED ECONOMIES, EUROPE)

Contents

Flowchart XIII: INVESTMENT MODULE, EASTERN EUROPE



Flowchart XIV: EMPLOYMENT MODULE, EASTERN EUROPE



ANNEX 3

THE AGRICULTURAL SUB-SYSTEM[a/]

In the economic literature of the 1950's and 1960's the role of agriculture in development was seen as secondary, in the sense that its functions were considered complementary to those of the industrial-modern sector. The latter was thought to represent the main sector of accumulation and growth. Subsequent theoretical investigation and the very disappointing performance of agriculture in most developing countries during the last two decades in development should be radically reexamined[b/]. Erratic and inegalitarian growth, persistence of malnutrition, periodic famines, slow growth of agricultural incomes, together with increased food dependence from abroad, have continued to affect, although with different intensities, a large number of developing countries, especially in Africa and South-East Asia. The figures of Table 3.1, in fact, show that with the exception of the Centrally Planned Economies of Asia and of the West Asian countries, agriculture and food output per capita have increased at low or negative rates.

Table 3.1: Annual growth rates of agricultural output per capita (in per cent)

Region*	Agricultural gross output per capita		Food output per capita	
	1960-65 to 1970	1970 1976	1961-65 to 1970	1970 1976
L. America	0.2	0.1	0.8	0.5
Africa	0.2	-1.5	0.1	-1.4
West Asia	0.4	1.1	0.3	1.4
Far East	0.8	0.1	0.9	0.2
CPE, Asia	1.0	0.7	0.9	0.6

Source: FAO, Fourth World Food Survey, Rome, 1977.

* These regions only broadly coincide with those defined in UNITAD.

a/ This section summarizes and updates the paper "Institutional and Technical Factors in Agriculture: Evidence for Selected Developing Countries" (by G.A. Cornia), July 1980, submitted to the ACC Working Group of the Task Force on Long-Term Development Objectives.

b/ The UN Committee on Development Planning, under the chairmanship of Tinbergen, recognised the need for such a reexamination already in the 1960's.

However, the situation is substantially worse than highlighted by these overall tendencies. Indeed, the initial conditions from which the low growth has been taking place were already quite distressing. In most developing countries average per capita food supply was conspicuously lower than requirements, while food consumption was traditionally very skewed. Now, recent investigation has shown that such inequality would appear to have increased even in countries experiencing relatively rapid agricultural growth. Thus, the combined effect of low starting points, slow or negative growth of food output per capita, and the worsening of the distribution of income and food consumption explain how the number of people with a deficient food intake has increased, and how famine threat continues to hang on many countries.

Quite evidently, slow and inegalitarian agricultural performance has been accompanied by a very slow growth of agricultural incomes, rural wages and small farmers incomes in particular. This tendency has often been reinforced by a deterioration of the internal terms of trade. Besides obliging many peoples to go by with empty stomachs, such a situation has contributed, in many instances, to reduce effective demand and, thus, to keep domestic industrial output low. It is now widely acknowledged that at the early stages of development, the role of agriculture in overall growth is determinant and that a sustained industrialization process can hardly take place unless a viable, surplus-generating agriculture has been created. As the Chinese say, agriculture is the foundation, and industry the leading sector. If the foundations are weak - to continue the analogy - industry collapses. Similarly, the growth of agriculture is very much conditioned by the supply of key industrial inputs.

Economic theory and empirical investigation have, by now, showed how strictly interwoven are the growth of the two sectors. It is customary to summarize the major interplays of industry and agriculture in the following way:

(1) Food and agricultural raw materials are supplied to the other expanding sectors of the economy, usually industry and services. Were this flow to be insufficient or irregular, industrialization would be likely to be jeopardized by inflation profit squeeze, increasing wages, declining domestic demand for manufactures and labour unrest.

(2) Part of rural cash incomes are spent for the purchase of industrial products. For several reasons (see policy conclusions of comprehensive scenarios) the growth of industry cannot take place exclusively via the growth of export markets. Hence, in developing countries, a <u>conditio sine qua non</u> for sustained industrial growth is the growth of the domestic market, through the increase and fair distribution of agricultural incomes.

(3) Particularly for those economies without a 'rent' sector, such as gold or oil mining, agriculture has to carry the weight of generating investible surplus, at least at the early stages of development. Indeed, the multiform squeeze of agriculture has permitted the accumulation of capital in industry in many of today's developed countries. A weak, stagnating and feudal agriculture cannot carry that weight. Many consider, therefore, that only rapid and diffused growth of agriculture can generate the necessary surplus to be used for capital accumulation in industry.

(4) The gradual modernization of agriculture entails a continuous flow of inputs originating in industry, such as cement, fertilizers, pesticides, more or less simple farming implements, pumps and, when mechanization sets in, tractors, trucks, etc. Two broad industries are responsible for the supply of such items, i.e the equipment-good and the basic-product sectors. Their growth is therefore to be considered essential if agriculture has to take off. Unfortunately, however, many developing countries are dependent in these sectors on the vagaries of foreign trade.

So, although there is nowadays a large consensus on the need for increasing agricultural output while drastically improving rural income distribution, views and policies differ widely on how to attain such objectives. According to what could be labelled 'the technocratic option', output growth and rural development are largely a technical problem. More land, more inputs, more labour, etc., should be imputed to agriculture, which would by this very fact see its output increase steadily. According to the opposite view, 'the institutional option', the existing economic and power structure in agriculture is the major obstacle to rural development. The provision of more and improved inputs, it is conceded, although necessary, would not be sufficient to ensure a fast and egalitarian growth, capable of wiping out rural poverty. The increase in the supply of inputs should be accompanied, or preceded, by measures assuring broadly equal access to land an other productive assets to the rural population. This could be achieved either through land redistribution or through some type of collectivization of agriculture. According to this view, the experience of South Korea and Taiwan or of China prove the feasibility of such blueprint in the two cases hypothesized. Of course, there are also many other 'options' which combine elements of the one and the other in various ways and degrees.

Quite evidently, the adoption of one instead of the other approach would have very different consequences in terms of benefit from growth, as well as in terms of the speed of such growth. In addition, the entire agriculture-industrial relationships and, hence, overall growth, would likely be affected in very diverse ways. This is why, to the most possible extent, an attempt has been made in the UNITAD system to model the structure and functioning of agriculture so as to test alternative rural development policies. In particular, the model has been devised in a way so as to simulate an input intensive path, as well as the effects on agricultural growth within a framework of an egalitarian rural development.

The formalization of the agricultural sector

For the reasons indicated in the preceding remarks, the agricultural sector has been given a different treatment in developing versus developed countries. In the latter, agriculture does no longer play a predominant role, neither in production and accumulation nor in distribution and consumption. Hence the production, technology and distribution aspects have been formalized in a simpler way. Agricultural final demand is fixed mainly by the level of domestic food consumption and by trade in agricultural commodities. Through the Leontief relation, the model determines jointly the level of output and value added to be produced by agriculture. Once agricultural value added is known, labour productivity in agriculture is made dependent on the overall level of productivity of the economy. Indeed, it has been observed[c/] empirically that the relation

$$L_1/L = f(VA_1/VA)$$

(with L and L_1 and VA and VA_1 representing overall and agricultural labour

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c/ See Danieli Luisa: "Labour Scarcities and Labour Redundancies in Europe by 1190: an Experimental Study", Dipartimento Statistico Matematico, Università di Firenze, 1971.

force and value added) tends to behave both over time and across countries, according to a reasonably uniform pattern.

