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MEDIUM- AND LONG-TERM MODELS FOR THE
ESCAP-REGION

- A review of existing models and a
proposal for a new model system -

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Introduction

Drawing up development plans and strategies should be based not only on qualitative assessments but also on quantitative analysis. Both the qualitative and the quantitative approach will only provide an adequate tool for policy recommendations if they are undertaken in a proper way. Besides, interrelationships between both ways of approaching problems of developing countries must be recognized in applying any of the two approaches. Without in-depth qualitative assessment of both assumptions underlying quantitative models and conclusions derived from modelling work, the models can not be considered as an essential input to the formulations of development strategies.

Bearing this in mind, the Development Planning Division of the United Nations' Economic and Social Commission for Asia and the Pacific (ESCAP) decided to revive its involvement in modelling work both for short-term and long-term projections. Short-term analysis started in late 1978 in close co-operation with UNCTAD, national institutions in ESCAP member countries and the University of Kyoto in Japan, with financial assistance from the Netherlands Government. Long-term projection work was initiated one year earlier in late 1977 with the immediate purpose to obtain a quantitative framework for development strategies for the United Nations' third development decade.

Due to lack of a team of staff members at ESCAP and because of the need for results within a year, it was decided to first consider the feasibility of using existing models and their results and conclusions. This proved not to be satisfactory. One of these modelling systems was "Future of Global Interdependence" (FUGI) developed by Professors Kaya and Onishi from Tokyo University and Soka University respectively. They were willing to adapt the model system in collaboration with ESCAP staff members in order to better cover the ESCAP-region and its development issues. The new version was called the ESCAP-FUGI model. Adapting a model without starting from scratch always leaves a series of issues not covered (adequately). This was the reason for ESCAP's Development Planning Division to ask the present author, who was a staff member at this division and was involved in the ESCAP-FUGI model, to write a paper* on the subjects mentioned in this paragraph:

- briefly review existing medium- and long-term models for the ESCAP-region;
- critically analyze the ESCAP-FUGI model;
- independently from the above develop a framework for a model system which optimally suits ESCAP's need for quantitative analysis of the in the long run relevant development issues.

Since it is not proper to critically review models and to construct a framework for a model system without exactly mentioning which development in the author's view are considered important, first a chapter will be devoted to

* Discussions with Hermine Weyland have been extremely beneficial to me, while preparing this paper. I am also very grateful to Rob Vos for his comments.

development issues in the ESCAP region and their priority in modelling.

The contents of this paper are:

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Chapter 1. Development issues in the ESCAP region and their modelling

1.1 Introduction

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional arm of the United Nations for Asia and the Pacific. The ESCAP region extends from Iran in the west to Mongolia in the north, Japan in the north-east and New Zealand and the Cook Islands in the south-east. It covers almost half of the surface of the earth. ESCAP's secretariat is stationed at Bangkok. It serves 55-60 % of world population living in such different developing countries as India, Nepal, Korea, Hong Kong, Indonesia, Laos, China and West-Samoa and in the developed countries Japan, Australia and New Zealand.

In a region as heterogeneous as the ESCAP region a broad spectrum of development problems comes to the fore, such as starvation, poor health conditions, insufficient schooling facilities, (hidden) unemployment, high population growth, landlessness, oversized servicesector, slumming of cities, low productivity, inappropriate manufacturing sector, inadequate financial resources, unequal international trade position, and so on and so forth.

Concentrating on these economic and social problems of development, finding solutions for the problems encountered may show the following stages:

- a. identifying the economic social and political system, in which some type of "development" is envisaged and the policies serving to stabilize and reproduce this system;
- b. evaluating the existing policy framework within the rationale of the system;
- c. suggesting, anticipating and evaluating policies that should lead to changing economic and social condition;
- d. implementing the most appropriate policies.

In this study by its very nature, we will refrain from the implementation part. On the other hand we will, as much as possible, try to evaluate constraints originating from the implementation phase, by adequately including them in the policy designation and evaluation phases.

Drawing up development policies requires assessing perspective implications of these policies. An extremely useful tool to arrive at possible future effects of development policies is to develop a mathematical model representing inter-relationships between the economic and social indicators of the countries concerned within and between the meso, macro and international level. Afterwards the consequences of the suggested development policies may be assessed through simulation using the constructed models.

The first requirement for such a kind of analysis to be fruitful, is that development problems are represented adequately by the economic and social variables appearing in the model. Thus, two types of extremely subjective choices must be made by users and authors

- which development problems are we going to try to incorporate in our analysis;
- by which economic and social variables do we represent the above development problems.

These subjects will be elaborated upon in the following section.

Secondly, having listed the variables to appear in the model, the model itself must be specified. A series of aspects has to be taken into account in drawing up the specification of the model

- which variables are to be included in the model;
- which are the interrelationships between the variables;
- what is the geographical scope of the analysis;
- what is the period of the analysis, partly reflected by the variables; is it going to be a short-, medium- or long-term model.

Specifying the model as well as choosing development problems to be studied and variables representing them, is subject to a few constraints:

- data limitations;
- manpower availability;
- technical constraints e.g. computer capacity.

It is clear that many of the decisions to be made about the model are subjective. Besides some constraints may appear at a later stage.

Finally, the model being constructed, development policies may be introduced into the model and the results may be assessed. This process may well give rise to the need to adjust the model by respecification, reestimation or inclusion of restriction.

The focus of this paper is on the aspect of development issue identification, variable selection and model specification. The geographical scope of this paper is the developing countries of the ESCAP region including their relationships to the rest of the world. Besides we will concentrate on development issues for the medium- and long-term (at least 5 years ahead). This implies that some variables and relationships which are important in the short run will not be included and on the other hand that indicators which in the short run can be assumed constant, must be included as variables.

In the following section we will briefly indicate development issues and related economic and social variables. Besides we will try to attach levels of priorities to each of them in order to obtain a basis for critically reviewing existing medium- or long-term models covering the ESCAP region (chapters 2 and 3)

and for developing a proposal for a model system. Attached priority levels leading to actually including the variables in the model does not only depend on theoretical priority level attached to them but also on derived priority because one variable can not be included without the other and on such constraints as data limitations, manpower availability and computer capacity. We shall try to determine priority levels taking into account the sincerity of data limitations expected to be encountered for each variable.

The following section, as well as the review of existing models covering the ESCAP region in chapters 2 and 3, will be the starting point for the proposal of a model system analyzing medium- and long-term perspectives of development in the ESCAP region, to be presented in chapter 4.

1.2 Development issues, model objectives, relevant variables and model specification

Any author, constructing a model should explicitly and does implicitly show his views on

- which are the most important issues, the model should be or is focussing upon
- what is the economic, social and political system concerned and how should or does the model describe it.

Policy analysis and recommendation are conditional on the part of the system which is described and how this is done.

Similarly, critically reviewing a model and its conclusions requires clarification of the views of the reviewing author regarding the importance of issues and the working and proper description of the system concerned. This paper aims at both reviewing existing medium- to long-term models covering the ESCAP-region and constructing a framework for a new model for the group of countries in the ESCAP-region. Therefore we will first concentrate on the question which development issues we consider the core of a model describing ESCAP's developing economies. Simultaneously, we will touch upon model-specification. A more elaborate discussion on model-specification is to be found in the following chapters.

Analyzing the economic and social systems of developing countries, one encounters a multitude of problems, possible policy objectives and perspective policy instruments. We shall mention a few of them. The balance of payment position for instance may worsen because of high oil prices on the import side and low commodity prices, trade barriers and export composition on the export side. A New International Economic Order is only one of the factors which may contribute to solving the balance of payments problem, because it may affect the level of exports.

Increasing exports implies more room for essential imports and may stimulate the countries economy. Whether this amounts to increasing traditional production or modern production depends upon the stage of development and its direction of the country concerned. Besides, the financial aspects should allow for increase and improvement of production infrastructure, education and so on and so forth. It goes without saying, however, that it is not production or infrastructure or employment which one should focus upon. Such indicators may be instrumental to the raising of living conditions of the people and that is where our ultimate interest lies.

Living conditions of people may be quantified by such variables as nutrition, housing, health and education, the basic needs variables, with particular emphasis on such groups as the rural and the urban poor. Quantifying such variables as calory intake per person, access to hospital beds and square metres per person in adequate houses for the lowest "income" groups is an extremely difficult task. Afterwards, specifying and quantifying relationships which explain developments in the above mentioned basic needs conditions, in the context of a model for a group of countries such as the ESCAP-region, is beyond the possibilities of presumably any modeling activity.

Thus, although many conventional issues such as improvement of the balance of payment, export promotion, employment creation, increase in agricultural production, etc., might be treated as objectives of the model to be laid out in this paper, one should concentrate on a limited number which are the core of the economic, social and political systems and which are to a large extent explanatory to developments in living conditions of the poor. Many of the above mentioned objectives are only partial objectives as well as possible instruments to improvement in living conditions and may in turn be influenced by living conditions.

Three elements of the system may be chosen, with the qualities of representing the core of the development problem as well as being largely explanatory to changes in living conditions of groups in the countries concerned. The elements on which the model should concentrate are

- a. income structure
- b. income levels
- c. food production and consumption.

The concept income structure comprises more than income distribution. Very important aspects are distribution of assets and wealth. Indicators such as the Gini coefficient of the distribution of personal income only pictures part of the system. Besides, it is a rather technical measure, which is hard to endogenize. At this stage, the other objectives income levels and food production need no further clarification. Below, we shall elaborate on explanation and implication of the above objective variables.

Models aiming at policy analysis and planning, require an appropriate set of instruments appearing in the model. They may be purely exogenous variables in the mathematical sense: the government e.g. may fix tax rates. On the other hand, instruments may be more or less endogenous: prices may clear the market but may as well be influenced by government policy. Thus one may distinguish between

- national instruments and
  - international instruments
- and between
- direct intervention and
  - indirect intervention.

One may think of the following aspects: intervention in factor markets, (labour, investment), monetary policy, price/wage policy which may differ from one sector to another, tariffs, import/export duties, trade regulations, bufferstocks, exchange rates, official development assistance, tax holidays for private foreign investment etc.

The links between instruments and the three objectives are provided by a multitude of variables. A rather crude schematic representation as well as a list of variables will be given below. Another aspect may first be treated more in general: disaggregation. One may consider several areas of disaggregation:

- geographical disaggregation: it stands to reason that the analysis preferably should be done at country level as it is the national government and other national institutions making the decisions; besides one might disaggregate within countries e.g. urban/rural;
- disaggregation of production: different sectors of the economy act and react in a different way, depending on the type of product, the size of the farm, the firm or the institution, the production method (traditional or modern), the tradability of the product and the formal or informal nature of production or service;
- disaggregation of population by social group: one may think of levels of schooling and skilling, levels (scales) of ownership, sectors of employment or ownership; this concerns both value added and final demand aspects.

Only as an example, some of the relationships between the three objectives, the instruments, and other variables occurring in the economic and social system, are represented schematically in table 1.1. The word "sector" refers to the sector of production, the word "type" refers to the type of labour or ownership. The kind of relationships between instruments (I), other variables (II) and objectives (III) may be given as follows:

- I → II parameters and variables are affected
- II → II "traditional" econometric model
- II → III qualitative and quantitative derivations of achieving objectives
- III → I mainly qualitative influence on policy
- III → II to a large extent represented in II → II.

It must be emphasized that only the most important primary linkages are represented.

Instruments		Other variables		Objectives	
I		II		III	
1	direct intervention in factor markets → II.1, II.2, II.3, II.4, II.11	1	production/sector → II.2, II.3, II.4, II.5, II.8, II.9, II.11, III.3	1	income structure) affect
2	price/wage policy → II.2, II.8, II.9, II.11, II.12	2	employment/sector/type → II.5, II.6, II.10, II.13, III.1, III.2	2	income levels) most
3	monetary policy → II.6, II.12	3	investment/sector → II.1, II.8, II.11	3	food production) elements
4	fiscal policy → II.6, II.12	4	operating surplus/sector/type → II.3, II.5, II.6, II.10, III.1, III.2		and consumption) of I and II
5	international trade arrangements → II.8, II.9	5	private consumption/sector/type → II.8, II.9, II.10, II.13, II.14, III.3		
6	foreign borrowing → II.7	6	government income → II.4, II.7, II.11, II.12, II.14, III.1, III.2		
7	private foreign investment facilities → II.3, II.8, II.9	7	government expenditure/sector → II.1, II.2, II.3, II.13, II.14, III.1		
		8	imports/sector → II.1, II.12, III.3		
		9	exports/sector → II.1, II.8, III.3		
		10	savings/type → II.3, II.5		
		11	wages/sector/type → II.2, II.4, II.5, II.6, II.10, III.1, III.2		
		12	prices/sector → II.3, II.4, II.8, II.9, II.10, II.11, III.2		
		13	demography → II.2, II.5, II.11, III.1, III.2		
		14	basic needs → II.1, II.13, III.1, III.2		
		15	developments in other countries → II.9		

Table 1.1 Links between instruments, objectives and other variables

A list of variables to be included in the model and mostly appearing in part II of table 1.1 is given in table 1.2.

The following interpretation may be given to the priority levels, which will be used by us:

- 1 - basic elements of models of any economy of less developed countries
- 2 - covering crucial development issues
- 3 - completing the picture.

It must be stressed that variables which have obtained e.g. priority level 3, such as basic needs aspects are not unimportant, on the contrary, but having included income distribution etc., additional benefits from also including housing is low in comparison to the cost of collecting all the data and constructing all detailed blocks of the model. In table 1.2 below, we have listed all relevant economic and social variables, related to development issues, considered important by us. In front of each variable our level of priority for the variable concerned is indicated. Variables have been divided into the following groups:

- macro variables, both national and international;
- subnational variables, urban-rural and sectoral variables
- demographic, distributional and basic needs aspects.

It is clear from the above that essential elements of the model are good sectoral disaggregation and division of the population in social groups to take care of differences in behaviour regarding consumption, investment, production etc. Besides, differences between groups and pressure to acquire scarce resources should be basic elements of the model. The role of the government in this respect must be treated very carefully. This is also valid in the international context: how does the economy and the government react towards changes in different parts of the international economy. One may in particular think of the openness of the economy and the accommodating and closing variables of the model. A detailed analysis of the typology of the country concerned regarding such factors as degree of (inter)dependency of the country, internal and external pressure areas and their effects on e.g. finance and credit is an essential element of the study.

priority level	economic and social variables
	<u>macrovariables, both national and international</u>
1	gross domestic product, gross national product
1	private consumption
1	public consumption
1	private investment
1	private foreign investment
1	public investment
1	exports
1	exports of goods
1	exports of services
1	imports
1	imports of goods
1	imports of services
2	competitive imports
2	non-competitive imports
2	bilateral tradeflows
1	official development assistance
2	debt services
1	government revenues
2	indirect taxes
2	direct taxes
1	savings
1	private savings
1	public savings
1	balance of payments
2	exchange rate
1	consumer prices index
2	investment price index
2	export price index
2	import price index
2	terms of trade (external)
1	wages
1	employment
2	unemployment
2	underemployment
2	trade barriers, self reliance
2	import substitution
2	export orientation
2	energy constraints

priority level	economic and social variables	
	<u>macrovariables, both national and international</u> (continued)	
2	other physical resource constraints	
3	environmental constraints	
2	financial constraints	
	<u>subnational, sectoral, urban/rural</u>	
2	sectoral distribution according to scale, technology and tradability	
2	agricultural sectors	
2	other primary sectors	
2	manufacturing sectors	
2	service sectors (incl. informal)	
2	production	
2	production function, changing coefficients	
2	labour skilled/unskilled	
2	investment by destination	
2	investment by origin	
2	private investment (by social group)	
2	private foreign investment	
2	public investment	
2	infrastructure	
2	private consumption (by social group)	
2	private savings (by social group)	
2	public consumption	
2	wages	
2	other income, operating surplus	
2	indirect taxes, subsidies	
2	competitive imports	
2	non-competitive imports	
2	prices	
2	exports	
3	re-exports	
2	domestic prices	
2	import prices	
2	urban/rural terms of trade	
3	land concentration	

priority level		economic and social variables
		<u>demographic, distributional and basic needs aspects</u>
1		population
	3	fertility
	3	mortality
	3	householdsize
2		labour supply
	3	labour force participation, male/female
2		migration, urban/rural
2		social groups, labourers/owners
2		income distribution, between social groups
	3	income distribution, within social groups
2		ownership, assets
	3	access to resources, schooling
	3	status
	3	bargaining power
	3	nutrition
	3	housing
	3	health
	3	education
	3	government policy: basic needs
2		infrastructure
2		prices
2		subsidies
2		transnational corporation
2		official development assistance

Table 1.2: Economic and social variables and the attached priorities for inclusion in the model.

Chapter 2   Review of existing medium- and long-term models

2.1   Introduction

In 1972 the Meadows (1972) team published the findings of their modelling work in "The Limits to Growth", predicting that the world is bound to encounter its collapse if present growth trends are to prevail into the twenty-first century. Because of these findings and the increasing consciousness of growing interdependence between various parts of the world, the number of world models has rapidly increased. But there are striking differences between their conclusions and this may leave their potential users in a perplexed or sceptical state of mind. The future outlook may range from economic collapse and widespread famine to universal prosperity.

What is the reason for these differences in conclusions? They may be explained by four broad categories of reasons:

- a - which issues and variables are included in the model;
- b - which interrelationships between variables have been introduced and how are they specified;
- c - what is the level of disaggregation: geographical, sectoral, social;
- d - which are the scenarios for exogenous variables and parameters and which are the targets, e.g. growth versus poverty elimination.