In the linear case this relation can be transformed as follows: $VA_1/L_1 = \alpha + \beta VA/L$. This relation makes labour productivity in agriculture dependent from the overall one. Labour demand can thus be derived by dividing total value added by labour productivity. Technical conditions of production (land, cropping intensity, inputs, etc.) are not made explicit in this framework, except by the structure of the inputs vector in the input/output table. Of course, the value of such vector strongly influences the level of value added as well as the demand for inputs. Investment demand is derived by multiplying labour demand by a given capital/labour ration.

For developing countries, agriculture has been modeled in greater detail. Land - which is explicitly introduced into the system - and other resources are distributed to three types of holdings: large, medium and small (in Africa the distinction which has been made is between subsistence holdings and plantation sectors). The definition of large, etc. varies according to the overall degree of land-scarcity. In Latin America, for instance, small farms can reach 20 hectares and large farms exceed 200 hectares, while in South and East Asia, small and medium farming never surpass 2 and 10 hectares. Production takes place on each of the three types of farms according to different techniques. Indeed, it has been observed that the inputs of land, intermediate inputs and capital per worker are higher in larger holdings, while the opposite is true for labour inputs and cropping intensity. As a result, labour productivity is generally higher, and yields per hectare lower, on big estates. Since the distribution of land among the three types of farms is kept exogenous in the system, it is possible to reckon the effects of alternative patterns of distribution in terms of land, labour and capital inputs, as well as in terms of agricultural output and value added. Hence, the model can be used to explore the employment, output and distributional effects of a more egalitarian agricultural growth. The results of such a process can be contrasted with those strategies emphasizing agricultural modernization through a more intensive use of fertilizers and machinery.

The explicit introduction of production factors also allows experimentation with different types of agricultural modernization and technological transformation. For instance, one may explore the viability of the "East Asian pattern" (as applied in Japan, Taiwan and China) which requires an increase in fertilizers, labour and land improvement works (e.g. irrigation) versus that of the "Western pattern", where an increase in intermediate inputs has been accompanied by mass mechanization, increase in the size of holdings and progressive expulsion of labour from agriculture.

For developing countries the model also introduces the cropping intensity (as the ratio between harvested and farmed area) as well as the total land supply. The latter is equal to the amount of arable land plus land extension, which should not exceed the maximum feasible values as estimated by FAO. The introduction of these variables allows the testing of other agricultural strategies based, where possible, on the extension of the arable area (as in Latin America) or on the extension of the harvested area by means of higher cropping intensities. These strategies, however, are not costless. An increase of the arable area generally requires a considerable investment - up to 1975 US$ 2,000-3,000 per hectare - in land clearance and preparation. Similarly, an increase in cropping intensity entails year-round irrigation and, hence, the execution of works of canalization, well-digging, etc. Unless these activities are carried out through the mobilization of surplus labour, a strategy of this type may require the substantial shift of investible resources towards agriculture.

The overall functioning of the agricultural sub-system in developing countries is similar to that adopted for the developed ones. Agricultural final demand depends upon domestic food consumption (which, in turn, varies according to the overall level of income and its urban-rural distribution) and upon trade in agricultural commodities. Agricultural output and value added are obtained through the Leontief's inverse relation. In the case of developing regions, as a next step, the share of value added and output to be produced by each of the large, medium and small farming sectors depends upon the proportion of land allocated (exogenously) to each of them. In each of them labour productivity is dependent on land per worker (LN/WO), cropping intensity (CRI), capital per worker (KA/WO) and intermediate inputs per worker (GO-VA)WO. The equation reads:

$$VA/WO = f\,[\,LN/WO * CRI,\ KA/WO,\ (GO-VA)/WO\,].$$

As noted earlier, the exogenous variables of this function are different in the large, medium and small farms. Hence labour productivity, as well as the requirements for land, labour, capital and other inputs, will vary considerably for the three different types of farming. Total productivity and requirements are obtained by adding up the three sectors. It follows that factor requirements are considerably affected by the exogenous share of land accruing to each class of farms. Labour demand in agriculture is added to labour demand in rural industries, and the total is compared with rural labour supply. Capital demand is added to the demand of all other sectors of the economy and compared with total savings. Similarly, total land demand is compared with land supply so as to assess whether the strategy envisaged is plausible or not. An excess demand is clearly not feasible and the assumption on which it is based should therefore be modified.

Results of the empirical analysis[d]

In the analysis of these various issues, a number of alternative data sources have been used. The most important is an unpublished collection of production data at the farm level, provided by the Farm Management and Production Economics Service of FAO. For 19 developing countries, this source provides farm data concerning owned, operated and harvested area, cropping intensity, labour, capital and fertilizer inputs, output, value added and others. All developing regions of the UNITAD system are represented in the sample, which covers 3167 farms altogether. These data have been used for estimating the labour productivity functions. Other sources of data include the results of the 1960 and 1970 'World Census of Agriculture' by FAO and 'Agriculture: Towards 2000', recently issued by FAO. They have been used particularly for the compilation of the data on land distribution, land use patterns, land supply and cropping intensities. The 'Economic Accounts' and the United Nations document PPS/Q1R/5 'Major Economic Indicators Showing Historical Development Trends' have been used to cross-check the data on labour, intermediate inputs and capital use obtained from the FAO collection of farm data. Lastly the input/output tables provided by UNIDO were used, as for the other sectors, to take care of intermediate consumption for both developing and developed[e] regions.

The results of the analyses concern the test of the farm-size/land-yield relation; the estimation of labour productivity relations; the analysis

d/ The results presented here refer only to the developing regions. For the developed ones the empirical analysis has consisted solely in the estimation of the parameters of the functions $L_1/L = a+b\ VA_1/VA$. Their interest being limited, they have been omitted in this presentation.

e/ For the latter, the productivity relation was estimated on data contained in document PPS/Q1R/5.

of substitutability and/or complementarity among production factors; and, the compilation of trend value for the exogenous variables of the agricultural sector. The latter will receive only a brief mention here.

Concerning the relation between farm-size and land-yield for the 15 developing countries, as retained after debugging the original tapes, a number of indicators have been ranked in ascending order according to the size of the farm (measured in hectares). They are: gross output per hectare (GO/LN), man-days of work per hectare (MD/LN), intermediate inputs (seeds, fertilizers) per hectare ([GO-VA]/LN), capital per hectare (KA/LN), cropping intensity (CRINT), gross output per worker (GO/WO) and gross output per man-day (GO/MD). When examining these indicators, a number of relations appear to hold true, with a few exceptions, in all developing countries in the sample. The main findings are that: a) factors inputs per unit of land (man-days, cropping intensity, intermediate inputs and capital) are inversely related to the size of the farm; b) yield per unit of land, measured in output as well as in value added terms, also decrease as the size of the farm increases; c) labour productivity increases as the size of the holding rises. Regression analysis has been used to obtain a rigorous test of these evident tendencies. For this purpose, the following models have been estimated, for each country, using the original farm data:

a) resources use	$\log MD/LN = a + b \log LN$
	$\log KA/LN = a + b \log LN$
	$\log (GO/VA)/LN = a + b \log LN$
	$\log CRI = a + b \log LN$
b) land yield	$\log GO/LN = a + b \log LN$
c) labour productivity	$\log GO/WO = a + b \log LN$
	$\log GO/MD = a + b \log LN$

The results of this test are presented in Table 3.2 hereafter, which confirms, to a satisfactory extent, the existence of a negative relation between factors use and land-yield on the one side and farm-size on the other, as well as a positive relation between farm size and labour productivity. The former relation, in regions where land is a scarce resource, which is always true for irrigated land, suggests that small farms are socially more efficient than large ones; therefore, a land redistribution would increase total output, besides improving income distribution.

The FAO farm data have also been used for the estimation of the labour productivity functions of the system. Such functions, which can be derived from an extended Cobb-Douglas, take the following form:

Table 3.2: Elasticity of Output, Man-days, Intermediate Inputs, Capital (all per hectare), Cropping Intensity and Labour Productivity with respect to Farm Size

COUNTRY	GO/LN	MD/LN	[GO-VA]/LN	KA/LN	CRINT	GO/WO	GO/MD
Barbados	-0.36	-0.51	***	-0.53	-0.22*	0.37	0.16**
Mexico	-0.20	-0.77	0.32	-0.38	0.07	1.07	0.58
Peru	***	-0.43	***	***	-0.15	0.80	0.47
Ethiopia	-0.55	-0.94	-0.30	-1.00	0.15*	0.26	0.38
Nigeria	-0.23	-0.57	-0.18	-0.56	***	0.59	0.29
Tanzania	-0.47	-0.57	-0.67	-0.95	-0.07	0.27	0.04*
Uganda	-0.74	-0.83	-0.74	-0.59	-0.41	0.15*	0.09
Syria	-0.64	-0.71	-0.60	-0.63	-0.17	0.20	0.08
Sudan	-0.42	-0.43	-0.27	-0.45	**	0.28	***
Bangladesh	***	-0.09*	-0.44	-0.37	-0.17	0.58	0.10**
Burma	-0.58	-0.65	-0.51	-0.44	-0.05*	0.16	***
India	-0.18	-0.52	-0.25	-0.32	0.08	0.61	0.33
Nepal	-0.21	-0.23	-0.30	-0.50	-0.17	0.50	***
Korea	-0.42*	-1.49	-0.73	-1.26	***	0.73*	1.06*
Thailand	***	***	***	-1.08	-0.15	0.41*	***

SOURCE: Computations of the author; all parameters are significative at over 90 per cent unless otherwise stated;

* significant at a level over 80%

** significant at a level over 70%

*** significant at a level less than 70%

$$GO/WO = e^A (LN/WO * CRI)^a * (KA/WO)^b * ([GO-VA]/WO)^c,$$

where the symbols have the same meaning as above. The estimations country by country have then been aggregated by means of appropriate weights so as to obtain the following regional estimates:

Table 3.3 Parameters of the productivity function in agriculture

	Const.	a	b	c	a+b+c
Latin America	3.4	0.37	0.14	0.44	0.95
Tropical Africa	3.1	0.34	0.19	0.38	0.91
West Asia	2.5	0.20	0.22	0.52	0.94
South Asia	4.0	0.60	0.12	0.30	1.02
East Asia	5.0	0.70	0.10	0.22	1.02

The coefficient of the labour force in the equation obtained for gross output is the complement to 1 of the sum (a+b+c). In South and East Asia, this coefficient can be taken as equal to zero, thus suggesting a saturation of manpower in agricultural production. Small positive coefficients obtain for Latin America and West Asia and a more positive significant coefficient for Tropical Africa where manpower is scarce. The coefficient of capital per worker is generally low, and the elasticity of land per worker relatively high, with an obvious relation to land scarcity f/. On the other hand, the elasticity of intermediate inputs per worker are more important in land abundant countries, such as those of Latin America, Tropical Africa and some of West Asia. To sum up, one gets a picture where output elasticities of each production factor would appear to be related to its relative scarcity.

As a further step in the analysis, the elasticities of the production factors obtained, country by country, from the estimation of the extended Cobb-Douglas production function

$$GO = e^A (LN * CR)^{\alpha} * WO^{\beta} * KA^{\gamma} * (GO-VA)^{\delta}$$

have been plotted one against the other, to see if any uniform pattern exists that would indicate the existence of relations of substitutability and/or complementarity among the production factors. The 15 elasticities of land (α) (see Table 3.4) have been plotted against the 15 elasticities

f/ In this respect, the low coefficients of land elasticity in West Asia are probably reflecting a mix of conditions between rain fed and irrigated land.

Table 3.4 : Elasticities of the Cobb-Douglas production function

Country	Constant	LH*CRI	M D	K A	(GO-VA)/WO	SUM a/	R^2
Barbados	1.79	0.17**	0.52	0.08***	0.38	1.15(0.90)	0.66
Mexico	3.54	0.19*	0.26	0.04**	0.25	0.74(0.70)	0.43
Peru	2.30	0.58	0.35	0.11**	0.23	1.27(1.16)	0.81
Ethiopia	0.74	0.20	0.44	0.23	0.25	1.12	0.63
Nigeria	4.20	0.54	0.18	0.11	0.13	0.96	0.80
Uganda	4.40	0.25	***	0.22	0.14	0.61	0.69
Tanzania	1.95	0.38	0.40	0.23	0.12	1.13	0.63
Sudan	1.76	0.12	0.35	0.29	0.19	1.05	0.50
Syria	2.23	0.15	0.28	0.09	0.52	1.01	0.63
Bangladesh	5.10	1.03	0.03***	0.10**	***	1.16(1.06)	0.65
Burma	-0.64	***	0.47	0.48	0.27	1.22	0.82
India	2.67	0.40	0.28	0.11*	0.30	1.09(0.98)	0.87
Nepal	3.96	0.71	0.03**	0.25	0.06***	1.05(0.96)	0.79
Korea	6.42	0.62	***	***	***	0.62	0.24
Thailand	4.25	0.73	0.08***	***	0.26	1.07(0.99)	0.89

Source: Author's computation;
all parameters are significant at over 90% unless otherwise stated;
* significant at over 80%
** significant at over 70%
*** significant at less than 70%
a/ the figure in brackets correspond to the sum of the elasticities which are significative at over 80%

of labour (β); so have those of labour (β) against those of capital (γ). And lastly, the elasticities of intermediate inputs (δ) were analyzed with respect to those of labour (β). The overall picture which appears to emerge from this analysis indicates that, as could be expected, there is a strong relation of substitutability between land and labour, emphasizing the existence and the feasibility of both extensive and intensive types of agriculture. Labour and capital equipment seem also to be linked - although less clearly - by a relation of substitutability while, on the whole, labour and intermediate inputs appear to be highly complementary in production. These broad findings would seem to suggest that, given the present and expected endowement of production factors in agriculture in developing countries, an acceleration of mechanization would have a labour displacing rather than an output increasing effect. One may, therefore, suggest to forestall it until full employment is achieved. These findings would also appear to substantiate the hypothesis that a policy based on a more intensive use of intermediate inputs would be likely to produce positive output and employment effects.

Two further results of the analysis are worth mentioning. The first concerns the very small changes in land concentration which appear to have occurred between 1950 (only for a few countries) or 1960 (for most countries) and 1970. The comparison of the data provided by the 'World Census of Agriculture' of these years show, in fact, almost no changes in the distribution of the operated holdings classified by farm size. The 1970 values, which have also been retained for the trend scenarios of the model, show the following values.