An example may illustrate these categories:

- a - if food production has not been treated separately from other agricultural commodities, no conclusions can be drawn about famine;
- b - if food is exported because of low domestic prices and wages and if the model specification does not take care of this aspect, conclusions may be too optimistic;
- c - if the model does not deal with the position of the lowest income group in a poor country the aggregate picture may show absence of starvation which is contrary to reality;
- d - if model simulation is not based on appropriate forecasts of productivity improvement in agriculture, conclusions may be unrealistic as well; if the target of the model is income growth without proper restrictions on food production, there may be too much of a shift to manufacturing industries.

In the following section we will briefly review some of the models in which the ESCAP region plays a role. We will confine our attention to :

- medium- to long-term models: the models of such studies as project-LINK by Klein are not discussed;
- models covering the economy as a whole: models which focus on a part of the economy such as MOIRA-study on agriculture by Linnemann c.s. are not included.

It is beyond the scope of this paper to review all details of the model specification of each of the studies as well as to extensively discuss the conclusions and the scenarios on which they are based. In section 2.3 broad development issues and their treatment in the models will be elaborated upon whereas in section 2.4 some of the conclusions will be compared.

2.2 The models

In one way or another models covering many countries and/or regions if not the world as a whole have been developed because the authors (and their sponsors) were motivated by one or both of the following topics:

- the gap between the rich and the poor, its implications, prospects for narrowing the gap, policies most likely to achieve this objective; here emphasis is on socio-political aspects of world development;
- the distribution of natural resources and the worsening of the environment, availability of raw materials, increase in pollution, policies to protect the world from a physical and an economic catastrophe; in this case, focus is on global, technical, economical and ecological aspects of the future of the world.

Only a very brief description of the major global models including their approach to geographical and sectoral disaggregation will be presented here as a preface to the discussion of specific issues.

1. The Forrester/Meadows models

The model was the first successful attempt to make concrete the concerns of the Club of Rome and the first global model to attract wide attention. It was described by Donella Meadows (1972) in "The Limits of Growth". Structurally, the models are a globally aggregated set of finite difference equations. The models assume that the relevant components of the global system are a set of ultimately finite resources (mineral resources, land for agriculture and living, pollution absorption capacity) and a set of interrelated exponential growth processes (population, capital accumulation, resource consumption and pollution). The world is treated as a whole and not divided into regions, which means that the deadline for the strong countries will be met at a much later stage whereas lack of resource availability and excessive prevalence of other constraints (population, pollution) are being encountered at this juncture by the weaker groups in the society of the world. Sectoral disaggregation has been very crude.

2. The Mesarovic-Pestel model

This still ongoing study was first described by Mesarovic and Pestel in the popularised book "Mankind at the Turning Point". At that stage the world was divided into 10 regions; referring to the ESCAP region the classification was:

- a - China, North-Korea, Mongolia
- b - Japan, South-Korea
- c - other LDC, West of Afghanistan, incl. Vietnam etc.

The study is based on 5 levels of activity

- individual level
- social/political level
- population/economy level
- technology level
- geophysical level.

For each region, the model consists of some submodels: economy, population, food, energy, etc. The agricultural model calculates availability of some 20 food items, whereas industrial production results from the economic model. International trade between regions is included. In a follow-up study the above region c has been divided into South Asia and South-East Asia.

3. The Bariloche model

The model developed at Argentina's Fundacion Bariloche under the direction of Herrera and Scolnik is often referred to as the Third World Model. It was constructed as a reaction to e.g. the Forrester/Meadows approach, their prediction and recommendation. Major criticism of the Bariloche group on e.g. the Forrester/Meadows model was:

- prediction may not be based on an extrapolation of present structures in the global system but should allow for fundamental structural changes;
- a perspective crisis is a crisis for the rich nations/groups within nations only; two-thirds of the world population already encounter many aspects of such a crisis.

The Bariloche group sets off from the preposition that the predominant problems, faced by society, are of socio-political rather than physical character. They are based on an inequitable distribution of power both between and within nations. The result is repression and alienation, largely founded on exploitation. Deterioration of physical environment does not result from human progress but from a social organisation which is based on destructive values. Therefore they committed themselves to the development of a normative model which would be concerned with sketching a way of arriving at the final goal of a world liberated from backwardness and misery. Their approach is for each of four regions (Africa, Asia, Latin America, Europe + North America) to maximize life expectancy which is related to four basic needs variables: nutrition, housing, health and education. The economic model incorporates 5 sectors: food, housing, education, other services and consumer goods, capital goods. Capital and labour are exogenous variables. Trade between regions has been ruled out.

4. The United Nations world model

The United Nations world model was developed for the United Nations Center for Development Planning, Projections and Policies by a team under the direction of Leontief, Carter and Petri. The purpose of this project was to provide a

tool of analysis to assess the impact of perspective economic issues and policies on the International Development Strategy. The model is a global input-output model, comprising 48 sectors, of which 8 are related to specific types of environmental pollution. World is divided into 15 regions, of which two are related to ESCAP:

- Asia, centrally planned economies (early 70's);
- other Asian LDC.

International trade per sector between regions is treated quite simply. Imports are a fixed percentage of domestic consumption. Exports are proportional to total world exports, adjusted for the level of regional stocks. The model can be used in two ways:

- 1 - availability of physical resources and growth rates of GDP are exogenously given; afterwards consumption, production, investment, employment, etc. are determined;
- 2 - investment and employment are exogenously given; necessary growth rates of GDP are obtained endogenously.

The model results do not provide annual forecasts but projections for the years 1980, 1990 and 2000.

5. The United Nations Global Econometric Model

The U.N. Global Econometric Model (GEM) of the Centre for Development Planning, Projection and Policy is a composite world development and trade model consisting of individual country models for developed and developing countries with a market economy (approximately 120). The model provides a framework for extrapolating present trends to the year 2000. Future levels of GDP in each country are based on expected or assumed trends in the level and productivity of its capital and labour. Afterwards a rather straightforward model is used to calculate the well-known two gaps (export-import, investment-savings).

6. The SARU-model

The Systems Analysis Research Unit (SARU) at the United Kingdom Department of the Environment developed a global model (SARUM) where the world is divided into 3 strata:

- USA
- other OECD, USSR etc.
- Third World incl. China.

SARUM is a model of limited aspirations regarding projecting the future. Much importance is attached to establishing sound data bases and relationships. The model structure consists of relationships based on such neoclassical concepts as

- all productive activities are carried out by "profit-maximizing entrepreneurs";
- all consumption and investment decisions are made by rational "economic man";
- government and other institutional phenomena are treated as "frictions".

Within each region 13 productive and consumptive sectors are identified.

7. The FUGI-model

An extensive report on the FUGI-model was presented in 1977 at the 5th Global Modeling Conference of the International Institute of Applied Systems Analysis. The model consists of a yearly dynamic macro-economic model and a static input-output model covering sectoral issues every five years. Next to these there is a report on an analysis of the energy sector which is not integrated with the FUGI-model.

The macro-economic model is a composition of macro-economic models for the 15 areas in which the world is divided. ESCAP LDC's are classified in five regions: East Asia, South-East Asia, South Asia, Asian Centrally Planned Economy-countries and other parts of Asia. For the input-output analysis, aggregation to three regions is introduced: East and South-East Asia, South and West Asia and separately Asia Centrally Planned Economies. Sectoral analysis is done for the economy divided into 14 sectors. The sectoral analysis is carried out using results of the dynamic macro analysis which are fed as exogenous variables into the sectoral domestic and international analysis. There is no feedback from the sectoral analysis to the macro analysis. The dynamic macro analysis is done on a yearly basis. For every five years the sectoral analysis provides a perspective or optimal sectoral disaggregation of production, international trade etc.

8. The ESCAP-FUGI-model

In cooperation with ESCAP, the FUGI-team set up a new model, based on the FUGI-model:

- covering the ESCAP-region in a more disaggregated way;
- paying more attention to some development issues and their modeling.

A description of this study as well as comments and suggestions for improvement are presented in chapter 3.

2.3 Treatment of development issues in the models

In the previous section, 8 models have been introduced, which have been selected by the following criteria:

- dealing with medium- and long-term development;
- covering the ESCAP-region;
- analyzing the economy as a whole and not only some sectors;
- providing results.

This selection has never been meant to be exhaustive but does cover a major part of the studies undertaken.

In this section we will approach the above studies^{*)} from the angle of development issues which might or should have been included to provide an adequate picture of perspective problems which to our opinion are most relevant. Setting off from the detailed list of variables and the attached levels of

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*) The ESCAP-FUGI-model will be discussed separately in chapter 3.

priority in chapter 1, we will focus on the following broad groups:

- a - international trade;
- b - capital flows, official development assistance and private foreign investment;
- c - production and technology;
- d - physical resource limitations and environmental constraints;
- e - demography and employment;
- f - distribution;
- g - basic needs.

It is beyond the scope of this paper to discuss in detail the model specification of these issues.

a. International trade

International trade between countries may be seen as a way to maximize welfare for nations or rather groups within nations and as a way to eliminate shortages which can not be covered (appropriately) by domestic production. Aggregation of countries to a region normally presupposes free flows of goods within the region. Increasing the level of aggregation of countries therefore reduces realism in representing country problems. Some positive developments may be related to increase in export revenues and many negative aspects may be caused by balance of payments deficits, high levels of imports and domestic shortages which can not be covered by imports. Aggregation of countries focussed upon, eliminates actual or perspective problems as well as possible solutions to these and other problems.

International trade between regions is not included in the Bariloche model and of course not in the Forrester/Meadows model because of its aggregate world picture. The United Nations world model aggregates imports by sector over the regions, which are determined using import functions. Afterwards it distributes aggregate import by sector over the exporting countries. The basis for this distribution is a system of fixed shares which may be adjusted because of such "domestic" regional developments as production shortages. Service payments are treated similarly. The United Nations Global Econometric Model basically uses the same approach, but now aggregated over sectors. This approach of assuming exports of a region to be a fixed share of a pool of total world trade does not represent such aspects as:

- price differences between exporting regions;
- bilateral trade relationships which will favour regions exporting to rapidly growing regions;
- trade barriers to specific regions.

These objections have been (partly) eliminated by the SARU-model and the FUGI-model. The SARU-model assumes that the bilateral trade flow of a commodity is determined by:

- production of the importing region;
- export price of exporting region, relative to the world price;
- a trade bias factor which is determined by such aspects as distance, politics and content of the "sectoral" commodity involved; determining these trade bias factors at a sectoral level is somewhat dubious.

The FUGI-model analyzes bilateral trade flows on a macro level using GDP of the importing country as the major explanatory variable; adjustments may be made through:

- export price relative to import price;
- availability of financial resources in the importing country represented by total exports, official development assistance and private foreign investment.

Services are treated as some kind of a mark up on commodity trade.

Subsequently sectoral net exports by region is determined distributing aggregate exports and imports over the sectors thus meeting domestic, world and sectoral consistency requirements.

Presumably an approach using bilateral trade flows is most appropriate if sectoral issues have been adequately taken care of. It is to be expected that such striking differences in approach between world models will yield very significant differences in results.

b. Capital flows, official development assistance and private foreign investment

What is said about the free flow of international trade within region is even more valid for capital flows. Here we will confine the discussion to capital flows between regions.

Private foreign investment must be seen autonomous flows, explained by such factors as investment climate, wage conditions and government policy. Official development assistance is rather autonomous as well, depending on such factors as availability of funds for aid by donor countries and social, political and economic qualities of receiving countries. Part of official development assistance may function as aid to compensate deficits. Such an accommodating role is also played by other components of capital flows.

Many studies do not pay attention to capital flows, which are much more difficult to grasp for a model builder than international trade flows. In the UN-world model, comprehensive information on aid combines all intergovernmental loans and grants, and debt repayment. For this reason developed countries have relatively large "aid" inflows, which are in fact intergovernmental short-term loans and repayment of debts. For the same reason developing countries have

substantial "aid" outflows. Aid flows are strongly politically determined and very hard to predict. The basic assumption of the UN-world model is:

- aid outflows are proportional to GDP of the exporting country;
- aid inflows form a fixed share of the total aid pool.

Further, the UD-world model assumes that private foreign capital inflow into a borrowing region is proportional to its domestic investment. Each region will lend a fixed share to the foreign loan pool providing these loans to borrowing regions.

A rather similar, though not yet fully operational approach was used in the FUGI-model. A division is made between official development assistance and private foreign investment. Supply of official development assistance and private foreign investment is proportional to the donor country's GDP; distribution over the receiving countries is done according to fixed shares.

Balance of payment problems have been dealt with by some authors in different ways. SARUM, either reduces the rate of expenditure proportionately to accumulated debt, or adjusts the exchange rate. In one way or another some models use this approach whereas many models completely put aside the balance of payments issue.

c. Production and technology

An essential part of any model should be the production function because it may relate production (capacity) to labour (skilled and unskilled), capital, land and technology, thus providing the basis for capital needs, labour requirements and land.

Two aspects are relevant:

- assumptions about substitution between labour, capital and land;
- assumptions about the role of technology.

As far as substitution is concerned one may distinguish between:

- production function allowing for substitution between labour, capital and land e.g. Cobb-Douglas and CES-production functions;
- production function based on fixed coefficients relating labour requirements, capital needs and land use to production.

Incorporating technological progress into the production function may be done by either inclusion of an exogenous variable representing technical progress or adjustment of parameters. In case of fixed coefficients between production, labour and capital, these coefficients may be adjusted to allow for technical progress.

The Forrester/Meadows model distinguishes between agricultural production function and industrial production function. For agriculture, production is determined by area and a capital output ratio which is adjusted for technical

progress. Industrial production is related to capital using a capital output ratio, while an adjustment is made for the degree of capital utilization caused by unemployment which in turn is related to investment both in the industrial sector and the service sector. A similar approach is used for merchandise and services. Technological developments of the world follow the path of technical progress of the USA.

Mesarovic and Pestel do not disaggregate into agricultural, industrial and service production. Each region has its own small macro-economic model from which the value of total production may be derived. The capital coefficient may be adjusted. The United Nations' Global econometric model also applies a very simple approach relating the increase in GDP to net investment through an incremental capital-output ratio, which may be adjusted. The FUGI-model specifies an aggregate production function relating labour productivity to accumulated investment per labourer and using expenditure on research and development or on education as a proxy for technical progress. In the Bariloche model, the production function chosen is the Cobb-Douglas function, which relates production to labour and capital in order to allow for substitution of capital by labour. Technical progress is incorporated by adjustment of coefficients. The analysis is done on a sectoral level. The same approach is applied in the SARU-model. However, in this model, the outputs of some sectors are limited by environmental constraints. Agricultural sectors are also treated differently, since the number of factors of production is now increased to include land in use, fertilizer and irrigation.

In the United Nations' world model, capital needs and labour requirements are related to production through sectoral input coefficients. Projection of these coefficients must take account of changes in regional per capita income as well as whatever changes in technology and in the resource picture can be anticipated. Most of the projections of input structures had two components: one for income-dependent changes and another for exogenously estimated changes in technology. The first aspect is represented by a time path aiming at the current technological structure of the USA or even beyond. Multiplicative adjusters, based on detailed studies of expected broad changes in techniques for the USA are applied to modify these income-dependent values.

d. Physical resource limitations and environmental constraints

The results of the Forrester/Meadows study "The Limits to Growth" was one of the major reasons for a dramatic increase in concern about reserves and usage of energy and mineral resources. For each of the mineral resources, the period during which it will be available is estimated given the current rates

of economic growth. The model does not differentiate between the various kinds of energy resources and the possibility of substituting some kinds of energy for others is not taken into account. The authors structure their model of the environment by relating pollution to industrial production and agricultural activities; reabsorption of pollution per unit of time depends upon the level of pollution. Lastly they introduce a feedback: growing pollution reduces the level of life expectancy as well as the fertility of land.

The Mesarovic/Pestel model only concerns itself with non-renewable energy-resources: oil, coal and natural gas. Conclusions are that these energy-resources will suffice for only a limited time and that nuclear energy cannot provide the solution because of the level of demand, the costs and the risks involved. The model does not pay much attention to the environment stratum and does not include a feedback of pollution to other sectors of the regions.

The Bariloche study, being normative, is reflecting the view of its authors that usage of energy and other resources as well as pollution heavily depends on the type of society envisaged. A more equitable society, aiming at the fulfillment of basic needs, an increase in leisure time etc. will reduce demand of natural resources, will avoid wasting or destroying these resources and consequently will decrease polluting activities.

The United Nations' world model provides the most detailed structure, as it was basically set up by Leontieff and his team, with the objective of analyzing the future of physical resource availability and pollution. Physical resources are subdivided into nine sectors both for production and consumption. It is estimated that known reserves probably will be sufficient to meet the needs of the first half of the next century. Taking into account the most significant pollutants and introducing five economic sectors which are concerned with anti-pollution activities, the conclusion from the analysis is that the problem of pollution is not insoluble using existing technologies and universally adopting regulations now already applied in the USA.

SARUM pays much attention to depletion of resources, concluding that it is not to be envisaged that this will play a crucial role. The environmental constraint affects the production function, which may be modified by a depletion function of accumulated production for a resource limited sector. This may result in an overall reduction of production and/or in variation in the inputs required.

The FUGI-model itself does not pay attention to the energy sector, the availability of mineral resources and the effects of environmental constraints. The report on the FUGI-project contains a separate chapter on a global metallic resources model estimating potential resources, future demand and future supply. This model is not integrated with the FUGI-model as introduced in section 2.1.

e. Demography and employment

Demography aspects may be included in a model because of the importance of population, fertility, mortality etc. as such and because of its interdependence with economic and other sectors of society. Only three out of eight models discussed in this chapter pay elaborate attention to demographic aspects. Most models in one way or another include employment.