<u>Table 3.5</u>: Per cent distribution of land by size of operated holdings

	small	medium	large
Latin America	6.6	21.6	71.8
Tropical Africa	84.3		15.7
West Asia	20.0	38.0	42.0
South Asia	20.9	48.2	30.9
East Asia	37.0	37.2	25.8

Source: UNCTAD's estimates on the 1970 'World Census of Agriculture' data, FAO. The definition of 'small', 'medium', 'large' is the following:
Latin America: 0-20 / 20-200 / 200-∞
Tropical Africa: subsistence (0-10) versus plantations (10-∞)
West Asia: 0-10 / 10-50 / 50-∞
South Asia: 0-2 / 2-10 / 10-∞
East Asia: 0-2 / 2-[illegible] / 10-∞

As one can see, Latin America has potentially an enormous amount of land which could be redistributed. Tropical Africa, on the contrary, seems to be characterized by a prevalence of small subsistence holdings. In West Asia and in South Asia there would seem to be scope for redistributing a certain amount of land from large to small holdings. This seems to be all the more commendable with reference to the plans for arable land extension made in developing countries.

Table 3.6 shows that only Latin America, Tropical Africa and, to a very limited extent East Asia, can count on a possible extension of arable area for increasing output, income and consumption in agriculture. For the countries of the other regions, other strategies ought to be adopted.

Table 3.6: Land supply in 1975 and 1990 (million hectares)

	Land available in 1975	Possible extension between 1975 and 1990	Maximum land available in 1990
Latin America	173	58	231
Tropical Africa	184	34	218
West Asia	73	5	78
South Asia	211	8	219
East Asia	49	7	56

Source: 'Agriculture: Towards 2000', FAO, 1980.

ANNEX 4

THE SUB-SYSTEM ON INCOME DISTRIBUTION, CONSUMPTION AND SAVINGS[a/]

It is now widely acknowledged that, in many developing countries, past growth fell short of achieving the target of eradicating mass poverty owing to grave distortions inherent to the distribution of income. The consumption of essentials (such as food, clothing and health products) has grown at very moderate rates. Furthermore, when considering the various income groups, the picture becomes even more disconcerting. Indeed, in many countries, the share of the lower deciles in food consumption have been declining even during periods of relatively rapid agricultural growth. The new approach which is being followed[b/] focuses on the identification of socio-economic groups characterized by different professional profiles (entrepreneurs, skilled and unskilled workers, white collars, small farmers, landless labourers, urban unemployed, etc.) and on their income accounting. Within each industry, total value added is distributed to the various income recipients; assumptions are then made on the shape of the income distribution within each income group. The various distributions are then mapped together into the overall size distribution (by percentiles) of household income.

However, such an approach requires an amount of information which, for a model with UNITAD coverage, does simply not exist. It was therefore decided to adopt a somewhat simplified approach which, although avoiding the thorny issue of income accounting for each socio-economic group, still leaves the possibility of simulating the effects of exogenous changes in the distribution of income on the level and structure of private consumption and, indirectly, on the satisfaction of some essential needs. The system also allows for the illustration of the basic features of the functional income distribution, as well as the effects of changes in its structure on the total saving rate.

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a/ This annex summarizes and updates the paper "Aggregate Consumption and Consumption Patterns: evidence from time-series and cross-sectional data" (prepared by G.A. Cornia, M. Gilli and G. Jerger), submitted to the meeting of the ACC Technical Working Group of the Task Force on Long-Term Development Objectives, Geneva, 10-11 July 1980.

b/ See for instance Rodgers Gerry et al.: "Bachue Philippines: Population, Employment and Inequality", Saxon House, 1978. See also Adelman, Irma and Robinson Sherman: "Income Distribution Policy in Developing Countries, a case-study for Korea", Oxford University Press, 1975.

The formalization of the income distribution, consumption and saving sector

Within each industry, value added is decomposed through two exogenous value added coefficients in labour and capital income. By adding through sectors one obtains total labour and total gross capital income. For developing countries a distinction is made between the urban and the rural sectors. The latter is equivalent to agriculture plus a fraction "m" of non-agricultural activities carried out in rural areas[c/]. Notice that the parameter "m" can be interpreted as a policy instrument by means of which a given balance between rural and urban can be achieved. Hence, for developing countries, the system generates rural labour income, rural capital income, urban labour income and urban capital income. For both developed and developing countries, the system describes institutional income transfers: capital income is distributed between the enterprise, household and government sectors, while all labour income accrues to households. Government levies direct taxes on household and enterprises as well as indirect taxes which are considered net of subsidies to production. It is equally assumed that household payments and receipts on the social security and welfare account balance out.

Once all transfers have taken place, the system generates the net disposable income of government and households (rural and urban for developing regions), and the gross (i.e. including depreciation) disposable income of enterprises. The system estimates at this point a simple keynesian consumption function (in constant prices) for the household sector, of the form $PC/POP = a + b\ NDIH/POP$, where PC, NDIH and POP stand for private consumption, household's net disposable income, and total population. For the developing regions, this function has been estimated separately for the rural and the urban sector, since it is reasonable to expect a different behaviour from them. For government, the system estimates a simple consumption function in current prices, i.e. $GC = \alpha NDIG$, where GC and NDIG stand for government consumption and net disposable income. Enterprises are assumed to save all their gross disposable income. In this way the system, characterized by three different saving/consumption propensities, determines total consumption (private and government) and total domestic savings (for developing countries, private consumption and household savings are broken down to rural and urban).

c/ A more elaborate treatment applies to the regional model for CPE, Asia. Attempts are made to extend this treatment to other regions.

Total private consumption and relative prices of consumption categories, both endogenous, are the main variables determining the structure of the household consumption basket, by means of a simultaneous non-linear (or linear) expenditure system (NLES or LES). In symbols PC(i) = f(PC, p(i)) where PC, PC(i) and p(i) stand for total private consumption, private consumption of item (i) and its relative price.

The consumption categories are the usual ones adopted in national accounting and in most household expenditures surveys, i.e. food, clothing, rent, furniture, health, transport, education and miscellaneous d/. These categories are very broad and each includes the essentials as well as luxury goods. However, they can be used as a first approximation for assessing the degree of satisfaction of some basic needs, such as food and clothing. The structure of private consumption depends upon the hypotheses made about the shape of the household size distribution of income. Indeed, if the expenditure system is of the non-linear type, i.e. if the marginal propensities to consume of each category change with the level of overall consumption, modifications in the size distribution of income entail changes in the structure of the consumption basket (a shift of income from the top to the bottom deciles, for instance, would be likely to increase the overall demand for essentials while accordingly reducing that of luxuries). The extent to which a NLES can accurately measure changes in the consumption structure is very much an empirical matter.

Many claim that, at this level of disaggregation, the changes are likely to be very modest. Furthermore, it should be stressed that if the expenditure system is of the linear type (LES), no numerical changes in the consumption basket would derive from a hypothesized income redistribution. For the regions where the rural-urban disaggregation has been introduced, it is still possible to analyze in this case the effects of changes in the rural-urban distribution of manufacturing and service activities on the overall saving rate and consumption structure. In particular this could be useful for analyzing some effects of rural development.

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d/ 'Private consumption by functional expenditure' is transformed in 'private consumption by production sector' by means of a transition matrix. Such a matrix has been built up for each UNITAD region. It is supposed to remain constant over time, a strong hypothesis.