The Forrester/Meadows model introduces population as determined by fertility and mortality which are functions of such variables as birth rate, birth control, fraction of population between 16 and 45 years old, and life expectancy at birth which in turn is linked to nutrition, health, pollution etc. Population and its components then provide inputs to other parts of the model such as labour force, and food, industrial and service production per capita.

Mesarovic and Pestel have developed a submodel for population, where birth and death rates are linked to food production. The database is not very strong, in particular where special methods are used to calculate caloric and protein deficiencies.

In the Bariloche model, population is affected by socio-economic phenomena. The core of the model is life-expectancy at birth, which has been chosen as the optimization variable of the model as a whole. Life-expectancy at birth is positively affected by caloric intake, education, housing and employment in the secondary sector whereas employment in the agricultural sector has a negative influence on life-expectancy at birth.

The other models treat population as an exogenous variable, which is used to determine such variables as labour force and expenditure categories per capita. The United Nations' Global Econometric Model does not pay attention to the difference between labour force and employment.

The FUGI-model determines employment on a macro level by multiplying labour force by the employment rate which acts as a policy variable rather than an endogenous variable. On the sectoral level value added in the input-output table is not disaggregated into wages and salaries and others, but the relationship between employment per sector and value added per sector is derived and used for projections and optimization of total employment.

In the United Nations' world model, employment is derived using input-output coefficients. These coefficients are adjusted on the basis of changes in GDP per capita and changes in technology. Alternatively, investment and employment may be specified exogenously to produce estimates of GDP.

The Forrester/Meadows approach is only to link employment in the industrial and in the service sector to capital invested in these broad sectors. Mesarovic and Pestel only use labour force in agriculture and in non-agriculture and insert the latter type into a production function.

The SARU-model derives distribution of employment over sectors using profit maximization based on Cobb-Douglas production functions. This approach includes sectoral wages.

In the Bariloche-model a Cobb-Douglas production function is used as well. Determination of necessary investment and employment, however, is not done by profit maximization but by maximization of life expectancy which may imply shifts from capital investment to labour usage, in order to increase labour income and therefore improve possibilities of basic needs fulfillment.

f. Distribution

Distribution of production and income between regions is included in all models, but is not expected to improve dramatically over the decades to come and may even worsen if concerted action is not taken. Besides, it has become very clear that international inequality levels do not tell us anything directly about economic inequality within nations and regions. We will therefore concentrate on distributional aspects within nations.

Most measurable of distributional aspects is personal income distribution. Income distribution between households may be the subject matter represented by such statistical indicators as the Gini-coefficient. Methodological aspects and data problems, however, tend to push the researcher/modelbuilder to indicators, such as income distribution between social groups, which are more significantly relevant. Underlying idea of this approach is the assumption that income distribution within social groups is rather fixed and changes in overall-income distribution between households are to be explained for a large part from relative changes in the average incomes of social groups.

How to define social groups, how to disaggregate society is a matter of model specification; one must bear in mind that distribution of production and distribution of assets, status and power may be much more relevant than income distribution. In one of its crudest forms disaggregation between urban and rural population, production, employment and income will yield valuable information, although, not disaggregating the urban sector into formal/informal and industry/services and not distinguishing between various social groups may eliminate the view on many problems and possible solutions.

Turning to our series of models, only two of them pay attention to income distributional aspects within countries or regions. The SARU-model imposes exogenously given changes in income distribution by means of time series of Gini-coefficients for each region. This is converted into income shares for groups in the population using the assumption of a log-normal distribution of income. The main purpose of this exercise is to arrive at demands for each commodity by each group. The time series of Gini-coefficients reflects a policy

approach and is not meant to imply an explanation of developments in income distribution.

In the Bariloche study, income distribution is approached in a normative way: new egalitarian society is the only way to escape from a catastrophe which is already at hand for a large part of population in the Third World. Attention in this study is focussed on nutrition, housing and education, which we will discuss below.

g. Basic needs aspects

Basic needs may be divided into four categories:

- nutrition
- housing
- health
- education.

Some studies only pay attention to food production, e.g. the Forrester/Meadows model and the SARU-model. The Mesarovic/Pestel model divides food into 26 basic food categories.

Only the Bariloche study may be seen as including other basic needs aspects. One may put it even stronger: basic needs is the core of the Bariloche study, as was clear from the introduction to this study where disaggregation into 5 sectors resulted in two non-basic needs sectors and three basic needs sectors: nutrition, housing and education. One of the important factors to be taken into account is the distribution of and the access to basic needs.

2.4 Conclusions of the models

Models, dealing with the future of (parts of) the world should ultimately focus on three issues:

- what is the outlook if no dramatic changes in policy will be introduced;
- what is the most appropriate direction of development the world should taken;
- what is the optimal change in policy if the world should move in that direction.

In this section we shall try to review the conclusions drawn from the models, in particular concentrating on the ESCAP region. Unfortunately publications on some of the studies do not provide (detailed results.

Treating the world as one unit, the Forrester/Meadows model as described in "The Limits to Growth" arrives at the following principle conclusions:

- if the present growth trends in world population, industrialisation etc. continue unchanged the limits to growth will be reached within a century, probably resulting in uncontrollable developments;
- the way out is to alter these growth trends and to establish a state of global economic and ecological stability where basic material and human needs of each person are satisfied.

Mesarovic and Pestel disagree with the above conclusion of perspective general collapse of the world. Crises will emerge in several regions of the world, which will of course affect other regions of the world because of their interdependence. Only organic growth and actions taken by the world community may offer possibilities to control regional catastrophes. It is envisaged that in South-Asia the pressure of the food crisis will increase, compared to the already very bad situation encountered nowadays. Import costs to cover these enormous food shortages can not be borne. Transportation from e.g. North-America to South-Asia at this scale would not be possible. Improvement of this situation would occur if investment would be shifted from industry to agriculture. However after some three decades things would be getting worse because of the destruction of the industrial bases, having a strong negative effect on agricultural production. A more active population policy combined with sufficient mobility of capital is the only way out. The foreign funds will require a concerted action from the world as a whole. Developing countries should not be provided with industrial consumer goods but only with capital goods. An adequate international distribution of labour should complete the picture showing the way out of disaster.

In the Bariloche analysis, Asia is the only region where basic needs satisfaction cannot reach the desired level. Again the food sector is the most important problem. Population growth is not reduced sufficiently. Ongoing technological progress is of extreme necessity. Drastic income redistribution contributes dramatically to basic needs satisfaction of the lowest income group.

The results from the United Nations' world model do not show optimism about reducing the income gap between developed and developing nations. The most pressing problem of food production can be solved technically if drastic public measures are imposed. Supply of mineral resources is not a problem of absolute scarcity, neither is pollution an unmanageable problem. Accelerated development in developing regions is possible under the condition that 30 to 40 per cent of GDP is used for capital investment. This will necessitate drastic measures of economic policy and measures leading to a more equitable income distribution are needed.

The macro-economic analysis in the FUGI-model predicts widening of the gap in per capita incomes between the rich and the poor regions. Zero-growth in industrially advanced regions would not contribute to diminishing the North-South gap. This gap might be reduced by an increase in official development assistance and private foreign investment in developing countries. This should be done in relation to the building of a new international economic order. Conclusions more specifically related to the ESCAP region can be found in the report of the follow-up study, the ESCAP-FUGI-model in the following chapter.

Chapter 3. The ESCAP-FUGI-model: description and comment

3.1 Introduction

The ESCAP-FUGI-model has been designed to provide perspective and optimal major structural variables for the main ESCAP countries or groups of countries. The model was primarily developed in Japan by Onishi and Kaya assisted by ESCAP staff members, Abe and Smit. It is based on a former model, known as the FUGI-model (the Future of Global Interdependence), which was presented at the 5th IIASA Global Model Conference in 1977 (Kaya, Onishi et.al. (1977)). A brief description of the FUGI-model and the issues treated by the FUGI-model is given in chapter 2. The FUGI-model was modified in order to better suit the needs of the ESCAP secretariat for a tool for policy analysis and planning for the third development decade DD3: 1980-1989.

Modifications broadly concerned:

- classification by region;
- specification of the model;
- inclusion of some more development issues.

Because of time-, data- and computer-limitations not all necessary modifications could be included. These will be reviewed in section 3.3: comments on the ESCAP-FUGI-model.

First we will present the model in its version as of early 1979, as it was presented at the United Nations Interagency Seminar on Medium- and Long-Term Projections, Bangkok, February 1979 and at the 7th United Nations Input-Output Conference, Innsbruck, April 1979.

The study focuses on such subjects as

- macro domestic expenditures, including investment;
- macro bilateral trade flows;
- private foreign investment and official development assistance;
- compilation and projection of 14-sector I-O tables;
- sectoral distribution of final demand, intermediate deliveries and value added over 14 sectors;
- projection and optimization of production and international trade by sector in consistency with projections of production and international trade at a macro level.

3.2 The model as of early 1979

3.2.1 Broad outline of the model

The ESCAP-FUGI-model consists of two sub-models:

- 1) The Asian Macro Economic Model (AMEM), and
- 2) The Asian Input-Output Model (AIOM).

Asian Macro Economic Model

The Asian Macro Economic Model is a dynamic macro-economic model which relates such aggregated variables as GDP, private consumption, private investment (housing and non-housing), government expenditure, bilateral trade flows, corporate profit, wages, consumer prices, wholesale prices, export and import prices, explicit deflators of government consumption, fixed equipment investment and housing investment, private foreign investment and official development assistance. Variables are presented both in constant and in current prices.

The model has a slightly different structure for different groups of countries: i.e., developing market economies (DME), advanced market economies (AME), centrally-planned economies (CPE), and Asian OPEC countries (OPEC). The major difference is found in the treatment of production and expenditure categories.

The model covers 28 regions, 15 of which are ESCAP countries and sub-regions (see table 3.1). Projections are made for each year through to 1990. Section 3.2.2 describes the full details of the AMEM.

1. Asian Macro Economic Model

Advanced Market Economies (AME)

Japan
Australia and New Zealand
Canada
United States
France
West Germany
Italy
United Kingdom
Other EEC countries
Other Advanced Countries: Israel, South Africa, Sweden, etc.

Developing Market Economies (DME)

Hong Kong, Macao, etc.
Korea
Indonesia
Malaysia
Philippines
Singapore
Thailand
Afghanistan, Bhutan and Nepal
Bangladesh and Pakistan
India
Sri Lanka and Maldives
Other Asia
Africa
Caribbean and Latin America

Centrally-Planned Economies (CPE)

USSR and East Europe
China and other Asian socialist countries

Asian OPEC (OPEC)¹⁾

Middle East

2. Asian Input-Output Model

North America
European Market Economies, South Africa, and Israel
Middle East including Iran
Latin America and Africa
Japan
Australia and New Zealand
India
Korea
Hong Kong, Macao, etc.
Indonesia
Thailand, Malaysia, and Singapore
Philippines
Other countries west of Burma
European CPE countries

Asian CPE countries are not yet included in AIOM

Table 3.1 Classification of regions

1) This bloc excludes Indonesia.

Asian Input-Output Model

The Asian Input-Output Model projects 14 sectoral outputs, etc. for 14 regions, 9 of which are ESCAP countries and sub-regions (see table 3.1). This model consists of four modules. The Input-Output Module deals with the prediction of input-output coefficients while the Final Demand Module ends up with the prediction of domestic sectoral final demand. These predictions are made consistent with the AMEM by using AMEM predictions of GDP, per capita GDP and total final demand. The Trade Module gives center estimates for sectoral exports and imports with upper and lower boundaries. Again, consistency with the AMEM is achieved by controlling the total exports and imports by country by AMEM estimates. The Linear Programming Module provides a method of optimising the domestic and international allocation of resources.

On the basis of projected values such as input-output coefficients, center trade estimates and macro variables, on the one hand the standard projection of 14 sectoral outputs is made. Introduction of the criteria for optimization on the other hand makes it possible to re-allocate resources in the domain of carefully prepared feasible boundaries.

Over-all model structure

The ESCAP-FUGI Model is a semi-dynamic model, where the macro part is fully dynamic while the input-output part remains static. The relation between the two sub-models is shown in Figure 3.1. It should be noted that the relation is one way; i.e., the results of the AMEM are reflected in the AIOM only, the reverse not holding.

Figure 3.1: the relation between AMEM and AIOM

The models AMEM and AIOM should have:

1. explicit consistency, by which it is meant that related variables should have consistent values, e.g. gross domestic product, final demand components and exports and imports;
2. implicit consistency, by which it is meant that sectoral distribution of consumption and production resulting from AIOM should be in line with patterns of development as depicted by AMEM (this is particularly true in the estimation of input-output coefficients and in the co-ordination of macro and input-output scenarios).

3.2.2 Asian Macro Economic Model

3.2.2.1 Verbal description of the model

In this section the first part of the ESCAP-FUGI model, the Asian Macro Economic Model (AMEM) is described. While the model in equational form is given at the end of this section, the model is first presented verbally.

The model has a different structure for different groups of countries to reflect differences in types of economies. Such groups are classified in four blocs:

- developing market economies (DME);
- advanced market economies (AME);
- centrally-planned economies (CPE);
- Asian OPEC countries (OPEC).

The model is a multi-regional link model and emphasis is placed on the interactions among regions different through international trade and capital flows. For the estimation of parameters the method of ordinary least squares has been employed, using data from 1953 to the most recently available.

Production

The model starts with an equation for average production capacity as a distributed lag function of investment (equation 3.1)¹⁾. For AME another explanatory variable, research and development expenses, is also introduced. Research and development expenses are explained by one year lagged GDP²⁾ (3.2). The production capacity, investment, and research and development expenses are all expressed per employed labourer. Employment is a function of the labour force and unemployment rate. In turn, the latter is explained by wage-share in GDP, non-house investment share in GDP, and growth of the civilian labour force (3.4 and 3.7). GDP equals the average production capacity for DME, CPE and OPEC. In other words, it is assumed that the projected capacity is fully utilized in the countries belonging to these blocs. For AME, capacity utilization is determined endogenously (3.5) and GDP is determined by expenditure (3.17). The index of capacity utilization is one of the explanatory variables of non-housing investment (3.12). Estimations of capacity are obtained by using the estimated values of production on the basis of equation 3.1 through the estimated values of regression coefficients.

Expenditure

The treatment of consumption is different for different blocs. While an explicit consumption function is introduced for AME, for other blocs consumption is treated as the residual of GDP after allowing for the other expenditure categories (3.9).

1) Hereafter equation numbers are shown in brackets.

2) GDP is gross domestic product if the area concerned is a country; it is a gross regional product if the area concerned is a region.

Where data is available investment is disaggregated into inventory investment, housing investment and non-housing investment. Inventory investment is explained by current GDP and its change, the interest rate, and inventories of the previous year (3.14). Housing investment is explained by GDP, population growth and the last year's interest rate (3.13). The specification of the non-housing investment equation is different for various blocs. For AME, explanatory variables are operating surplus, exports, the interest rate and the rate of capacity utilization, all of which are lagged one year. For DME and OPEC, they are GDP, exports and the availability of foreign capital, represented by the sum of various types of development assistance. For CPE it is GDP of the previous year alone.

Total exports and total imports of a region are defined as the sum of bilateral trade flows in merchandise adjusted for services and other differences (3.15 and 3.16). Bilateral trade flows, described by equation (3.8) are determined in a different fashion for different blocs to which importing regions belong. If an importing region belongs to AME, bilateral trade is explained by its GDP and by prices. If an importing region belongs to either DME or OPEC, the explanatory variables are its own GDP and the sum of exports and foreign capital deflated by the export price index (in other words, available foreign exchange in real terms for imports). For CPE as an importer, total exports is the only explanatory variable.

Government revenue is linearly related to GDP (3.11). Government consumption expenditure is related to government revenue (3.10).

Wages and profit

The model attempts to project unemployment rates by civilian labour force, the share of wages in GDP, and the share of non-housing investment in GDP (3.4). The unemployment rate gives the level of employment (3.7) and becomes one of the explanatory variables for wage rate determination (3.20). Other variables explaining the wage rate are consumer prices, labour productivity and the ratio of operating surplus to GDP. Operating surplus, in turn, influences salaries and earnings, investment, capital stock and the interest rate (3.19). Finally, labour productivity is defined in (3.21).

Prices

We have seen in the above sections that prices have a direct role in some equations. For example, in exports, investment, operating surplus and wages. Another important role of prices is to transform variables expressed in constant prices to current prices (parts 4 and 5). Variables in current prices have been

used in the operating surplus equation, operating surplus being first explained in current prices (3.19) and subsequently deflated by an implicit deflator of investment (3.22).

Prices are represented by price indices and implicit deflators. Wholesale prices are related to such variables as import prices, real wages, labour productivity, the money supply-current income index (the ratio of money supply to GDP), and the ratio of operating surplus to current GDP (3.24). Consumer prices are explained by wholesale prices, wages, prices of import goods and the money supply-current income index (3.25). Prices of investment goods are explained by wholesale prices and the level of investment (3.27). The implicit deflator for housing investment is related to the deflator of private investment and wages.

Special attention is paid to a set of equations which explain export prices, import prices and exchange rates. Exports prices, expressed in 1970 US dollars, are presented in equation (3.29) as a function of several variables depending on the type of bloc. AME region's export prices are related to last year's wholesale price, import prices and the world liquidity-trade index. The latter variable supposedly affects prices in a similar way as the money supply-real income index does in the domestic market. For DME countries prices of primary commodities are added. For CPE countries, explanatory variables are commodity prices, oil prices and import prices, whereas for OPEC countries the export price index is related to the oil price index alone. Export prices in current US dollars can be derived by using the exchange rate (3.30). Exchange rate movements are explained by the region's balance of payments situation (3.34). Import prices in current US dollars are defined as the unit value index of imports (3.31) and import prices in national currency are calculated by using the exchange rate.

Expenditure at current prices

The price indices and deflators make it possible to obtain current price values of expenditure components (3.36 to 3.40). The total summation of all the components gives GDP in current prices (3.45) and, dividing this by GDP in constant prices (3.33), the GDP deflator is obtained. The definition of the trade balance is given in equation (3.46).

Official development assistance

The last part of the model describes the level and direction of official development assistance (ODA) and private foreign investment (3.47 to 3.50). Matrices of parameters are estimated and can be adjusted for future changes in policy affecting exports and investment.

3.2.2.2 AMEM in equational form

Production

$$\begin{aligned} \frac{(x^{**})}{1} = & \bar{z}_a \left\{ \alpha + \beta \frac{\sum_{t=t-4}^t \theta \cdot \Delta s_p^*}{1} + \gamma \frac{\sum_{t=t-4}^t \theta \cdot r_d^*}{1} \right\} + (\bar{z}_b - \bar{z}_o) \left\{ \alpha + \beta \frac{\sum_{t=t-4}^t \theta \cdot \Delta s_p^*}{1} + \right. \\ & \left. \gamma \frac{\sum_{t=t-4}^t \theta \cdot r_{ed}^*}{1} \right\} + (\bar{z}_o + \bar{z}_c) \left\{ \alpha + \beta \frac{\sum_{t=t-4}^t \theta \cdot \Delta s_p^*}{1} \right\} \end{aligned} \quad (3.1)$$

$$r_d^* = \alpha + \beta x_{-1}^* \quad (3.2)$$

$$d_p^* = \alpha + \beta s_{p-1}^* \quad (3.3)$$

$$u = \alpha + \beta \left(\frac{w}{x} \right)_{-1} + \gamma \left(\frac{\Delta s_p^*}{x^*} \right)_1 + \delta \frac{\bar{l}_{cs}}{\bar{l}_{cs0}} \quad (3.4)$$

$$x^* = \psi x^{**} \quad (3.5)$$

$$s_p^* = s_{p-1}^* + \Delta s_p^* - d_p^* \quad (3.6)$$

$$l = (1.0 - u) \bar{l}_{cs} \quad (3.7)$$

Expenditure on GRP (at constant prices)

$$\begin{aligned} e_{(i,j)}^* = & \bar{z}_a \mu_a \left\{ \alpha + \beta x_{(j)-1}^* + \gamma \left(\frac{p_{e(i)}}{p_{m(j)}} \right)_{-1} + \delta \left(\frac{\bar{e}_m \cdot p_{m(j)}}{p_{w(j)}} \right)_{-1} \right\} + \\ & (\bar{z}_b \mu_b + \bar{z}_o \mu_o) \left\{ \alpha + \beta (e_{(j)-1}^* + \frac{1}{p_{e(j)-1}} \right. \\ & \left. (o_{da(j)} + \Delta s_{op(j)} + \bar{a}_m + \bar{a}_c)_{-1}) + \gamma x_{(j)-1}^* \right\} + \\ & \bar{z}_c \mu_c (\alpha + \beta e_{(j)-1}^*) \end{aligned} \quad (3.8)$$

($\bar{z}$ relates to importing region (j))

$$c^* = \bar{z}_a (\alpha + \beta x^* + \gamma c_{-1}^*) + (\bar{z}_b + \bar{z}_c + \bar{z}_o) \cdot (x^* - e^* - m^* - g^* - \Delta s_p^* - \Delta s_h^* - \Delta s_i^*) \quad (3.9)$$

$$g^* = \alpha + \beta r^* \quad (3.10)$$

$$r^* = \alpha + \beta x_{-1}^* \quad (3.11)$$

$$\begin{aligned} \Delta s_p^* &= \bar{z}_a \lambda_a \{ \alpha + \beta y_{c-1}^* + \gamma e_{-1}^* + \delta i_{-1} + \varepsilon \psi_{-1} \} + \\ &(\bar{z}_b \lambda_b + \bar{z}_o \lambda_o) \{ \alpha + \beta x_{-1}^* + \gamma e_{-1}^* - \delta \left(\frac{1}{P_{e(j)-1}} \cdot \right. \\ &(\phi_{da(j)} + \Delta s_{op(j)} + \bar{a}_m + \bar{a}_c)_{-1} \} \} + \\ &\bar{z}_c \lambda_c \{ \alpha + \beta x_{-1}^* \} \end{aligned} \quad (3.12)$$

$$\Delta s_h^* = \alpha + \beta x^* + \gamma \Delta \bar{n} + \delta \bar{i}_{-1} \quad (3.13)$$

$$\Delta s_t^* = \alpha + \beta x^* + \gamma (x_{-1}^* - x_{-2}^*) + \delta \bar{i}_{-1} + \varepsilon s_{i-1}^* \quad (3.14)$$

$$e^* = \alpha + \beta \sum_j e_{(i,j)}^* \quad (3.15)$$

$$m^* = \alpha + \beta \sum_i e_{(i,j)}^* \quad (3.16)$$

$$x^* = e^* - m^* + c^* + g^* + \Delta s_p^* + \Delta s_h^* + \Delta s_i^* \text{ (for AME)} \quad (3.17)$$

$$s_i^* = s_{i-1}^* + \Delta s_i^* \quad (3.18)$$

Profit-Wage

$$\left(\frac{Y_c}{s_p}\right) = \alpha + \beta\left(\frac{x}{s_p}\right) + \gamma\left(\frac{\omega \cdot l}{x}\right) + \delta\left(\frac{\Delta s_p}{x}\right) + \varepsilon\left(\frac{i-1}{100}\right) \quad (3.19)$$

$$\omega = \alpha + \beta p_{c-1} + \gamma p_y + \delta\left(\frac{u}{u_0}\right) + \varepsilon\left(\frac{Y_c}{x}\right)_{-1} \quad (3.20)$$

$$p_y = \left(\frac{x^*}{l}\right) / \left(\frac{x^*}{l}\right)_0 \quad (3.21)$$

$$y_c = y_c^* \cdot p_i \quad (3.22)$$

$$w = \omega \cdot l \cdot \left(\frac{w_0}{l_0}\right) \quad (3.23)$$

Prices

$$p_w = \alpha + \beta p_{w-1} + \gamma\left(\frac{\omega}{p_y}\right) + \delta i_{v-1} + \varepsilon\left\{\left(\frac{Y_c}{x}\right)_{-1} / \left(\frac{Y_c}{x}\right)_0\right\} \quad (3.24)$$

$$p_c = \alpha + \beta p_{w-1} + \gamma \omega + \delta p_{m-1} + \varepsilon \bar{i}_{v-1} \quad (3.25)$$

$$p_{cg} = \alpha + \beta p_{w-1} + \gamma \omega + \delta \bar{i}_{v-1} \quad (3.26)$$

$$p_i = \alpha + \beta p_w + \gamma\left\{\left(\frac{\Delta s^*}{x^*}\right) / \left(\frac{\Delta s^*}{x_o^*}\right)\right\} \quad (3.27)$$

$$p_h = \alpha + \beta p_i + \gamma \omega \quad (3.28)$$

$$\begin{aligned} p_e &= \bar{z}_a \{ \alpha + \beta p_{w-1} + \gamma \bar{l}_{qw-1} + \delta p_{m-1} \} + \\ &\quad \bar{z}_b \{ \alpha + \beta p_{w-1} + \gamma \bar{l}_{qw-1} + \delta p_{m-1} + \varepsilon \hat{p}_{ec} \} + \\ &\quad \bar{z}_c \{ \alpha + \beta \bar{p}_{ec} + \gamma \bar{p}_{eE} + \delta p_{m-1} \} + \\ &\quad \bar{z}_o \{ \alpha + \beta \bar{p}_{ce} \} \end{aligned} \quad (3.29)$$

($\bar{z}$ relates to reporting region (i))

$$p_e^s = p_e / \rho_s \quad (3.30)$$

$$p_m^s = \frac{\sum_i \{p_{e(i)}^s \cdot e_{(i,j)}^*\}}{\sum_i e_{(i,j)}^*} \quad (3.31)$$

$$p_m = p_m^s \cdot \rho_s \quad (3.32)$$

$$p = \frac{x}{x^*} \quad (3.33)$$

$$\frac{\rho_{sdr} - \rho_{sdr,-1}}{\rho_{sdr,-1}} = \alpha \left(\frac{b}{x} \right) - 1 \quad (3.34)$$

$$\rho_s = \rho_{sdr} / \rho_{sdr, USA} \quad (3.35)$$

Expenditure on GRP (at current prices)

$$e = p_e \cdot e^* \quad (3.36)$$

$$m = p_m \cdot m^* \quad (3.37)$$

$$c = p_c \cdot c^* \quad (3.38)$$

$$g = p_{cg} \cdot g^* \quad (3.39)$$

$$\Delta s_p = p_i \cdot \Delta s_p^* \quad (3.40)$$

$$\Delta s_h = p_i \cdot \Delta s_h^* \quad (3.41)$$

$$\Delta s_i = p_w \cdot \Delta s_i^* \quad (3.42)$$

$$d_p = p_i \cdot d_p^* \quad (3.43)$$

$$s_p = s_{p-1} + \Delta s_p - d_p \quad (3.44)$$

$$x = e - m + c + g + \Delta s_p + \Delta s_h + \Delta s_i \quad (3.45)$$

$$b = p_e \cdot e^* - p_m \cdot m^* \quad (3.46)$$

Official development assistance and private overseas investment

$$o_{da(i)} = \alpha_i x_i \quad (3.47)$$

$$\Delta s_{op(i)} = \beta_i x_i \quad (3.48)$$

$$o_{da(j)} = \sum_i \gamma_{i,j} o_{da(i)} \quad (3.49)$$

$$\Delta s_{op(j)} = \sum_i \delta_{i,j} o_{da(i)} \quad (3.50)$$

$$s_{op(j)} = s_{op(j)-1} + \sum_i \Delta s_{op(j)} - f_d(j) \quad (3.51)$$

i = AME region

j = DME region

Where for each region:

- $\bar{a}_m$ DME's official development assistance (net) received from multi-lateral agencies, in SDR
- $\bar{a}_c$ DME's official development assistance (net) received from centrally-planned economy zone, in SDR
- b trade balance of current account
- c private final consumption expenditure (at current prices)
- c^* private final consumption expenditure (at constant prices)
- d_p^* depreciation of fixed capital (at constant prices)
- e exports of goods and services (at current prices)
- e^* exports of goods and services (at constant prices)
- $e_{(i,j)}^*$ exports of merchandise from region i to region j (at constant prices)
- f_d fade out of overseas private investment
- g government final consumption expenditure (at current prices)
- g^* government final consumption expenditure (at constant prices)
- $\bar{i}$ average interest rate on loan
- $\bar{i}_v$ money supply-current income index

$\bar{l}$	employment
$\bar{l}_{cs}$	civilian labour force
$\hat{l}_{qw}$	world liquidity-trade index
m	imports of goods and services (at current prices)
m^*	imports of goods and services (at constant prices)
$\bar{n}$	population
$o_{da(i)}$	total official development assistance supplied by AME region i
$o_{da(j)}$	total official development assistance received by DME region j
p	implicit deflator of GRP
p_c	implicit deflator of private consumption expenditure (consumers price index)
p_{cg}	implicit deflator of government consumption
p_e	export price index (in 1970 \$US)
p_e^s	export prices index (in current \$US)
$\bar{p}_{ec}$	export prices index of primary commodities
$\hat{p}_{eE}$	oil export unit index
p_h	implicit deflator of housing investment
p_i	implicit deflator of fixed equipment investment
p_m	import price index (in 1970 \$US)
p_m^s	import price index (in current \$US)
p_w	implicit deflator of increase in stocks (wholesale prices index)
p_y	labour productivity index
r^*	government current revenue (at constant prices)
r_d^*	research and development expenses (at constant prices)
r_{ed}^*	expenditure on education
s_i^*	total inventory (at constant prices)

s_p	fixed capital stocks (at current prices)
s_p^*	fixed capital stocks (at constant prices)
Δs_h	housing investment (at current prices)
Δs_h^*	housing investment (at constant prices)
Δs_i	increase in stocks (at current prices)
Δs_i^*	increase in stocks (at constant prices)
$\Delta s_{op(i)}$	private foreign investment by AME region i
$\Delta s_{op(j)}$	private foreign investment in DME region j
Δs_p	non-housing investment (at current prices)
Δs_p^*	non-housing investment (at constant prices)
t	denotes times
$\bar{t}_m$	rate of customs duty to total imports
u	unemployment ratio
w	compensation of employees (at current prices)
x	gross regional product (at current prices)
x^*	gross regional product (at constant prices)
x^{**}	gross regional product at average rate of capacity utilization (at constant prices)
y_c	operating surplus (at current prices)
y_c^*	operating surplus (at constant prices)
$\bar{z}$	denotes dummy variables: for AME : $\bar{z}_a = 1$ else $\bar{z}_a = 0$ for CPE : $\bar{z}_c = 1$ else $\bar{z}_c = 0$ for OPEC: $\bar{z}_o = 1$ else $\bar{z}_o = 0$ for DME : $\bar{z}_b = 1$ else $\bar{z}_b = 0$

w	index of average wage and salary per employee
ρ_s	foreign exchange rate index (in terms of \$US)
ρ_{sdr}	foreign exchange rate index (in terms of SDR)
ψ	production capacity parameters which is endogenous for AME; otherwise one
λ	parameters of adjustment for investment (scenarios)
μ	parameters of adjustment for trade flows (scenarios)
-	denotes exogenous variables
*	denotes variables in constant prices
	variables for population etc.: in thousand persons
	indices are based on 1970 = 1
	other variables in million \$US.

3.2.3 Asian input-output model

3.2.3.1 Structure of AIOM

Economic development implies changes in the composition of output and foreign trade. In order to depict such changes, input-output techniques initiated by Leontief provide us with a good foundation. The input-output model recognizes explicitly that economic activity includes far more than effort oriented towards final product alone. Total output is the sum of outputs used to satisfy the intermediate demands of the productive sectors of the economy, together with those which are directed towards the fulfillment of final demand.

The purpose of constructing AIOM was to project and to suggest desirable structural changes of the world economy in 1985 and 1990. To do so, it is necessary to have: (1) projected input-output tables for 1985 and 1990; (2) sectoral international trade estimates and their upper and lower boundaries for 1985 and 1990; and (3) an optimization scheme. AIOM is comprised of four modules each of which deals with the above. The IOM (input-Output Module) deals with the prediction of input-output coefficients; the FDM (Final Demand Module) predicts sectoral domestic final demands; the TM (Trade Module) gives centre estimates for sectoral exports and imports with upper and lower boundaries; and the LPM (Linear Programming Module) provides a method of optimizing the allocation of domestic and international resources.

The relation between the four modules and AMEM is illustrated in Figure 3-2. Input-output coefficients and sectoral final demands are projected in IOM and FDM on the basis of GDP, GDP per capita, and total final demand given by AMEM.

Such projected I-0 coefficients and sectoral final demand and AMEM projections of GDP per capita and the bilateral trade matrices are fed into TM, where the regression estimates of sectoral trades are modified to keep consistency with the AMEM estimates. On the one hand TM provides central estimates of exports and imports as well as intervals of these. Consistent solutions can be obtained by solving input-output accounting relations. Within the intervals of exports and imports given by TM. Unique solutions of sectoral value added and trade figures are obtained. This case is described as the standard projection case. On the other hand the outputs of TM, IOM, FDM and the AMEM projections of GDP per capita all enter LPM, where estimates of the optimal domestic and international allocation of resources are obtained.

Figure 3-2 Structure of AIOM

3.2.3.2 Input-output model (IOM)

In analyzing the structure of an economy input-output relations provide a first approximation of the real situation although input-output relations are often over simplified because of problems involving sectoral classifications (particularly for developing countries), the role of technology (e.g., fixed coefficient assumption), etc. The present model covers 14 sectors (see table 3.2).

<u>Sector</u>	<u>Economic activities</u>
1.	agriculture, forestry, fishery
2.	mining
3.	food, beverages, tobacco
4.	textiles, wearing apparel, leather, wood products, furniture
5.	pulp, paper, printing, publishing
6.	chemical products incl. petroleum and coal products, rubber, glass
7.	metal, metal products
8.	non-electrical machinery
9.	electrical machinery
10.	transport equipment
11.	construction
12.	electricity, gas, water
13.	merchandise, services
14.	transportation, communication

Table 3.2 Sectoral classifications of I-O-tables

Before discussing the estimation procedure of input-output coefficients difficulties in treating country input-output tables for aggregation are briefly pointed out.

(a) Lack of reliable tables for many developing countries

For some developing countries tables themselves are not available. Even if tables are available they may be unreliable because they often fail in achieving the consistency required for input-output tables. For example, the sum of a row may not equal the sum of the corresponding column.

(b) Country differences in methodology of input-output tables

The most important differences are found in the treatment of imports. There are three ways: imports (both competing and non-competing) can be distributed along the rows of input-output table; alternatively competing imports alone can be distributed; or domestic flows and imported goods can be separately treated.

(c) Country differences in specification of table

Sectoral classification is different from one country to another while transactions are valued either in producer's prices or in purchaser's prices. Moreover, it is difficult to obtain tables for the same year.

These problems should be consistently treated in the aggregation procedure. Estimation or revision of input-output tables would be necessary for case (a), while data modification is necessary for cases (a) and (b) to maintain consistency. Some of these problems can be overcome by the aggregation procedure adopted below.

Regional input-output table

The world is divided into 14 regions, of which Japan, India, Korea, Indonesia and the Philippines are treated separately as single regions. For other regions which include more than two countries, a process of converting a set of country tables into a regional table is developed. The process is different from one region to another because of the regional differences in the availability of country tables. If input-output tables of all the countries in a region are available, then the regional table can be constructed as an aggregate of all the country tables by transforming them into the same specification.