Empirical results

The results of the empirical analysis[e/] refer to the saving/consumption function and to the expenditure system. Table 4.1 reports the estimates of the function PC/PCP = (NDIH/POP). For developed countries, the United Nations' 'National Accounts' data were used, whereas for developing regions, the estimations were carried out on the basis of the ILO source. The results confirm previous findings for the developed countries. In less developed regions, the results consistently indicate higher consumption propensities in the urban than in the rural sector. Such a phenomenon may be ascribed to the difference in source and stability of income between the urban sector (where wages are predominant) and the rural sector (where self-employment incomes are most common). Geographical location and household size would also appear to have a certain influence on the observed dualism. Another interesting finding of the analysis of the ILO expenditure surveys concerns the shape of the overall saving/consumption function. Indeed, the results of an extensive statistical test showed no evidence to support the Keynesian assumption of declining marginal propensities to consume for rising incomes: at the margin, the propensity to consume was found to remain constant in the overwhelming majority of the cases analyzed. Were this to hold true, measures aiming at redistributing income could not be opposed on grounds that they reduce the saving rate and, therefore, growth.

The empirical results concerning the estimation of the consumption expenditure system are a little less satisfactory. A non-linear expenditure system (NLES) has been successfully fitted to the time-series data of developed regions, as indicated by the good values of the statistical tests. For these regions it is therefore possible to simulate the effects of changes in the household size distribution of income on the structure of consumption and output. For the developing regions, however, it has not been possible to estimate a satisfactory non-linear expenditure system, because of data limitations. Indeed the household expenditure surveys do not provide, quite obviously, information on prices. Pending further investigation, it was decided to opt for a linear expenditure system,

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e/ The data sources used for the data analysis and estimation of the relations between income distribution, saving and consumption include the United Nations' 'Yearbook of National Accounts'; the ILO's 'Household Income and Expenditure Statistics'; the World Bank's 'Income Distribution Statistics: a Compilation of Data'.

Table 4.1: Aggregate consumption function parameters *

		North America	Western Europe	Eastern Europe	Japan	Other Developed	Latin America	Tropical Africa	West Asia	South Asia	East Asia	Centrally Planned Economies Asia
URBAN	a	104	200	-	184	219	120	40	150	25	90	-
	b	.89	.82	-	.64	.77	.72	79	.85	.76	.70	-
				-								-
RURAL	a			-			160.	50	150.	35.	80.	-
	b			-			.61	74	.85	.65	.65	-
				-								-

* PC/POP = a + b NDIH/POP ; all estimates are in 1970 constant prices; regional results were obtained by aggregating parameters estimated at the national level.

which was satisfactorily estimated for the urban and rural sector separately. Table 4.2 provides a summary of the marginal propensities to consume for each of the categories (their sum is equal to one) which have been retained for the developing regions.

These figures have been obtained by weighing the national values of the countries included in the ILO data base. From the results of Table 4.2 as well as from the results of national estimates, there are clear indications that the marginal budget share for food decreases when income per capita rises. The opposite happens, although the evidence is less firm, to the budget shares of rent and transport. Less clear patterns are formed for the budget shares of the other consumption categories.

Rural-urban dualism is evident when analyzing the results of Table 4.2. Significant variations between marginal budget shares probably reflect different sets of preferences and prices as well as different economic environments. Marginal share of food is consistently higher in rural areas, while the composition of non-food expenditure also shows, at the margin, elements of dualistic behaviour. This applies particularly to clothing and rent. On the whole the share of necessities would appear to be higher in the rural than in the urban sector. While it is impossible, at least for the time being, to simulate for developing countries the potential effects of a redistribution of income within the household sector, one can simulate the effects of alterations in the rural-urban income distribution.

Table 4.2: Marginal propensities to consume as estimated through a linear expenditure system

	Latin America		Tropical Africa		West Asia		South Asia		East Asia	
	urban	rural	urban	rural	urban	rural	urban	rural	urban	rural
Food	.290	.353	.572	.650	.257	.360	.522	.705	.400	.496
Clothing	.108	.120	.095	.099	.116	.187	.116	.164	.091	.114
Rent	.290	.190	.134	.011	.269	.231	.076	-.085	.165	.140
Furniture	.070	.068	.062	.070	.114	.127	.073	.066	.065	.051
Medical care	.029	.030	.016	.013	.039	.044	.042	.069	.051	.024
Transportation	.073	.113	.054	.098	.081	.070	.038	.005	.056	.034
Education	.089	.068	.027	.036	.026	.037	.077	.024	.121	.103
Miscellaneous	.051	.058	.040	.021	.098	.043	.055	.051	.051	.035

ANNEX 5

SOME RESULTS OF SENSITIVITY ANALYSES

1. Introduction

Systematic tests of sensitivity analyses have been conducted on the two main groups of exogenous variables of the model, i.e. trade and technology variables:

- On the trade (and financial side): trade shares, exogenous prices, POP (average population per country) and DUT (protection level) variables, ODA, interest rates, capital transfers.

- On the technology side, capital-labour ratios (by sector), time trend, land shares in agriculture, cropping intensity.

These tests have been conducted by giving shocks (± 5%) to each variable, studying results on each region under two separate broad exercises:

(a) Each region taken in isolation from others.

(b) All regions interlinked through the system.

The first exercise is meant to give approximate linear relations linking the main endogenous variables to the exogenous variables (i.e. a kind of reduced form of regional models). The results can be used to generate at a later stage a linearized version of the model, in which each "reduced form" of the 11 regional models can be linked through the same trade and financial relations as the original system.

The second exercise provides useful economic information on the reaction of the system but one important remark should be made: its results are strongly dependent on the absolute level of the linkage variables and the exogenous growth rates of GDP, and are therefore valid only for scenarios using such values. Trade shares, import equations, price levels and GDP growth rates play a major role in the differential values taken by endogenous variables as a result of a shock to any exogenous variable.

As an illustration, a few results comparing the sensitivity analyses conducted with two distinct "base" scenarios, i.e. IDS1 and IDS2 (see part III) are given hereunder.[a] The only exogenous variables considered are the GDP growth rates of individual regions. The scenarios have the same trade

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a/ No results are quoted for CPE, Asia, since the model for that region was not operational in 1981.

shares, the same GDP growth rates by region, but differ in two respects:

- In scenario IDS1, agricultural growth rates are high in developing countries (see table page 76), and import equations simulate a regional integration of the equipment sector (equations with a negative term with GDP).

- In scenario IDS2, agricultural growth rates are relatively low, which means that a high level of agricultural imports into DG's is required; import equations simulate a fragmentation of markets within regions (equations without a negative term with GDP).

This paper will firstly give some detailed results on scenario IDS1. Major findings are then compared for the two scenarios, and finally a comparison of results is made between the UNITAD model and another model (GIOM).

2. Sensitivity analyses on scenario IDS1

All results are given in terms of elasticities, i.e. the ratio of the relative change of an endogenous variable to the relative change of the exogenous variables, here the GDP of one region. The interpretation of such figures should be carefully defined. As an example, let us give a 1% change in the GDP of the North American region (NA). If the endogenous variable refers to the same region, say total imports, the elasticity of 1.5 means that a 1% growth of GDP in 1990 should generate a 1.5% growth of total imports, in current prices, after some time, say, a couple of years. If the endogenous variables refer to another region, say total exports of Latin America, the meaning is this: for a given GDP growth rate of Latin America (here 6.3%), a 1% growth rate of North America induces a 0.3 growth of all exports of Latin America after some time, say a couple of years.