For most of the regions, however, such is not the case. As a result, regional tables must be constructed with some of the standardized country tables and partial data of other countries. The following steps were taken:

- Step 1 - to construct a base table by aggregating available input-output tables of the region;
- Step 2 - to find data of sectoral gross outputs and value added of those countries where input-output tables are not available to modify the base table by using these partial data.

United Nations' World Industrial Statistics provide such partial data. In step 2 technological coefficients a_{ij} and the value added ratio v_j are modified for the region concerned as follows:

$$v_j = \frac{x_j^o + \sum_k k x_j^k}{z_j^o + \sum_k k z_j^k} \quad (3.52)$$

$$a_{ij} = a_{ij}^o \frac{1 - v_j}{1 - v_j^o} \quad (3.53)$$

where X_{kj} = value added of j-th sector of k-th country of the region;
 Z_{kj} = gross output of j-th sector of k-th country of the region;
 v_j = value added ratio of j-th sector of the region;
 a_{ij} = technological coefficients of the region;

and superscript o refers to the base table.

By choosing the value added ratio and technological coefficients as above the gross output and the value added for each sector of the region are consistent with the present data.

Projection of input-output tables for 1985 and 1990

There are in principle two kinds of methods for predicting input-output tables. One method is to determine parameters on the basis of information concerning initial values and the future values of the sums of rows and columns of input-output tables.

The RAS method is an example of this type.⁴⁾ This method, however, is not applicable in our model because only the macro-economic framework, not the sums of rows and columns, is given to project future tables. The method adopted has been the application of multivariate analysis to the present data. Since the time series data of input-output tables are not available except for a few countries, the analysis is based on cross-section data.

As the economy grows the technological coefficients may change for several reasons including technological change, changes in relative prices of inputs, changes in product-mixes and changes in output.

It may be too drastic to assume that all these effects can be approximated by the impact of economic growth on technological coefficients but, remembering that our input-output tables are those of 14 sectors and 14 regions, and that effects of economic growth are probably dominant, we have assumed that as the economy grows, the input-output structure approximates that of countries of the same GDP level. The technological coefficients are separated into two parts: one is influenced by economic growth and the other is characteristic of the region. This latter is because some parts of the technological coefficients cannot be explained solely by economic growth.

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4) See, for example, R. Stone, J. Bates and M. Bacharach (1963).

In the FUGI-model, which provided the foundation of the present ESCAP-FUGI-model, principal component analysis (P.C.A.) was employed in dealing with technological coefficients. P.C.A. is a convenient method when we want to describe each of many variables (in our case 14) by a linear function of a smaller number of other variables with a high degree of accuracy. It was found unsatisfactory, however, in that the fit of estimates in a few sectors was poor and the correlation coefficients lower than 0.6. The estimates were often conservative, changes over time being relatively small.

To remedy these defects a new algorithm has been adopted called maximum correlation coefficient analyses (M.C.C.A.), which is an extension of canonical regression analysis. The basic concept is to find a direction in the data space along which the regressed estimate shows the best fit.

Suppose that α^O is a column vector of input-output coefficients of the regional table, the last component of α^O being the value added ratio. By the nature of input-output coefficients

$$\mathbf{1}_m' \cdot \alpha^O = 1 \quad (3.54)$$

holds, where $\mathbf{1}_m$ is a m-dimensional vector with unity as each component, i.e. (1 1 .....1)'. .

α^O is disaggregated into two parts, α^C and α^R , where α^C is to be estimated with the highest goodness of fit as a function of GDP per capita. α^R is determined as the difference of α^O and α^C in the base year and α^R remains constant for the projection period. a_i^C , i-th component of α^C , can be expressed as a function of GDP per capita:

$$a_i^C = \psi_i (\text{GDP/P}) \quad (3.55)$$

We may project α^C for target years if we have GDP/P of target years. The latter being provided by AMEM, we can estimate future values of α as:

$$\hat{\alpha} = \hat{\alpha}^C + \alpha^R \quad (3.56)$$

where α^C is given by substituting future GDP/P in equation (3.55). Such estimated $\hat{\alpha}$ becomes the basis for further analysis. This procedure is carried out for each column vector of the input-output matrix.

3.2.3.3 Final Demand Module (FDM)

Regarding the estimation of final demand patterns, first final demand values for each sector are estimated for 1967 to 1973 (using A and V calculated in IOM (3.1.3.2).⁵⁾

For reasons of consistency estimations are carried out by solving the equation:

$$\text{where } f = (I - A)V^{-1}x - (e - m)^{6)} \quad (3.57)$$

f = column vector of final demand;

x = column vector of value added;

e = column vector of exports in f.o.b.;

m = column vector of imports in f.o.b.;

V = diagonal matrix of value added ratios;

A = input-output coefficient matrix.

Parameters such as the elements of A and V are estimated by M.C.C.A. for each year from 1967 to 1973. Value added and trade figures are directly substituted in the above equation.⁷⁾

Thus calculated final demand values for each sector for each region are not free from errors, which partly come from the estimation of parameters A and V and partly from statistical discrepancies of export and import data as well as value added data.

Using such estimated final demand values for each sector and for each region we first tried regression analysis for each of these time series data as a linear function of GDP per capita of the region. In order to obtain a basis for projecting final demand patterns. The results were not satisfactory.

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5) From 1967 onwards the ISIC statistical treatment has been in its present format. In order to maintain consistency, the initial value was taken in 1967 where we employ data from World Industrial Statistics.

6) This equation is derived from the fundamental input-output accounting relations: $z = Az + f + e + m$ and $x = Vz$, where z is a column vector of gross output.

7) It should be noted, however, in the process of data transformation - mainly sectoral allocation of trade figures - value added and trade figures may possess some errors.

Much improvement has been obtained by a similar analysis where it is assumed that the coefficient of GDP per capita will be the same for each region as far as it belongs to the same bloc. AME and other blocs are explicitly differentiated. The following equation is therefore applied for AME and for other regions:

$$k^f_i / k^p = \alpha_0 + \sum_j \alpha_j \cdot j^D + \beta \cdot k^x / k^p \quad (3.58)$$

where k^f_i = domestic final demand, region k, sector i

k^p = population, region k

j^D = dummy, region j

k^x = GDP, region k.

In case the t-value of the coefficient of GDP per capita is less than 2.0, final demand per capita is assumed to be fixed at the 1970 level.⁸⁾ Finally, projected final demands are adjusted proportionately to keep consistency with macro projections.

3.2.3.4 Sectoral Trade Module (TM)

The function of TM is to provide both point and interval estimates of sectoral exports and imports of each region. The point estimates correspond to control values of interval estimates and must satisfy the following conditions:

(a) They should be as close as possible to the estimates obtained from the regression analysis of the past data;

(b) They should be consistent with total trade estimates given by AMEM, i.e.,

$$\sum_i k^e_i = E_k \quad (3.59)$$

and

$$\sum_i k^m_i = M_k \quad (3.60)$$

where k^e_i the estimate of the export of i-th sector of k-th region in f.o.b.; k^m_i the estimate of the import of i-th sector of k-th region in f.o.b.; E_k , M_k the total export and total imports of k-th region estimated by AMEM.⁹⁾

8) It should be noted that the pattern in 1970 is calculated by equation (3.52). The possibility of negative final demands, exist and if this should be the case, such negative final demands values are changed to zero.

9) Notational changes have been made to avoid complication. E_k and M_k refer to e^* and m^* for k-th country of AMEM respectively.

(c) They should satisfy the supply-demand balance of such goods in the global context. In equation form, this is equivalent to:

$$\sum_k k^e_i = \xi_k \sum_k k^m_i \quad (3.61)$$

Theoretically speaking ξ_k should be equal to one but actual ξ_k is slightly different: in most cases between .9 and 1.2. The average values in the last ten years are used for ξ_k in TM to keep consistency with actual data.

(d) They should not produce negative value added in any sector;
i.e.

$$x = V(I - A)^{-1}(f + e - m) > 0 \quad (3.62)$$

This equation holds true for any region. For simplicity sector subscripts for regions are omitted here.

A primitive way of determining e and m to satisfy the above constraints is to solve the following optimization problem:

$$\min J = \sum_k || \frac{e}{k} - \hat{e}_k || + \sum_k || \frac{m}{k} - \hat{m}_k || \quad (3.63)$$

subject to constraints (3.59) through (3.62) where $\hat{\cdot}$ indicates the regression estimate and the subscript k refers to the k -th region. ¹⁰⁾

This is a quadratic programming problem with approximately $2 \times 14 \times 14$, i.e., 392 variables which are a fairly large number of variables. Instead of solving the above quadratic programming problem TM adopts the following method.

(1) Construct the initial estimates of exports and imports of i -th sector for k -th region as:

$$k^e_i^I = \hat{e}_i \frac{E_k}{\sum_i k^e_i} \quad (3.64)$$

$$k^m_i^I = \hat{m}_i \frac{M_k}{\sum_i k^m_i} \quad (3.65)$$

where I indicates the initial estimates. These estimates obviously satisfy equations (3.59) and (3.60).

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10) Similar approach was made by A. Nagy (1972).

(2) Rewrite k_i^e and k_i^m in terms of initial estimates as:

$$k_i^e = k_i^{eI} + k_i^{eI} (\delta_i + f_k) \quad (3.66)$$

$$k_i^m = k_i^{mI} + k_i^{mI} (\gamma_i + g_k) \quad (3.67)$$

where $i = 1, 2, \dots, 14$; $k = 1, 2, \dots, 14$.

Determine residual parameters δ_i , γ_i , f_k and g_k by minimizing the following:

$$\begin{aligned} \min \quad J = & \sum_i (\delta_i^2 + \gamma_i^2) + \sum_k (f_k^2 + g_k^2) \\ & + \lambda \sum_i \frac{1}{(m_i^I)^2} \left(\sum_k k_i^e - \xi_i \sum_k k_i^m \right)^2 \\ & + \lambda \sum_i \frac{1}{(m_i^I)^2} \left\{ \sum_k k_i^m (\gamma_i + g_k) \right\}^2 \end{aligned} \quad (3.68)$$

Minimization is carried out subject to the constraint of (3.59) and (3.60) m_i^I is defined in the above equation as $\sum_k m_{ki}^I$, the world total trade of i -th sector products.

The third and fourth terms of equation (3.68) are introduced so as to satisfy equation (3.61) without any considerable change in estimates of world trade in each sector. λ is an adjustable parameter.

(3) Check whether the results of the above process violates the inequality constraint (3.62). If so, replace the calculated negative value added by a small positive number. Adjust other sectoral value added, so that the total of revised total GDP should be the same as before. The next step is to calculate $e - m$ for each region by:

$$e - m = (I - A)V^{-1} \tilde{x} - f \quad (3.69)$$

where $\tilde{x}$ is the revised x .

(4) Modify e and m so as to satisfy (3.62) with as little change as possible.

This process is more economical than the quadrate programming method, as optimization in equation (3.68) requires the solution of a linear simultaneous equation of only 98 ($3 \times 14 + 4 \times 14$) dimension. The application of this process to real data has been found very successful.

It is also to be noted that both imports and exports are estimated in f.o.b. values so that trade in services and transportation may be treated explicitly in the model.

3.2.3.5 Standard sectoral projections

From the sectoral trade module (TM) point estimates of exports and imports can be obtained. Using the input-output module (IOM), on the other hand, technological coefficients and final demand patterns can be obtained. In view of the basic demand-supply balance in the input-output accounting framework information is sufficient to determine sectoral value added uniquely. The balance equation is:

$$x = (I - A)^{-1}V (f + e - m) \quad (3.70)$$

where notations were explained in former sections and regional subscripts are omitted for simplicity sake.

Calculated value added in this way constitutes the standard sectoral projection. This case becomes a point of comparison. In the linear programming model intervals of exports and imports are given instead of point estimates. Therefore, it is not possible to solve for sectoral value added by equation (3.70). To solve for sectoral value added and exports and imports it is necessary to introduce an optimization procedure, which is the subject of the next section.

3.2.3.6 Linear Programming Module (LPM)

By LPM (Linear Programming Module) of AIOM we wish to allocate resources domestically - as manifested by sectoral value added solutions, and internationally - as manifested by sectoral exports and imports in such a way that some kind of criteria is maximized under certain constraints. Linear programming is the analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those variables are subject to a number of restraints in the form of linear inequalities.

There are two ways of evaluating LP optimization in planning.¹¹⁾ The first is based on the idea that parametric programming methods provide a fairly cheap means of exploring the frontiers of the economy's choice set while the second view emphasizes the ability of an LP model to simulate a general equilibrium or competitive resource allocation, complete with the prices of the dual solution. Our LPM belongs to the first category.

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11) See, for example, Chapter III by Lance Taylor in Blitzer, Clark, Taylor (1975).

In order to define the feasibility zone we introduce three types of constraints. The first reflects real limitations such as input-output balances and balance of payments constraints. The second is closely related with the scenarios we choose. For example, when we wish to maximize manufacturing value added, we may assume that agricultural production should not decrease or that employment in manufacturing should not decrease. The third type of constraint is introduced for purely technical reasons in order to obtain realistic LP solutions. Boundaries on exports and imports and constraints on the changes in industrial structure are examples of this category.

Input-output balances have appeared in many places. Constraints on trade were discussed in section on Final Demand Module (FDM) while scenario constraints are to be discussed in the next chapter. The boundary on the changes in industrial structure is widely taken.

All these constraints make up a fairly realistic approximation of the set of feasible alternatives. The LP algorithm is an effective means to get out to the boundaries of this set. Constraints actually used except for the second type will be explained further in the next section.

Once we set up the feasible zone, what is necessary is the criterion to move the economy to the boundaries. We shall explain it in most general terms. A total or grand objective function (J) is constructed as a weighted linear summation of some partial objectives (J_m). Such objectives as agricultural production, employment, and manufacturing value added are partial objectives. In symbol forms, this is expressed as:

$$J = \sum_m W_m \cdot J_m \quad (3.71)$$

where W_m is a weight of the m-th objective.

The M-th partial objective is expressed as a linear function of sectoral value added (x_i), sectoral exports (e_i), and sectoral imports (m_i) for all the regions.

$$J_m = \sum_k w_k^m \left(\sum_i C_{ki}^* \cdot x_i + \sum_i C_{ki}^e \cdot e_i + \sum_i C_{ki}^m \cdot m_i \right) \quad (3.72)$$

where w_k^m = weights assigned to the k-th region in the m-th partial objective; and C_{ki} = coefficients for endogenous variables (x, e, and m) of LP.

The coefficients $\{C_{ki}\}$ transform endogenous variables to the m-th objective. Suppose employment is the m-th objective. Then C_{ki}^* is the ratio of employment to value added of k-th sector of k-th region while C_{ki}^e and C_{ki}^m are zero. If the m-th objective is agricultural gross production, then

$k_i^{C^x}$ is the inverse of the ratio of value added for sector 1; for other sectors $k_i^{C^x}$ is zero. $k_i^{C^e}$ and $k_i^{C^m}$ are zero for all sectors.

Weights in each region (w_k^m in equation (3.72)) can be different from one region to another. For instance, we may assign zero weight to advanced market economies when we wish to maximize industrial production of developing countries.

By setting up this grand objective function it is possible to optimize two or more partial objectives. However, it involves arbitrary value judgement in choosing the weights for various partial objectives. In this ESCAP-FUGI exercise it is mainly dealt with a grand objective function (J) with only one partial objective.

In sum, LPM enables us to allocate resources both domestically and internationally. The solutions of LPM depend upon:

- (1) criterion function;
- (2) constraints;
- (3) exogenous variables and parameters.

All of these are affected by the scenarios drawn up. Scenarios are manifested directly in the choice and specification of objective function and constraints. The third component, part of which is the output of AMEM, indirectly depends upon scenarios because scenarios of AIOM should be consistent with those of AMEM.

3.2.4 The ESCAP-FUGI model at work

The paper, mentioned in section 3.1, which gives a description of the ESCAP-FUGI model, also contains about a hundred pages estimation and projection results. Without pushing the reader through almost endless numbers of tables, we will try to give some idea about what the model can do and what not.

Any set of projection results requires assumptions about future structure of the model and values of exogenous variables and parameters. A combination of future structure of the model and certain values of parameters and exogenous variables is called a scenario. Figure 3.3 indicates that it is possible to prepare separate scenarios for AMEM and AIOM. Ideally, scenarios for two sub-models should be perfectly co-ordinated, but this is technically impossible. The best we can do is to prepare a combination of scenarios which are co-ordinated as well as possible. This point requires more explanation and will be discussed after introducing the scenarios.

The first approach to prediction is to estimate trend values for the parameters and for both exogenous and endogenous variables. This kind of prediction is different from predictions based on some scenarios such as LDC's export-led growth. In order to distinguish the latter we call the present trend estimation case the "standard scenario". For AMEM this is merely a trend analysis. For AIOM, it is standard sectoral projections (see section on standard sectoral

Figure 3.3 Scenarios and the two sub-models.

projections). In addition to standard scenarios for AMEM and AIOM, many other scenarios are drawn up. Input-output scenarios are combined with appropriate macro scenarios. The combination of AMEM standard scenario and AIOM standard scenario constitutes the basic standard scenario and in comparison with this scenario we can assess the effects of other scenarios. In this sense many of these scenarios can be seen as partial sensitivity analysis, because they try to assess the effects of changes in parts of the economic structure on the rest of the economic system by analysing how much deviation occurs from the basic standard scenario.

In the next section macro scenarios are discussed. Input-output scenarios and combined scenarios are the topic of a later section of this chapter.