Two alternative computations can be derived from these figures: one is the relative annual growth rate in any endogenous variable which is induced by a 1 per cent, or a 1 per thousand annual change in the GDP growth rate of North America from 1980 to 1990, under the assumptions (including GDP fixed growth rates) of scenario IDS1. Alternatively, one may refer again to a 1 per cent change in the GDP growth rate of NA region in 1990, but relax, for other regions, the assumption of a fixed growth rate. Instead, it may be interesting to make an assumption of fixed trade gap, and to compute the change in the growth rate of the region (or any other variable) induced by a 1 per cent GDP change in North America. This will be done in the next section, both for scenarios IDS1 and 2. In the present section, therefore, all elasticities refer to the impact of a change in the GDP growth rate of one region, in 1990, under an assumption of fixed GDP growth rates for other regions.

Table 1

Scenario IDS1 - Impact of a 1% GDP growth of region R, on economic variables of the same region (fixed growth rates for all other regions)

Autonomous growth region:	NA	WE	EE	JP	OD	LA	TA	NE	IN	AS
Endogenous variables	All elasticities expressed in per cent									
Current price variables										
All exports a/	0.5	0.8	-	-	-	0.2	-	0.3	-0.1	-
of which: energy a/	0.6	-	-0.6	-0.4	-	0.3	0.3	0.3	0.1	0.4
All imports a/	1.5	1.3	1.0	1.15	1.1	0.7	0.6	1.1	0.65	0.65
of which: energy a/	1.3	0.7	-	0.9	0.5	0.8	1.2	1.5	0.5	1.3
Trade gap	-6.9	-13.9	-1.9	-11.7	-6.9	-34.2	-1.9	-1.2	-3.4	-12.2
Payment gap	-6.2	-9.4	-2.2	-9.2	-10.6	-2.1	-3.4	-0.9	-2.2	-4.9
Constant price variables										
Exports of manufactures a/	0.6	1.15	0.8	-	0.1	0.2	0.1	0.45	-	0.2
Imports of manufactures a/	1.9	1.7	1.3	1.6	1.1	0.8	0.6	1.15	0.3	0.7
Value-added:										
Agriculture	0.4	-0.3	0.9	0.9	0.5	1.0	1.5	1.5	1.1	1.5
Food processing	0.5	-0.5	0.9	1.1	0.9	1.1	1.3	1.5	1.25	1.6
Energy	1.2	2.0	0.7	1.2	1.15	0.9	0.6	0.5	0.6	0.1
Basic products	0.9	0.9	1.0	0.9	1.0	0.9	0.6	0.95	1.0	0.7
Light industry	0.9	0.6	1.0	0.8	1.0	1.1	1.0	1.3	1.6	0.9
Capital goods	1.15	1.1	1.1	0.8	1.2	1.0	1.35	1.4	0.9	0.85
Construction	1.0	1.2	1.4	1.1	1.1	0.9	0.6	0.9	0.9	1.0
Services	1.0	1.1	0.9	1.1	1.0	1.0	0.8	1.0	0.9	1.0
Manufacturing VA	1.0	0.8	1.0	0.9	1.0	1.0	1.0	1.2	1.2	0.85
Investment	1.1	1.2	1.5	1.1	1.1	0.9	0.6	0.95	1.0	0.95
Employment	0.9	0.7	0.2	0.9	0.9	0.95	1.2	1.15	1.0	1.1
Private consumption	1.2	1.3	0.9	1.5	1.5	1.2	1.75	1.7	1.1	1.5

Note: for the list of regions, see annex 1.

a/ All trade data referring to developing regions (LA, TA, NE, IN, AS) exclude the intra-regional trade due to regional integration in the equipment and machinery sector. Trade and payment gaps, however, are the same whether this intra-regional trade is included or not. See text.

Table 2

Scenario IDS1 - Effects induced by a 1% growth of specific regions in all regions (fixed growth rates for all target regions)

Target regions :	NA	WE	EE	JP	OD	LA	TA	NE	IN	AS
Endogenous Variables	1) 1% growth of NA									
Trade gap	-6.9	4.5	-0.6	3.8	2.0	22.5	0.6	0.6	1.0	4.7
Payments gap	-6.2	3.1	-0.7	3.0	3.1	1.4	1.8	0.4	1.1	2.0
Land gap	...	...	...	...	...	-0.1	-1.6	0.2	0.2	-0.3
Employment gap	-7.3	-	-	0.4	-	0.1	0.1	-0.3	-	0.1
All exports	0.5	0.1	-0.2	0.4	0.2	0.3	0.2	0.2	0.2	0.4
of which:										
-energy	0.6	-0.4	-0.6	-0.1	0.1	0.2	0.1	0.2	0.2	0.15
- manufactures	0.6	0.15	-	0.4	0.25	0.55	0.1	0.1	0.2	0.7
	2) 1% growth of WE									
Trade gap	2.2	-13.9	0.4	3.9	3.2	22.1	1.1	1.15	1.6	4.9
Payments gap	1.85	-9.4	0.3	3.1	4.9	1.4	3.1	0.8	1.7	2.0
Land gap	...	...	...	...	...	-0.1	-3.3	-0.1	...	-0.3
Employment gap	-	-7.2	-	0.3	-	0.1	0.1	0.2	-	0.1
All exports	0.4	0.8	-	0.4	0.3	0.3	0.5	0.3	0.4	0.4
of which:										
- energy	0.35	-	-0.3	0.25	0.3	0.25	0.25	0.3	0.15	0.13
- manufactures	0.6	1.1	0.3	0.4	0.3	0.25	0.6	0.3	0.6	0.6
Manufactures VA	-	0.9	-	0.1	-	-	-	-	0.1	0.2
	3) 1% growth of Japan									
Trade gap	0.9	1.8	-0.6	-11.7	3.7	9.7	0.5	0.8	0.8	7.3
Payment gap	0.8	1.4	-0.7	-9.2	5.6	0.6	1.3	0.5	0.8	3.0
Land gap	...	...	...	...	...	-	-1.2	0.1	0.4	-0.1
Employment gap	-	-	-	-13.0	0.1	-	0.1	-0.1	-	0.1
All exports	0.15	-	-0.2	-	0.4	0.1	0.1	0.2	0.1	0.4
of which:										
- energy	0.1	-0.5	-0.6	-0.4	0.7	-	0.2	0.2	-	0.4
- manufactures	0.1	-	-	-	0.2	0.1	0.1	0.2	0.1	0.3

Table 1 gives the direct and indirect effects of a 1% growth of any one region on the economic variables of the same region. Indirect effects are induced mainly by the trade matrices via the increase in North American imports, which call for exports from other regions, and hence for additional production and additional imports from those regions. These indirect effects can be traced up in table 2 for a 1% GDP growth of NA, WE and JP.

The direct effect of 1% change in GDP growth of North America can be seen, in table 1, in the import elasticity 1.5 (1.3 for energy alone). The impact on the trade gap is, however attenuated by the second order effect on NA exports, including intra-regional trade between USA & Canada, with a 0.5 elasticity (o.6 for energy alone). This limits the trade gap elasticity to -6.9; on manufactures alone, a heavy trade deficit is bound to emerge from the import elasticity (1.9) and the indirect export elasticity (0.6).