Macro scenarios

Macro scenarios are formulated basically by changing parameters (or pre-determined variables) and by fixing targets directly or indirectly. There are several such parameters, pre-determined variables and targets in the model. Macro scenarios are constructed by combining these components. Let us first explain these components.

Growth Performance of Developed Countries - The growth performance of developed countries is a crucial element affecting the economies of the developing world. The experience of the 1970s taught us the importance of this factor. By arbitrarily assuming faster or slower economic growth of developed countries we can assess the impacts of the assumption on the developing world.

ODA - Total amount of ODA allocated to each developing country depends upon the economic growth of developed countries, their ODA-GNP ratio and their preference regarding ODA distribution. Faster economic growth will favourably affect the total amount of ODA to developing countries while the ODA-GNP ratio as a policy target is a result of the past economic performance of developed countries and the climate of world politics; similarly, whether or not more aid should be given to the least developed countries is a matter discussed in international political fora.

Exports - The development of exports depends heavily upon the international economic and political climate as well as on export promotion efforts of individual countries. There are several issues concerning export promotion.

One is export-led growth of low-income countries. As a result of their individual efforts and international co-operation to promote exports of low income countries they may increase exports gradually. Another issue is growing protectionism. In recent years it has been clearly recognized that slower growth in developed countries adversely affects international trade. The last issue in this category is concerned with the self reliance in international trade. When the developed countries become more protective developing countries should protect themselves by tightening the ties among themselves. At the same time efforts to find complementarity in their trade and industrial structure have been strengthened among developing countries in recent years. One example is the strengthening ties of ASEAN. All these can be treated in our model by shifting up or down the bilateral trade equation (or by changing parameter μ in equation 3.8 of section 3.2.2.2).

Doubling GDP per capita of low-income countries - The doubling of GDP per capita of low-income countries between 1980 and 2000 has been proposed in international meetings. This target is equivalent to a compound annual growth rate in GDP per capita of 3.5 per cent. We shall discuss what the effects of this would be on other developing countries and how the North-South gap as well as the gap within developing countries would develop. This doubling of income target is incorporated indirectly in the model by moving the non-housing investment equation by 20 per cent (see equation 3.12 of section 3.2.2.2).

Prices of oil and other primary commodities - One of the proposals regarding future developments of prices of commodities including oil is to set up a system of indexation relating these prices to prices of manufactured goods. In the past, prices of manufactured goods have risen steadily while prices of the vast majority of primary commodities have experienced large fluctuations. This asymmetry has affected income and the terms of trade of primary commodity producing developing countries. In the scenarios given below oil prices are set to grow at 7 per cent per year from 1980 onward; similarly, commodity prices are assumed to grow at 6 per cent per year. At the later stage this assumption will be changed in two ways: (a) by setting the growth rate of both oil and commodity prices at 6 per cent; (b) by indexing both prices to a weighted average of export prices of advanced market economies.¹²⁾ For (b) the weights for export prices are total exports of each advanced market economy.

12) The above indexation is expressed as:

$$p_e = \frac{p_{ec}}{\bar{p}_e 1980} \cdot \bar{p}_e$$

where $\bar{p}_e$ = weighted average of export prices of AME countries;
 p_{ec} = commodity (or oil) price index.

Population - population is another important element in the scenarios. Ideally this variable should be an endogenous variable but for simplicity it was decided to treat it as an exogenous variable. We use the medium population projections of the UN for this purpose.

The above mentioned components of scenarios can be divided into three groups from the viewpoint of developing countries; optimistic, pessimistic and standard. In tabular form they are:

	(optimistic)	(pessimistic)	(standard)
Growth	- DC's faster economic growth than trend	- slower economic growth	- trend
ODA	- ODA/GDP at 0.7 per cent target rate	- ODA/GDP ratio less than actual	- trend
	- Distribution of ODA in favour of low-income countries	- unchanged distribution	- trend
Trade	- export-led growth	- non existent	- non existent
	- no growing protectionism	- growing protectionism	- no growing protectionism
	- self-reliance in international trade	- self-reliance	- not self-reliant
Income target	- income doubling	- not doubling	- not doubling
Commodity prices	- increase in oil price 7 %; other primary commodity prices 6 %	- same	- same
Indexation-	no	- no ¹³⁾	- no ¹³⁾ (yes) ¹⁴⁾
Population-	UN medium projections	- same	- same

Optimistic and pessimistic cases bound the possible growth rates of the region, and serve as reference points.

Standard macro scenario

This scenario identifies the levels of production, consumption, investment, international trade, prices, etc. where trends and policies of the past continue. The results of this scenario indicate the kind and magnitude of problems which could emerge in the future if no important changes were imposed. This scenario functions as a basis for comparison from which to assess alternative policies.

13) Maybe yes.

14) This case will be a variant of the standard case. So far, we have not succeeded in this.

Optimistic macro scenario

This scenario combines all the positive factors mentioned above. The 0.7 per cent ODA target is assumed to be fulfilled for the coming decade and more ODA is shifted in favour of low-income countries. In order to let the low-income countries take off and in order to compensate for lack of financial and other resources, this scenario envisages a development strategy giving more priority to the low-income countries. The scenario is designed to give more ODA to low-income countries by diverting it from higher-income developing countries. Low-income countries are defined as countries with per capita income less than \$US 250 in 1976. They are: Indonesia; Afghanistan, Bhutan and Nepal; Bangladesh and Pakistan; India; Sri Lanka and Maldives; Other Asia; and Africa. In order to assess this scenario we will do the following: reduce the ODA share of non-low-income DME countries by the following scheme:

$$ODA^* = (0.95)^{t-1979} ODA^*_{1977} \quad (1)$$

where ODA^* = ratio of world ODA and ODA to non-low-income DME;

t = year.

Thus, the ODA share of low-income countries will increase. This increment is proportionately distributed to each low-income country in accordance with its GDP in 1980. The weights are as follows:

Indonesia	0.0850
Afghanistan, Bhutan and Nepal	0.0235
Bangladesh and Pakistan	0.1300
India	0.3394
Sri Lanka and Maldives	0.0165
Other Asia	0.0321
Africa	0.3736.

Another element constituting the optimistic scenario is concerned with trade. Export promotion is considered to be an engine for fast industrial growth. The so-called export-led growth and self-reliance can be manifested by shifting the bilateral trade flow function.¹⁵⁾

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15) For all DME except NICS (newly industrializing countries) - Korea, Singapore and Hong Kong - matrix elements of bilateral trade flows toward all regions are multiplied by the following scheme: 1.1 for 1980, 1.11 for 1981, ... 1.19 for 1990. In addition, to reflect the self-reliance aspect, for all DME, matrix elements of bilateral trade flows toward all DME are multiplied further by the following scheme: 1.1 for 1980, 1.11 for 1981, ... 1.19 for 1990. Hence, India's export to Malaysia, for instance, is multiplied by 1.21 for 1980 (1.1²), 1.23 for 1981, ... 1.32 for 1990.

The doubling of GDP per capita of low-income countries between 1980 and 2000 has been proposed in international meetings. This target is equivalent to a compound annual growth rate in GDP per capita of 3.5 per cent. In this we discuss what the effects are on other developing countries and how the North-South gap as well as the gap within developing countries develop.

It is assumed that the prices of oil and other commodities are growing at 7 and 6 per cent respectively.

Pessimistic scenario

Contrary to the optimistic scenario, the pessimistic scenario is a combination of all the negative factors so far mentioned.

The world economic situation at present does not look bright; high unemployment rates and low economic growth in developed countries undoubtedly have affected exports from developing countries and official development assistance flows to them. In order to analyse the effect of different levels of economic growth in developed countries on the exports and economies in general of developing countries, we do the following: in case projected GDP hits the upper boundary, the upper boundary will be reduced by 20 per cent. For example, if the projected GDP growth rate for Japan is 7.5 per cent which is the upper boundary, the upper boundary would be reduced to 6 per cent (20 per cent less than 7.5 per cent). In case the projected GDP growth rate is lower than the upper boundary, the maximum projected GDP growth rate for the entire projection period would be reduced by 20 per cent and used as the new upper boundary. If such a maximum is found to be 5 per cent, then the upper boundary would be set at 4 per cent. This kind of correction is only applicable to AME.

The ODA-GDP ratio is often regarded as a policy target. When AME is in recession, it is possible that AME reduces this ratio. In the pessimistic scenario we will reduce the present share by 20 per cent for all AME. For example, Japan's share being 0.2 per cent in 1977, it will be set at 0.16 per cent for the entire projection period. It should be noted here that ODA in the standard macro scenario is set at the share in 1977. In addition, there is a growing fear that the world will move back to the age of protectionism. The bilateral trade flows function is shifted down to take account of this fear.

Assumptions on the prices of oil and commodities are the same for the standard macro scenario.

Input-output scenarios

As in the case of AMEM, standard and other scenarios are prepared for AIOM.

Point estimation of exports and imports makes it possible to solve sectoral value added by the input-output accounting framework. This case becomes the standard scenario. Other input-output scenarios are depicted in the framework of the linear programming optimization problem. What to optimize (objectives) as well as under what constraints we should optimize become very important questions to raise. We shall explicitly describe objectives and constraints for each scenario in the following. There are, however, a few common arrangements for the scenarios. Since optimization can be discriminatory to each region, we can perform optimization for both total developing countries and ESCAP developing countries in each case unless explicitly stated. Objectives can be formed in terms of value added, gross output, exports, imports, employment, and labour cost.

Standard scenario

Our global model has a capacity to project what the future will be under normal circumstances. By AMEM we can project the 1985 and 1990 macro figures without introducing specific assumptions on oil prices, foreign aid, and so on. Similarly in AIOM we can obtain standard estimates of sectoral outputs by estimating sectoral exports and imports. We call this type of estimation without optimization our "standard scenario". In other words, the standard scenario refers to the case for finding solutions to simultaneous equations of input-output relations. Similar to the macro-standard scenario, the purpose of the input-output standard scenario is twofold:

- 1) to identify projected levels of sectoral final demand, value added and international trade and to analyse the kind and magnitude of problems, possibly emerging in the future when the economy grows in accordance with the past trend;
- 2) to serve as a point of comparison to facilitate assessment of other scenarios such as maximization of employment in manufacturing industries.

Combination of this scenario with the macro standard scenario gives the basis of comparison. Such a combined scenario is called the basic standard scenario.

Lima target

In March 1975, the Second General Conference of UNIDO adopted the Lima Declaration and Plan of Action on Industrial Development and Co-operation. The so-called Lima target was set for developing countries to obtain a share of at least 25 per cent of the total world industrial production by the year 2000, while observing that the industrial growth so obtained should be distributed among developing countries as evenly as possible. This statement is rather

ambiguous. The present consensus is that "Industry" excludes mining and electricity/gas/water and consists solely of manufacturing activities. The term "industrial production" is defined as net output (value added, or the manufacturing sector's contribution to GDP). The definition of "developing countries" includes only "developing market economies" listed in the United Nations Yearbook of National Accounts Statistics.

In AIOM we indirectly treat the problem of the Lima target. We maximize industrial production, that is, value added by manufacturing (sectors 3 to 10), with or without constraints on agricultural production (value added) and employment. The constraint on agricultural production is such that production does not decrease from the level projected by the basic standard scenario, while that on employment is such that employment in manufacturing and service sectors should not decrease from the projected level. The last constraint is imposed because industrialization without any employment creating effects is less desirable.

Results of LP maximization are compared with the adjusted Lima target shares of ESCAP developing countries in 1985 and 1990. Results of industrialization maximization LP gives the maximum feasible sectoral and international shifts in the production structure. It is of interest to see how dependent developing countries may become on food flows from developed countries as a result of their efforts to industrialize. This scenario will be combined with the corresponding macro optimistic scenario.

Maximization of agricultural production

Although rapid industrialization still remains the king-pin of the developmental process in the poorer countries, increasing attention has been given to agriculture, particularly food supply. This scenario indicates what might happen if developing countries attain self-sufficiency in supply of food and other agricultural commodities or move toward it. We may do this with or without imposing any constraint. Because industrialization remains the key to economic development, we may keep the manufacturing production (value added) not less than the projected level in 1985 and 1990 by the combined standard scenario. The other possible constraint is that employment in the manufacturing sector should not shift to agriculture. Alternatively, agricultural output (value added) can be maximized by squeezing the output of both manufacturing and tertiary sectors.

The difficulty of treating food production is mainly one of data. In our sectoral classification, sector 1 includes agriculture, fishing and forestry, and sector 3 processing of food, beverages and tobacco. What we are concerned with is the food supply which is a part of sector 1. Since we cannot separate

sector 1 further at the moment, we hypothesize that food production proportionately increases where the value added of sector 1 increases. Maximization of the value added of sector 1 indirectly leads to the food-supply increment, not necessarily to the maximization of it. This scenario will be combined with macro optimistic and pessimistic scenarios.

Export maximization

For newly industrialized countries such as the Republic of Korea the export of manufactured goods is the focus of economic policy. Under this scenario we will see the effect of maximizing exports of manufactured goods of semi-developed countries as well as developing ESCAP countries. This scenario will be combined with the macro optimistic scenario.

Export minimization

Developed countries are increasingly feeling the pressure of exports from the developing countries including exports of more sophisticated industrial products. In the developed countries move towards a hardened stand on protection the results could be a stagnation of the world economy with adverse impacts on the developing economies. In practice the countries exporting manufacturers may at times be obliged to accept export restraints. This self-restraint aspect can be handled by minimizing exports of developing countries. Export of sectors 3-10 are minimized for all the countries. This case is combined with pessimistic macro scenario.

Import minimization

This may be the other side of the coin of export maximization and minimization scenarios. It is, however, interesting to observe the feasibility of trade by introducing this scenario. We will minimize the import of agricultural goods for developing countries. This will depict the situation of self-sufficiency. The corresponding macro scenario is the pessimistic scenario.

Employment

Creating employment is one of the principal goals of the development strategy. Employment in the manufacturing and tertiary sectors will be maximized under this scenario. Employment in the agriculture sector is difficult to investigate because it is difficult to distinguish unemployment from underemployment. This is combined with all the macro scenarios.

Labour cost minimization

By this scenario we envisage the ideal pattern of international division of labour by minimizing the total world cost of labour. Shifts of production can be expected from labour-intensive industries of developed countries to those of developing countries. It should be noted that minimization is carried out under a constraint that the GDP per capita by region is fixed by AMEM. This scenario can be combined with the standard scenario.

Combined scenarios

Macro projections are carried out for 1985 and 1990 by setting up these scenarios. By using the macro results, AIOM tries to project structural change. Input-output tables for the target years are constructed and further calculations are made based upon them. Standard projections are made by point-estimating the trade and final demand components. Other scenarios require the use of LP optimization procedure. Given the GDP per capita of the region, LP minimization looks at first sight to be logically very strange because the results will never be reflected back into the macro projections. We admit that there is a jump in logic but it should be understood clearly that the full link will be done in future work. For the macro standard scenario the corresponding I-0 scenario is standard projection and this presents no problem. For the macro optimistic scenario we have a choice of two or three scenarios. The model includes the export maximization efforts; it is one of the aspects of the positive policy mix of the macro scenarios. Hence, it seems that the combination of the optimistic macro scenario and the I-0 export max scenario depicts the very optimistic or ideal situation. In such a case there are possible interpretations of I-0 optimal solutions.

- 1) In case of scenarios other than the standard scenario the matching scenario for I-0 gives the likely industrial structure attained during the projected period of time. For example, the macro-scenario introducing export-led growth per se cannot tell anything about the structure and gives only aggregate results. However, it should be understood that by assuming export-led growth something should happen to change the structure to fit it. Government subsidy might be given to encourage the exports of particular commodities. Normatively, export promotion should be done from the viewpoint of industrial reallocation. In this connection LP maximization fits well. If we understand it this way, it is easy to trace the simple algorithm behind the scene.

- 2) Another way of interpreting the results of optimization is that given per capita income there are several ways of achieving it by changing structures. For example, for \$US 500 several patterns are possible. The point should be clearly distinguished that for macro it is an individual country's endeavour while the I-0 deals with a more global view. In most cases it is the plan of the group of developing countries. Maximization of the group's welfare does not necessarily coincide with an individual country's view.

Tables 3.3 and 3.4 sum up the scenarios and their combinations. The implications or meanings of the combined scenarios are explored below.

Macro scenarios :   M(0)   Standard
                          M(1)   Optimistic
                          M(2)   Pessimistic

I-0 scenarios :   I(0)   Standard
                          I(1)   Lima target
                          I(2)   Agriculture maximization
                          I(3)   Export maximization
                          I(4)   Export minimization
                          I(5)   Import minimization
                          I(6)   Employment maximization
                          I(7)   Labour, cost minimization

Table 3.3 Summary presentation of all the scenarios.

	I-0							
Macro	I(0)	I(1)	I(2)	I(3)	I(4)	I(5)	I(6)	I(7)
M(0)	X	X	X	X	X	X	X	X
M(1)	X	X	X	X			X	
M(2)	X		X		X	X	X	

Table 3.4 Combined scenarios.

Projection- and optimization results will not be reviewed here.

3.3 Comments on the ESCAP-FUGI model

Commenting on a model, the construction of which one has contributed to, leaves the present author with some mixed feelings. Having taken part in the construction and simulation phase of the modeling activity, there is the advantage of a rather good knowledge of the in's and out's of the model. This implies that possible omissions and inadequacies may be clearly spelled out. However, while participating in the modeling work, multitudes of difficulties in improving the model come to the fore. These may arise from data-, computer-, manpower- and time-limitations. Knowing all this means a disadvantage to the commenting author, because he might leave out suggestions for improvement knowing the degree of difficulty to apply these suggestions.