Turning to the production structure, it can be seen that manufacturing V.A. has an elasticity of 1, higher for capital goods (1.15) than other sectoral V.A., and that construction and services also have (in constant prices) an elasticity of 1. The highest response is found on the energy sector (1.2), partly on account of the exports induced by the demand of other regions. The lowest figures (0.4 and 0.5) are naturally found for the agriculture and food processing sectors, especially under the assumptions of low exports of this scenario. Investment response is high (elasticity of 1.1) and employment response lower (0.9) on account of a productivity increase.

Table 1 permits a comparison of these figures with what happens in other developed regions as a result of an autonomous 1% growth. For example, the import elasticity of Western Europe is 1.3, almost as high as in North America but the indirect export effect is relatively high (0.8), largely due to the increase of intra-regional trade. For Eastern Europe, Japan or the Other Developed (OD) region, import elasticities due to autonomous shocks to their respective growth are lower (around 1.0) but no indirect effect on exports are induced. Japan therefore needs a growth of other regions to balance its trade. This is even more apparent when considering trade in manufactures alone. Import elasticities are found to be 1.9, 1.7, and 1.6, with an indirect export response of 0.6, 1.15 and 0 for the three regions of North America, Western Europe and Japan respectively. For energy, the imports and exports elasticities of Western Europe are of the same order, around 1, while Japan has an import elasticity of 0.9 and no induced export elasticity.

On the production side, the high elasticities of agriculture and food processing for Japan (0.9 and 1.1) are worth being noted, as well as the high energy sector elasticity (1.15 to 2) of all industrialized countries except Eastern Europe (0.7). The elasticity of manufacturing V.A. is about the same as that found for North America (around 1), but with a lower figure for Western Europe where the elasticity of construction and services is the highest (1.2 - 1.1). In all developed regions, the employment elasticity is lower than 1 (0.7 in WE) on account of productivity increases.

The low employment effect of Eastern Europe for material goods (0.2 elasticity) is built in the model. In that region, the highest production effects can be observed in the agriculture and food processing sector (0.9), and the construction sector (1.4).

If autonomous shocks of 1% growth are given to developing regions, table 1 shows that the import elasticities are almost everywhere around 0.7 (1.1 in West Asia). Similar figures obtain for imports of manufactures[a]. The latter figures appear very low compared to observed data (1.1 to 2 in 1963-75), or even to scenario IDS2: LA(1.2), TA (1.9), NE (1.5), IN (0.7), AS (0.9). Indeed, the difference between IDS1 and IDS2 scenarios is a measure of the decrease in interregional trade due to the policy of regional integration in scenario IDS1. On an assumption of no trade creation, the difference between the two elasticities provides a first approximation of the new intra-regional trade in IDS1 (see part II). In the production structure, the agricultural V.A. elasticities are very high in Tropical Africa (1.5), West Asia (1.5) and East Asia (1.5) as could be expected, and moderate in Latin America (1) and South Asia (1.1). High elasticities are also found in the manufacturing V.A. (around 1.0), with higher figures in West and South Asia (1.2) and lower in East Asia (0.85). These figures reflect the technology choices, which, in South Asia, curbs the income increase of the rural sector and orient development of demand towards industrialization. Also worth being mentioned is the relatively low elasticity of the energy value-added, around 0.5 - 0.6, except in Latin America (0.9). Energy imports, on the other hand, have a high elasticity (1.2 to 1.5) except in South Asia. These figures reflect the low domestic supply response in the energy sector during the observation period (1963-75). These figures are embodied in the coefficients of import equations, which determine the domestic production versus import substitution. With the high energy prices prevailing since 1975, these coefficients may have changed to alleviate the import burden. This computation indeed points to the need for a faster substitution.

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a/ With, however, a low figure for imports and exports of manufactures of South Asia, (0.3 and 0 respectively), which reflect the relative de-linking of that region as a result of import substitution policies during the observation period.

Table 2 illustrates indirect effects on other regions, comparing the impact of an autonomous 1% growth of North America, Western Europe and Japan respectively on developing regions. As can be seen, the impact is much stronger on most regions when Western Europe grows up than in the case of a North American and even less Japanese growth. This can be traced up to the export elasticities of developing regions (around 0.4 in response to a Western European growth, around 0.3 and 0.1 in response to a North American or a Japanese growth respectively), and also to the trade gap elasticities or to the export of manufactures. This will be further reviewed in the next section, when comparing scenarios IDS1 and IDS2.

3. A comparison of growth linkage effects in scenarios IDS1 and 2

The preceding tables on growth elasticities are used in this section to compute a growth linkage effect on the assumption that the trade gaps remain constant in the exposed region. For example, it can be seen in table 2 that a 1% growth in North America induces a trade gap improvement of 22.5% in Latin America under an assumption of stable growth for that region. Table 1, on the other hand, shows that an autonomous growth of 1% of Latin America deteriorates the trade gap by 34.2%. It can therefore be inferred that the growth of Latin America induced by a 1% growth of North America should be equal to 22.5/34.2 = 0.66% if the trade gap was kept constant. Such growth likage effects are reproduced in tables 3 and 4 both for scenarios IDS1 and IDS2. When an autonomous growth of 1% is given to a region, the corresponding column gives the linkage growth effects on any specific region on an assumption of constant trade gaps for that region and constant growth for others. This is an extreme assumption which may not be meaningful for some developed regions or for West Asia where growth is not trade-constrained. Interesting findings however emerged. In the following text, figures referring to scenario IDS2 are quoted, since the assumption of fragmented markets is the closest to a continuation of present policies.

If considering autonomous growth in the developed regions, the following linkages can be observed with developing regions (see table 3). A 1% growth of North America approximately induces a 0.4 growth in Latin America and East Asia, around 0.3 in Tropical Africa and South Asia, and 0.1 in Tropical Africa. As might be expected, Latin America and East Asia rank first.

Table 3

Linkage growth effects induced by a 1% growth of DD regions (trade gap fixed for target region and for no other)

Target regions	NA	WE	JP	OD	LA	TA	NE	IN	AS
Scenarios	1) GDP growth induced by a 1% growth of NA								
IDS1	1	0.32	0.33	0.30	0.66	0.31	0.51	0.30	0.39
IDS2	1	0.33	0.61	0.22	0.37	0.11	0.21	0.20	0.42
	2) GDP growth induced by a 1% growth of WE								
IDS1	0.32	1	0.33	0.47	0.65	0.61	0.95	0.48	0.40
IDS2	0.26	1	0.37	0.40	0.34	0.22	0.38	0.35	0.30
	3) GDP growth induced by a 1% growth of JP								
IDS1	0.14	0.13	1	0.54	0.28	0.27	0.65	0.24	0.60
IDS2	0.10	0.11	1	0.49	0.14	0.10	0.25	0.14	0.45
	4) GDP growth induced by a 1% growth of OD								
IDS1	0.03	0.08	0.09	1	0.10	0.11	0.12	0.13	0.08
IDS2	0.02	0.06	0.01	1	0.01	0.01	0.04	0.03	0.17

Table 4

Linkage growth effects induced by 1% growth of DG regions (trade gap fixed for target regions and no other)

Target regions	NA	WE	JP	OD	LA	TA	NE	IN	AS
Scenarios	1) GDP growth induced by a 1% growth of LA								
IDS1	0.06	0.05	0.08	0.08	1	0.16	0.23	0.11	0.09
IDS2	0.06	0.06	0.09	0.03	1	0.04	0.07	0.02	0.03
	2) GDP growth induced by a 1% growth of TA								
IDS1	0.01	0.04	0.05	0.10	0.10	1	0.12	0.12	0.07
IDS2	0.01	0.07	0.09	0.07	0.02	1	0.02	0.03	0.02
	3) GDP growth induced by a 1% growth of NE								
IDS1	0.02	0.11	0.11	0.09	0.10	0.10	1	0.16	0.08
IDS2	0.03	0.16	0.17	0.06	0.03	0.02	1	0.14	0.04
	4) GDP growth induced by a 1% growth of IN								
IDS1	0.01	0.02	0.03	0.07	0.08	0.10	0.13	1	0.06
IDS2	-	0.01	-	0.01	-	-	0.02	1	0.01
	5) GDP growth induced by a 1% growth of AS								
IDS1	0.03	0.04	0.10	0.13	0.12	0.11	0.30	0.40	1
IDS2	0.03	0.04	0.13	0.08	0.03	-	0.09	0.25	1

If the autonomous growth springs from Western Europe, the induced growth for West Asia is the highest (0.4), followed by Latin America and South Asia (0.35), East Asia (0.3) and, last, Tropical Africa (0.2). The corresponding figures for a 1% growth of Japan are in general lower: East Asia (0.45), West Asia (0.25), Latin America and South Asia (0.14), Tropical Africa (0.1). Interestingly, the highest growths induced by Japan are located in the Pacific area, i.e. East Asia (0.45) and the OD region (0.49).

If linkages among developed regions are considered, the reciprocal effects of North America and Western Europe are noteworthy (around 0.3), while the CD region (Australia, New Zealand and South Africa) has a growth around 0.5 induced by Japan, 0.4 by Western Europe and 0.2 by North America. Japanese growth induced by North America is high (0.60) but not the other way round (0.10). The same asymmetry is observed in the Japan-Western Europe linkages (0.40 versus 0.11). Eastern Europe (not reproduced in the table) strongly responds to a Western European growth (0.95) but induces a low growth in all regions whether developed or developing.

Developing countries, in turn, can have an impact on the growth of developed countries (see table 4). Western Europe response to an autonomous growth in the South is highest if growth originates from West Asia (0.16), of the same order (0.04 - 0.07) if it starts from Latin America, Tropical Africa and East Asia, and negligible if it comes from South Asia. Corresponding figures are lower for North America, except when the growth originates from Latin America (0.06). Japan is sensitive to growth originating from West Asia (0.17), East Asia (0.13), Latin America (0.09) and Tropical Africa (0.09). The OD region responds to a growth originating from East Asia (0.08), Tropical Africa (0.07), West Asia (0.06) and Latin America (0.03).

Interregional South-South trade can also induce some linkage growth effects, but which are far from reaching the level of North-South linkages. Thus, West Asian growth has an elasticity of 0.09 to the growth of East Asia, and 0.07 to the growth of Latin America; South Asian growth has an elasticity of 0.25 to the growth of East Asia, and the smallest linkage growth effects are observed in East Asia which has been seen to be sensitive to the growth of developed market regions. In general, the low South-South linkages can be said to reflect the assumptions of the scenario on the North-South orientation of trade.

The linkage effects result from the interplay of the trade subsystem, in particular the trade share matrices, with the system at large. Since the trade share matrices are the same for the two base scenarios, IDS1 and

IDS2, as well as the base growth assumptions, the difference between the linkage effects of the two scenarios can only come from the import equations. A surprising finding, at first glance, is that the growth linkage effects happen to be generally higher for scenario IDS1, where a regional integration is simulated within each developing region than in scenario IDS2 (fragmented markets). This means that the ratio used to compute the growth linkage effect, say trade gap induced into LA by a 1% growth of NA divided by trade gap of LA induced by a 1% autonomous growth, is larger in scenario IDS1 than in scenario IDS2. In general (for TA, NE, IN, AS), the denominator, i.e. the trade gap induced by an autonomous growth process of the developing region is much lower in scenario IDS1, and therefore causes the ratio to be higher than in the other scenario. This seems consistent with the basic assumptions. If arguing in terms of economic policy, it follows that growth is less trade-constrained in a scenario of collective self-reliance than in a scenario of fragmented markets, and that, therefore, the computation of the growth linkage effect (say between AS and NA) is less meaningful in the former case than in the latter.

4. Comparison of results between UNITAD and GIOM models

Another comparison can be made between the results of two models, i.e. UNITAD and GIOM (the Global Input-Output Model) used by the Department of International Economic and Social Affairs (DIESA), UN Headquarters. The latter reflects the pre-oil crisis linkages[a] and can therefore be usefully compared with scenario IDS2 with fragmented markets.

The comparison is made on the basis of a GIOM scenario in which 1% growth of employment is assumed simultaneously in three developed regions, i.e. North America, high income Western Europe and Japan. This comes close to an assumption of a 1% GDP growth in the three regions. Furthermore, growth is trade-constrained in Latin America, Tropical Africa, South and East Asia, but not in the other regions. When computing the growth linkage effects in these regions for the UNITAD model, care must be taken to include not only the growth induced by the three developed regions (with a geographical scope larger for Western Europe) but also the second order effect induced by the growth of the four developing regions. This is done in the following table:

a/ It was built in the early 70's by Leontief et al.

Table 5

Comparison of GIOM and UNITAD models
Growth linkage effects induced by a simultaneous
growth of three developed regions

	IDS1 - UNITAD -	IDS2	GIOM[a]
NA	1.0	1.0	0.97
WE	1.0	1.0	1.0
JP	1.C	1.0	1.1
LA	2.C	C.97	0.44 - 0.48
TA	1.70	0.46	0.43 - 0.49
IN	1.90	1.0	0.50
AS	1.70	1.2	

The differences among growth linkage effects is evident in spite of the difference in geographical converage of regions. Results are very close for Tropical Africa between GIOM and IDS2, i.e. around 0.46 but sharply differ in the other regions, in the sense that linkage effects roughly are twice as great in IDS2 as compared to GIOM: around 1 for Latin America (IDS2) compared to 0.46 (GIOM), around 1.1 for Asia (IDS2) compared to 0.50 (GIOM). It is difficult to give a precise explanation; the energy price can play a role but this is not the best guess. Subject to confirmation on figures, it seems likely that the reason should be sought in the trade dependence process, as is the case in the same table between scenarios IDS1 and IDS2. The difference in figures would be well explained if an autonomous growth process of a developing region led to a much lower trade gap in UNITAD-IDS2 than in GIOM. This in turn should be traced back to the I/O tables and the import equations where a constant propensity to import is assumed in GIOM, as opposed to UNITAD where trade equations are more complex (see part II). Perhaps the explanation can be found in the observation period, which for the GIOM model, is limited to the 1960's, a period of higher trade dependence than the 1963-75 period used in UNITAD.

a/ The difference in the number and definition of regions between the two models is reflected in the table - GIOM includes two Latin American subregions, two African subregions and only one region covering South and East Asia.

Overall, sensitivity analyses appear in this study most revealing as to the response of the system. Further results will be published in subsequent studies.