Below, we shall try to list comments and suggest improvements rather frankly not allowing perspective difficulties to leave out a possible comment or suggestion. Some of the remarks have been discussed within the group of people attached to the modeling work, but were not implemented because of various reasons e.g. time limitations. Besides, the ideas living in the modeling team for the ESCAP-FUGI study do not necessarily fully coincide with the objectives, described as a possibly optimal set by the author of this paper and elaborated upon in chapter 1.

Many comments therefore must not be seen as criticism to the model but as a clarification of the possibilities to use the model to analyze developing countries' problems. We divide this section into two groups of comments on the model:

- representation of development issues in the model (section 3.3.1)
- specification and estimation of the model (section 3.3.2).

3.3.1 Representation of development issues in the ESCAP-FUGI model

In this section we shall discuss the treatment of development issues along the same lines as in section 2.3, focussing on broad groups of issues rather than on details of representation and specification. The broad groups are:

- a - international trade
- b - capital flows, official development assistance and private foreign investment
- c - production and technology
- d - physical resource limitations and environmental constraints
- e - demography and employment
- f - distribution
- g - basic needs.

Before discussing these aspects in detail some remarks will be made about classification by region and by sector.

Classification of countries by region is given in table 3.1 in section 3.2.1. Setting off from the assumption that for the ESCAP region we should concentrate as much as possible on countries rather than on groups of countries, treatment of developing countries in AMEM is almost as good as possible, although the union of Pakistan and Bangladesh is inappropriate in view of big differences in population and economic structure and the consequent problem issues and policies coming to the forefront. On the other hand, advanced market economies in AMEM might be aggregated a little more as is done in the AIOM part, as the only reason for including these regions in the model is the international trade and capital flows and the problems related to them such as the international division of labour and the international distribution of resources.

In general, it should be better to apply the same classification by regions for both parts of the model, AMEM and AIOM, because that might eliminate problems which emerge while aggregating countries or regions in moving from AMEM to AIOM e.g. intraregional trade and capital flows.

No sectoral disaggregation is introduced in AMEM whereas in AIOM a 14-sector approach. However, AMEM, moving on its own without being influenced by the results of AIOM, does provide macro levels of exports, imports, GDP and final demand components, which act as given totals for AIOM and which are not affected by changes in the economic structure of the region, as suggested as optimal by AIOM. Examples may clarify this point. The effects of a shift from a traditional export economy trading primary commodities to an economy exporting manufactured goods as may be found optimal by AIOM, does influence the sectoral results, but does not affect such variables as bilateral trade flows and investment in AMEM. If optimization in AIOM shows that it would be better to move from agricultural production to traditional industrial production or further to the manufacturing of machinery products this is not reflected in the investment-function and the production-function in AMEM.

It should be advisable to disaggregate AMEM into agriculture, other primary manufacturing (perhaps 2 sectors) and services and to provide linkages from AIOM and AMEM.

a) International trade

International trade is one of the major topics of the ESCAP-FUGI model which may be inferred from the authors' stand naming the model FUGI: Future of Global Interdependence. In section 3.2.2, the basic structure of the international trade part of the model is described. It is treated along the following lines:

In AMEM the bilateral trade flow of goods is determined by GDP of the importing region and in many cases by prices and/or availability of foreign exchange.

Total exports of goods and service of a country is obtained by adding bilateral

exports of goods and afterwards introducing a non-proportional mark-up, which is obtained by regressing exports of goods and services to exports of goods (equation (3.15) in section 3.2.2.2). Total imports of goods and services are determined in a similar way. Although the treatment of services must be improved, modeling of international trade in goods through bilateral trade flows is presumably as good an approach as any other. Treatment of international trade in AIOM is rather complex (section 3.2.3.4). Total exports and imports from AMEM are treated as totals which should be consistent with added sectoral exports and added sectoral imports. Moreover, world exports of a sector should meet world imports of that sector and, within the region, sectoral exports and imports should be consistent with domestic final demand, intermediate deliveries and domestic output, all at the sector level. In case of a need for standard projections, trade estimates should satisfy the above constraints and should be as close as possible to the structure of international trade, emerging from the past. For the optimization analyses, intervals for sectoral exports and imports are calculated. This approach as such is very elegant.

Reviewing we may conclude that both parts, AMEM and AIOM, in isolation treat international trade very adequately. However, as was already stated above, the relationship between both parts is very poor. Introduction of a broad sectoral analysis in AMEM and the requirement of consistency of these broad sectors with groups of smaller sectors in AIOM may improve realism. If optimization in a certain year in AIOM provides results which are not fed back into AMEM, it is no use to repeat optimization for every five years because there is no relationship between the results of these 5-year periods. The same holds for other aspects such as employment.

b) Capital flows, official development assistance and private foreign investment

Capital flows, other than official development assistance (o.d.a.) and private foreign investment (p.f.i.) are not introduced in the model. Although p.f.i. appears in the model, if only in the AMEM, it is not yet operational. The only variable remaining is o.d.a. and it is not used in AIOM, which is rather realistic, since o.d.a. may be seen in relation to macro variables, rather than to sectoral variables with given final demand.

Availability of o.d.a. is determined by economic development in donor-countries (eq. 3.47) and a parameter for willingness of a country to provide o.d.a. This parameter (α_1) can be treated as a policy parameter (cf. section 3.2.4). This approach is quite attractive.

Distribution of o.d.a. between developing countries is done in a rather mechanistic way, applying a matrix of parameters determining some kind of bilateral o.d.a. flows. This implies that the amount of o.d.a. flowing into a country, is fully supply determined. Although this makes sense to a large

extent, one should include the domestic situation of the receiving country as well, considering such indicators as balance of payments deficits, budget deficits and debt-service ratios.

c) Production and technology

For advanced market economies the AMEM-part of the model distinguishes between production and production capacity. Production is determined by total expenditures minus imports. Production capacity is obtained as the estimated value of production, as it is explained in a regression equation by (lagged) investment. Another explanatory variable is research and development expenses, which is a variable supposed to embody technical progress. All variables are introduced as expenditure per worker.

In the case of developing countries, it is only (lagged) investment which determines production capacity, again on a per worker basis. Production is assumed to equal production capacity, implying that investment is the only barrier to growth. Investment itself is explained from last year's GDP and last year's availability of foreign exchange (if significant). Having GDP determined by production capacity, consumption acts as a residual taking care of balancing expenditure against production. The problem with this approach is that for some countries (Korea, Malaysia, the Philippines), growth in GDP is a self-sustaining process in the absence of variables other than GDP influencing investment.

Consumption, only acting as a residual, should be influenced by some variables or constraints. For some countries, one might prefer to use investment or imports as residual in the balancing equation. Moreover, as was stated in the case of international trade, the quality of the model will improve considerably if a broad sectoral disaggregation is applied. Production functions for agriculture, manufacturing and services are entirely different and the weights of these sectors in total product change drastically over time; the same holds true in the case of investment functions, consumption functions etc.

While AMEM specifies production functions allowing for some kind of substitution between labour and capital, AIOM, on the other hand, is based on the fixed coefficient production function approach. These coefficients may be changing over time in relation to GDP per capita, thus introducing some kind of technological development and structural change. However, value added is not split into wages and others, thus not allowing for the possibility of changes in the labour and capital input coefficients. For some scenarios, a relationship over time is set up between employment and value added, with the effect that maximization of employment may be introduced. For almost all countries the elasticity of employment to value added in secondary and tertiary sectors is less than one, and may even be negative. This relationship between employment and value added is, of course, determined by wages, investment prices and

physical substitution between labour and capital, and therefore must be considered very carefully. Again, it is indeed a pity that there is no feedback from scenarios on employment in AIOM to the rather exogenous way of determining employment (on aggregate) in AMEM. Disaggregating AMEM into broad sectors would extremely facilitate checking consistency between AMEM and AIOM. Besides, results from AIOM may be used to adjust production functions in AMEM.

Investment in AIOM is not treated separately. Owing to data problems domestic final demand is not divided into consumption, investment, etc. The final demand pattern showing the distribution of aggregate final demand over the input output sectors is determined in relation to GDP per capita. Industrialization, requiring investment, does not result in a change in final demand pattern, as this is only related to GDP per capita. Moreover, GDP per capita is determined by AMEM which is not influenced by results of AIOM. Although it is feasible to draw up industrialization scenarios both for AMEM and AIOM, it is not possible to obtain any reasonable degree of consistency. Some type of investment requirement feedback within AIOM and between AMEM and AIOM should be introduced.

d. Physical resource limitations and environmental constraints

Because of the orientation of the model towards aspects of (under) development, the environmental issues have not been included. However, not including physical constraints, such as land resources and energy may lead to an unrealistic analysis.

e. Demography and employment

In AMEM civilian labour force is exogenous and employment is related to it in many cases through an exogenously given (policy variable) unemployment rate. In AIOM, employment is related to production through fixed input coefficients. This subject has been elaborated upon in the above discussion on production and technology. Demographic aspects have not been included.

f. Distribution

In the discussion on distributional aspects in Section 2.3, we have made introductory remarks about which distributional aspects are relevant: distribution of income, assets, skills and power between social groups. One of the crudest ways is to disaggregate urban and rural production, employment and income, or to disaggregate into (formal/informal) primary, secondary and tertiary sectors. Neither in AMEM nor in AIOM has any attention been paid to these subjects. The only aspects included are the distribution of employment over the input-output sectors in AIOM.

g. Basic needs aspects

Basic needs aspects are not included in the ESCAP-FUGI model. Even nutrition cannot be distinguished from other agricultural production.

3.3.2. Specification and estimation of the model

Having covered the representation of major development issues above in 3.3.1, we now concentrate on details of specification and estimation of relationships between variables in the ESCAP-FUGI model.

The parameters in AMEM have been estimated by the method ("backward") stepwise ordinary least squares. We will not discuss the estimation results one by one, although some of the estimates emerging from the fully automatic computer program do require to be looked at carefully.

Setting off with the production function in AMEM,* we at once touch upon one of the difficult parts in any macro-model: how to include labour (supply/demand), how to specify technical progress (embodied/disembodied), how to represent capital stock. The determination of capital stock is impossible, due to lack of adequate data.

It is therefore more appropriate to use incremental capital output ratios (ICORs) and explain the increase in capacity (Δx^{**}) from (lagged) investment (Δs_p^*), or specify total capacity as a distributed lag function of investment. Multiplying both sides of (3.1) by labour L , e.g. in the case of developing market economies (DME) gives:

$$x^{**} = \alpha L + \beta \sum_t^{t-4} \theta_t \Delta s_p^* + \gamma \sum_t^{t-4} \theta_t r_{ed}^* \quad (3.1.a)$$

which shows that basically there is no constant term which is able to take care of the truncation of the distributed lag ($t \dots t-4$), whereas α is the contribution of labour to total capacity. The "constant term" α in (3.1) must be very sensitive to the specification of (3.1). Besides, only allowing for technical progress if it can be represented by expenditure on research and development or on education, is perhaps a little weak. Only three developed and three developing regions show a proper coefficient. Finally, a log linear form is more appropriate in view of properties of the elasticity of substitution.

The concept of unemployment in developing countries and the representation of it by a statistical indicator called the unemployment ratio is a rather dubious matter. Specification of an equation explaining the unemployment ratio (eq. 3.4) from the share of wages in GDP, the share of investment in

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* equation numbers refer to the model in equational form in sub-section 3.2.2.2.

GDP and civilian labour force should be queried. Because one cannot afford to be unemployed, data on unemployed are unreliable and meaningless. The indicator w/x^* , the share of wage income in total GDP, is presumably not very relevant.

Bilateral trade flows of goods on the import side depend, to some extent, on the balance of payments situation etc. It is questionable whether the inflow of foreign exchange, as inserted in the model (eq. 3.8) is a good indicator for this kind of aspects. As was stated in the previous sub-sections, distinguishing between agricultural exports and manufactured exports, for example, may improve the quality of the model. In many cases, particularly for agriculture, supply constraints should be taken into account. Concerning total exports of services, it is presumably better to relate this to world exports of services through trade in services shares than use a mark-up on exports and imports of goods (e.g. 3.15 and 3.16).

Using consumption as a residual may be appropriate for some countries. For many countries, however, imports and/or investment may be treated as a residual. Imports are very often constrained by exports (and o.d.a. etc.), while investment, owing to its generally high import content, is limited by the level of imports. Some disaggregation of the investment function may be useful if a behavioural equation is to be specified. The government sector and the role of public enterprise should be spelled out more carefully. Government revenue consists of indirect taxes, direct taxes, export duties etc. and therefore may be related to the relevant variables separately. Government expenditure is constrained in some way by government revenues (+ o.d.a. etc.), although deficit spending, inflationary deficits etc. may be attractive. It seems better to explain g (in current prices) than g^* (in constant prices).

Housing investment may be explained from savings and inflation as well (3.13). These savings should be introduced as $x_d - c$ where x_d = disposable income needs its own equation. Inventory investment (3.14) can be considered to contain some behavioural elements. In general it also plays a balancing role. One of the behavioural elements may be the degree of capacity utilization (per sector).

Modelling price determination and the role of prices is a complicated matter. In all cases where prices are included in the model ($p_w, p_e, p_{eg}, p_i, p_h, p_e, p_e^s, p_m^s, p$ in equations 3.24 - 3.32) we should consider the following matters:

- it may be more appropriate to specify a behavioural equation for the variable in constant prices rather than for the variable in nominal prices; for example in the case of private consumption and government expenditure, the constant price approach may not be realistic.

- the general price deflator needs to be determined simultaneously with the other price levels: these other price levels should be related to p_w , wholesale prices, which represent inflation, prices and related variables should be solved simultaneously.

The income distribution aspects of GDP: GDP equals wage income + operating surplus (+ net indirect taxes) is not included. The wage level is determined in the well-known way. Operating surplus is related to GDP, the wage share in GDP and the investment share in GDP. The wage share in GDP is obtained by multiplying the above derived wage level and labour demand. Results may be very poor because of the aggregation of agriculture and industry. The wage share in GDP may be seen as a proxy for the industrial structure.

In general, it is necessary to include an explanation as well as the effects of gaps between investment and savings, and income and expenditure of the private and the public part of the economy. This should be used as a series of indicators making the distribution of o.d.a. more demand oriented. In this context, private foreign investment must be explained as well, relating it to investment, wage levels etc. in "receiving" countries rather than to the economic situation of the "donor" countries.

In the previous subsection, we have discussed some aspects of consistency between AMEM and AIOM. We shall present the most important aspects of these consistency requirements:

- consumption by broad sectors;
- investment by broad sectors;
- government expenditure by broad sectors;
- wage and salary income by broad sectors;
- operating surplus by broad sectors;
- exports and imports by broad sectors;
- employment by broad sectors;
- sectoral prices.

Simultaneously including all these consistency requirements in the analysis, provided the required disaggregation is feasible, on a year by year basis is just a little too much. This could only be done using iterative procedures and that is not feasible in view of the scope of the models. The second best and presumably optimal solution is to assume block recursiveness on a yearly basis: $AMEM_t \rightarrow AIOM_t \rightarrow AMEM_{t+1}$ etc.

The above listed consistency requirements indicate the need for further disaggregation of some of the sectoral variables such as final demand and value added and the improvements which may be obtained by introducing sectoral employment and prices. Disaggregating the agricultural sector (e.g. food

versus non-food) and the service sector (formal versus informal) again should add to the quality of the model and thus to the quality of the results.

In the Input-Output Module of AIOM, all technical changes, to be reflected in changes in input-output coefficients, are explained from GDP per capita, in a cross-section analysis, which may not be fully adequate. Besides, the table being in value terms, attention should be paid to the effects of price changes. The final demand pattern presumably cannot be considered as a linear function of GDP per capita as well.

A higher level of consistency in scenarios is the last aspect which will yield to realism and usefulness of the ESCAP FUGI model to developing countries' projections and planning.

4. Proposed outline for a system of medium- and long-term models of developing ESCAP-economics

In the previous chapters we have discussed, partly at great length, existing models covering the economies of the ESCAP-region. From chapters 1 and 3 in particular the reader will have obtained a picture of the kind of model which the present author prefers and the type of elements of which it should consist. In this chapter we will design a system of models which might suit ESCAP's need for a tool for policy analysis, projection and planning. In the first section, a broad picture of the model will be presented enabling the reader to get a bird's eyes view of the model. In the second section of this chapter, the various sub-systems of the model and their interrelationships will be shown more in close up.

4.1 Major features and broad outline of the model

Since the emphasis of this modeling study is on developing countries problems in the national and international context, we should treat these countries one by one and include in the analysis interrelationships between these countries among themselves and with the rest of the world. The rest of the world might be classified in a few regions: North America, European Market Economies, Middle East, European Centrally Planned Economies, and other developing countries. It may be difficult to do a detailed study of China and the other Asian Centrally Planned Economies.

Modeling the economic, social and political systems of developing countries in order to evaluate policies aiming at improving certain objectives, requires clearly spelling out off

- objectives,
- instruments
- and their interrelationships.

This has been done in chapter 1, in particular in table 1.1. We shall just review the major elements.

Three elements have been chosen as objectives, with the qualities of representing the core of the development problem as well as being largely explanatory to changes in living conditions of groups in the countries concerned:

- a) income structure
- b) income levels
- c) food production and consumption.

In chapter 1 these objectives have been further elaborated upon.

Models aiming at policy analysis and planning require an appropriate set of instruments, appearing in the model. In chapter 1 we have distinguished between

- national instruments and
  - international instruments
- and between
- direct intervention and
  - indirect intervention.

Thus one may list the following instruments

1. direct intervention in factor markets
2. price/wage policy
3. monetary policy
4. fiscal policy
5. international trade arrangements
6. foreign borrowing
7. private foreign investment facilities.

which is presumably rather exhaustive.

Interrelationships between instruments and objectives may be very direct, but will be in general channelled through economic and social variables. Many of them have been listed in chapter 1 and will come to the fore in the remainder of this chapter.

To set off it would be good to study the macrostructure of the region concerned. It is attractive to apply the same overall modelstructure to each region but there must be freedom to pay attention to differences in economic, political and social structure between regions. Some aspects are very relevant:

- open versus closed economies
- small versus large economies
- accommodating variables: imports and/or consumption and/or investment and/or government expenditure.

Besides, one needs to carefully study existing and perspective gaps

- income gaps between social groups
- food production gap
- investment-savings gap
- import-export gap
- public sector deficit or surplus.

Although, in general, the variables to be included in the model are the same for each region, causal relationships between these variables and specification of these relationship will depend upon the region concerned. The same holds true for certain aspects of the economic and social system.

It is clear, that aggregation of variables in many cases reduces the feasibility to specify an equation which adequately explains the variable concerned. Many of the above mentioned indicators will suffer from too high a level of aggregation if they are not disaggregated. Production functions in agriculture are completely different from those in industry and from those in services. Employment creation may only be studied fruitfully on a sectoral basis. Consumption patterns will change when incomes are changing. Export in a traditional exporting economy must be explained differently from export in a region with export oriented industrialization.

Input-output analysis is an extremely useful tool to handle sectoral disaggregation. Sectoral classification should optimally be designed in such a way that resulting sectors are homogeneous with respect to

- size of farm or industry or service institution
- traditional or modern production methods
- tradability
- formal or informal.

Details of the classification by sector will be presented in the following section. We will end up with some 20 sectors. In some cases some data cannot be traced in existing input-output tables. Additional information may be required.

The primary input sectors optimally should be disaggregated in such a way that there can be distinguished between social groups in labour and operating surplus; simultaneously one may concentrate on the urban and the rural sector separately. The following social groups may be focussed upon

- 1 - selfemployed, peasants, unskilled labourers
- 2 - owners of small-scale enterprises, farmers skilled workers, middle-class-salary earners
- 3 - owners of large-scale enterprises, plantations, technicians, salary earners.

Thus, it is feasible to assess the effects of changes in the export, investment or consumption structure on labour and labour income and thus on income distribution.

On the other hand must be stated, that the consumption pattern is strongly related to income by social group. Investment behaviour heavily depends upon investment needs by sector and operating surplus by social group. This shows that optimally final demand should be disaggregated by social group as well. Since existing input-output tables in general do not provide information at the above mentioned level of disaggregation, results from other studies should fill the gaps.

Investment ideally must be demand oriented. To transform these investment by destination to investment by origin a matrix of investment coefficients is required. This will be a very difficult task, needing a huge amount of additional information.

Income distribution has been introduced as the distribution of income between social groups. Within social groups one will find distribution of income as well. The latter distribution seems to be fairly stable over time. This leads to the conclusion that it will not be worth the efforts of data collection and modeling to try and endogenize this kind of income distribution between households. Endogenizing total income by social group and size of the social groups will enable us to derive average income per household in each social group.

Determination of size of social groups and transfers from one social group to another can only be achieved if a demographic sub-system is included. This should include labour supply, both skilled and unskilled, in rural and urban areas. Together with labour demand by sector this will influence wages, (hidden) unemployment and underemployment and migration between rural and urban areas. Subsystems explanatory to the demographic subsystem are income distribution and basic needs satisfaction.

As basic needs may be seen nutrition, health, housing and education. Apart from the food aspect it is beyond the scope of this modelsystem to include detailed explanations and repercussions of (lack of) basic needs satisfaction. Partly this will be covered by income levels and income structure, partly it is a matter of government policy. Only food provision should play a very important role.

This completes a brief outline of a model which is a multicountry dynamic input-output model and may be called Asian Dynamic Input-Output Model (ADIOM). Details about composing parts of ADIOM will be presented in the following section. In table 4.1 below all elements are put together in an input-output table. One may find most objectives and instruments in the bottom-left and top-right parts of the table.

	Intermediate sectors	Total intermediate deliveries	Consumption by social group labour/owners	Government cons./inv.	Investment by social group owners	Exports	Final demand	Imports	Total output
Agriculture									
Extractive industries									
Manufacturing industries									
Construction									
Electricity, gas									
Water									
Merchandise, trade, commerce									
Formal services									
Informal services									
Total intermediate									
Imports									
Total non-value added									
Labour, by social group									
Owners by social group									
Depreciation									
Net indirect taxes									
Total value added									
Total output									

Table 4.1 Broad picture of the input-output table for a country.

4.2 The composing parts of ADIOM.

Regionalization

The model proposed here is called Asian Dynamic Input-Output Model (ADIOM). It may be seen as a system of multicountry dynamic input-output models with special reference to developing ESCAP member countries. Since relationships to developed ESCAP member countries and to other parts of the world are relevant aspects regarding the future of ESCAP's countries, these countries and regions must be somehow inserted in the system as well. Asian Centrally Planned Economies (China, Vietnam, Laos, Kampuchea, North Korea, Mongolia, Afghanistan) are not treated on a country level but are lumped together. These considerations result in the classification by region as presented in table 4.2.

<u>Region number</u>	<u>Countries included</u>
1.	Korea
2.	Taiwan
3.	Hong Kong, Macao
4.	Singapore
5.	Philippines
6.	Malaysia
7.	Thailand
8.	Indonesia
9.	Sri Lanka
10.	Bangladesh
11.	Pakistan
12.	India
13.	Other Developing ESCAP countries ^{*)} , market economies
14.	Japan
15.	Australia, New Zealand
16.	North America
17.	European Market Economies, South Africa, Israel
18.	Middle East, including Iran
19.	European CPE countries
20.	Latin America, Africa
21.	Asian Centrally Planned Economies

Table 4.2 Classification by region.

^{*)} Nepal, Bhutan, Pacific Islands

The main objective of ADIOM is to provide a tool for the analysis of alternative policies for developing ESCAP market economies: regions 1 to 13. The proposed structure of the model is focussed on this need. For the other regions, developed countries, developing countries outside the ESCAP-region, and Centrally Planned Economies, certain elements of the proposed model structure may be left out, since for these regions, emphasis is on international trade and capital flow relationships with developing ESCAP market economies. In this chapter we will use the concept "region" meaning a country or a group of countries (cf. table 4.2).

Diagrammatic representation

Before discussing the composing parts of the model, a diagrammatic presentation of the broad outline of the model (section 4.1) is given in figure 4.1, where the model is pictured from a slightly different angle compared to the representation in table 1.1. In order not to overload the diagram with arrows, only the most important relationships have been included.

The diagram consists of a few blocks of elements. The top layer concerns the objectives: income structure and income level (21) and gross output of food (1), while at the bottom the instruments are represented: taxes (7 and 25) and other government influence (24). The elements in between show the economic and social variables, taking care of relationships between instruments and objectives and being in turn influenced by the objectives. These variables can be divided into 4 groups: the input variables in the first column: elements (2) to (7); the final demand variables in the second column: elements (8) to (13) and at the right the interactions and gaps: elements (14) to (20) and the input-output structure: elements (22) and (23).

Sectoral classification of the input-output analysis for the intermediate sectors

The core of the model at a country (region) level, linking many of the other parts of the model, is the input-output table. In the broad outline in section 4.1 we have listed some of the properties, which should be found in the sectoral classification of the intermediate sectors. The sectors must be, to a large extent, homogeneous with respect to

- size of farm or industry or service institution
- traditional or modern production methods
- tradability
- formal or informal.

Figure 4.1 Diagrammatic presentation of the broad outline of the model.

Many of these properties coincide, reducing the number of sectors. Small scale farming normally follows traditional production methods and has a low level of tradability for the goods produced because a major part of it is produced for subsistence purposes. Modern manufacturing industries normally are set up on a large scale while the products have a high level of tradability. The informal service sector consists of small size units, not interested in tradability. These considerations lead us to the sector classification proposal as listed in table 4.3. The size of the production unit in general has been mentioned.

Sectors 1 - 5 are the primary industries. There are 10 sectors for secondary industries (sectors 6 - 15). The last 5 sectors cover tertiary activities. The agricultural sector is divided into 3 subsectors

- 1 - small farming, merely subsistence
- 2 - medium size farming, partly food, partly non-food
- 3 - large scale farming, mainly non-food.

Sectors 2 and 3 may be export sectors. The mining sectors has been split up to distinguish between energy and others. The disaggregation of the manufacturing sectors is based on tradables (6 - 11) and non-tradables (12 - 15). The order in which sectors for tradables are listed broadly reflect an increasing level of industrial development. Non-tradable sectors have large infrastructural contents. In the service sectors, informal services have been separated because this is where the (un(der))employed try to "earn" a living.

Sectoral classification of the input-output tables

1. agriculture and fishery (small)
2. agriculture farmers (medium)
3. agriculture and forestry - plantations (large)
4. mining excluding coal and petroleum
5. petroleum, coal etc. (large)
6. food, beverages, tobacco, textile, wearing apparel
leather, wood products (small)
7. ditto (large)
8. chemical products including petroleum products (large)
9. metal and products and non-electrical machinery (large)
10. electrical machinery (large)
11. transport equipment (large)
12. construction (small)
13. construction (large)
14. electricity, gas (large)
15. water, including watercontrol (large)
16. merchandise, trade and commerce (large), including banking and
communication
17. merchandise, trade and commerce (small)
18. services (large), government and private, including education,
housing, health
19. services, formal n.e.s.
20. services, informal.

Table 4.3 Sectoral classification of the input-output tables

Disaggregation of value added

Not considering net indirect taxes, which will be discussed at a later stage, value added may be divided into labour income and operating surplus income. Since this is the basis for the determination of the income distribution, which in turn affects consumption investment and savings patterns it is essential to do a very careful job in modeling value added component of the countries' economies.

To start off, it is extremely useful to distinguish between rural and urban areas because of differences in production structure, consumption structure, wage levels, aspects of un(der)employment etc. Further, differences in levels of skilling are important factors in production functions, wage determination, employment opportunities etc. Therefore, it is necessary to

distinguish between unskilled, skilled and highly skilled labour. Finally, ownership scale, as one of the determinants for operating surplus, is relevant to production functions, consumption and investment behaviour, tradability and foreign influence. Thus we arrive at a rather optimal division of population into social groups as depicted in table 4.4.

Population and ownership in the rural areas

- 1a. peasants, small farmers
- b. landless labourers, unskilled
- 2a. farmers
- b. skilled workers
- 3. large scale farmers

Ditto in the urban areas

- 1a. self-employed (3 employees)
- b. unskilled workers
- 2a. owners of small-scale enterprises (10)
- b. skilled workers (blue collar)
- c. middle-class - salary earners (white collar)
- 3a. owners of large-scale enterprises
- b. technicians
- c. salary earners

Table 4.4 Population by social groups.

Categories b and c always indicate labour whereas the first (a) group represents entrepreneurs/owners. Most likely categories 1b and 2b in the rural areas will be aggregated due to data availability (ILO workers' classification). Important differences between classes of ownership are access to investment goods and types of labour employed. In general, both for rural and urban, 1a. has low access to investment goods, 2a. has a medium level and 3a. has a high level of access to investment goods. The relationship between ownership/farm/firm and types of labour is schematically represented in figure 4.2.

skill workers	ownership scale	rural			urban		
		1	2	3	1	2	3
1	unskilled	x	x	x	x	x	x
2	skilled, salary earner			x		x	x
3	technician professional						x

Figure 4.2. Employment of labour by type by farms/firms by size.

Demographic subsystem

Before describing the production system and explaining such variables as investment and labour demand, we should consider labour supply, both skilled and unskilled, being constraints to as well as partly explanatory to demand for labour and investment goods. Discrepancies between demand and supply of labour will lead to

- unemployment/underemployment
- changes in wages
- migration
- changes in the reservoir of the informal service sector.

A schematic representation of the demographic subsystem is given in figure 4.3. Subsystems explanatory to the demographic subsystem are income distribution and basic needs on the one hand and wages and prices on the other.

Figure 4.3 The demographic subsystem,

where BIR = birth rate

FPR = female participation rate

HHS = household size

LSF = labour supply, female

LSM = labour supply, male

LSU = labour supply, unskilled

LSS = labour supply, skilled

LST = labour supply, total

MIG = migration rural-urban or vice versa

MDR = mortality rate

POP = population.

This subsystem is valid both for the urban and the rural area. Adding an R or an U to each of the variables gives the rural and the urban component separately. The two may run without interdependence, provided that $MIGR = -MIGU$.

Some remarks may be made:

- The indicated relations between income distribution and household size are highly probable to run in the following direction: the larger the household size the better the distribution parameters look, because of pooling of incomes and informal transfer mechanisms within the extended family. It has also been found that low incomes of an informal nature are more often than not associated with complementary earning functions rather than serving as head-of-the-household incomes.

However, there is also a feed-back from income level to household size: the lower the level, the larger the household size. But such a relation holds only cross-country wise.

- Female participation and birthrates appear to correlate only in developed economies or in high-class brackets of underdeveloped economies. In extended family environments the relation does not hold because of the pooling of services effect. The relationship between income distribution and basic needs satisfaction and such variables as female participation-rate, birth rate and mortality rate.
- Migration is supposed to be a lagged response to differences in wages (and price) levels between the urban and the rural sector, representing discrepancies between labour demand and supply. Of course some gap between urban and rural wages is considered normal. Thus

$$POPU = POPU_{-1} (1 + BIRU - MORU) - MIGU.$$

A similar equation holds for POPR.

Production functions for manufacturing industries

Thus far the model has been embedded in the input-output framework. This implies that, essentially, a production function must be postulated assuming fixed wage and profits coefficients. However, this is highly unrealistic. It has been found that small scale industries have notoriously low substitution elasticities and large scale units may show unexpectedly high ones.

If substitution elasticities between wage and capital are low, depressed wages do not incentivate the hiring of labour. This means that value added shares for wages will decline. As a result income distribution will be seriously affected. For large scale units with high substitution elasticities depressed wage levels may mean employment absorption, and consequently positive distribution effects may be expected. The model should be capable of pointing at such effects which may be at the root of the differences in income distribution trends observed for countries like Korea and Taiwan on the one hand and India and Malaysia on the other hand.

Presumably, it is not far from reality to accept at the sectoral level the fixed share of aggregated labour, operating surplus and other value added components, giving room for the various value added components to adjust simultaneously within this boundary. This allows us to formulate production functions with substitution for the relationship between production, labour, capital and other variables.

The model might be formulated as follows:

$$X_i = \sum_j \alpha_{ji} X_j + Y_i \quad (4.1)$$

Where X_i = gross output of sector i

α_{ji} = input-output coefficients intermediate sectors

Y_i = value added of sector i .

Assuming fixed a_{ji} , a production function for X_i is essentially the same as a production function for Y_i because

$$Y_i = (1 - \sum_j \alpha_{ji}) X_i \quad (4.2)$$

For Y_i a CES or Cobb-Douglas production function may be formulated:

$$Y_i = f(LDS_i, LDU_i, K_i, Z_i) \quad (4.3)$$

where LDS_i = input of skilled labour

LDU_i = input of unskilled labour

K_i = input of capital goods

Z_i = input of other production factors including variables for technical progress.

In order to better permit estimation and further analysis, it may be preferable to relate ΔY_i to ΔLDS_i , ΔLDU_i , ΔK_i , ΔZ_i . Optionization will lead to values for ΔLDS_i etc. if gross output X_i is given or estimated and thus ΔY_i can be obtained. For each of the input categories for labour and for capital the respective input coefficient b_{li}^{1i} . $\tilde{b}_{li}^{1-\beta_{li}}$ (4.4)

Where $\tilde{b}_{li}^*$ = new input coefficient

b_{li} = old input coefficient

$\tilde{b}_{li}$ = optimal input coefficient for incremental output

β_{li} = weight for adjustment.

These weight β_{li} must be based on the share of last years production factors in this years production factors adjusted for the degree of penetration of new methods.

Replacement investment may be treated similarly. Actual operating surplus may differ from calculated operating surplus using the above coefficients because of wage and price developments. If access to investment goods is constrained the above procedure must be amended.

Production in the agricultural sector

The agricultural sector is one of the sectors where investment decisions may be made in a somewhat different way. Since some other aspects of the agricultural sector are important as well in determining production, labour demand, investment and last but not least migration and income distribution, we shall pay some more attention to this sector.

Production in the agricultural sector is performed quite differently by small farmers compared to larger farmers producing either for the urban market or for the export market. The latter group has been disaggregated into medium farmers and large farmers (+ plantations). Inputs of intermediate goods are taken care of by the input-output table. Production should be related to several variables depending on the scale of the farm or estate.

For the peasant or small farmer, investment in stocks and in machinery largely depend upon income. The same is valid for transport equipment, while constructs might be related to income and stock formation. Production then can be explained from area, adjusted upwards for use of fertilizers and labour quality (labour quality may be represented by basic needs variables, health, etc.), investment (machinery and equipment etc.) and technological improvements. New addition to land may, on the other hand, insert decreasing returns to scale, owing to the on average lower quality of additional land. Finally, area per worker will influence productivity. Labour demand equals labour supply since it is assumed that there is no open unemployment in the rural areas.

The larger farmer and certainly the estate base investment decisions about machinery and equipment on income and on factor costs as well. Construction investment is related to stocks and to machinery, whereas transport equipment is rather complementary to production. In the production function capital plays a definite role. Labour demand both skilled and unskilled can be explained from production and investment, thus shifting excess labour supply to the group of subsistence farmers and putting pressure on migration from rural and urban. The same variables occur in the production function as for the small farmer. We should add to this water control (irrigation etc.) which improves productivity. This should be seen as investment by the government (I-O sector 15). A schematic representation is presented in figure 4.4.

Figure 4.4 Production and employment in agriculture.

where: subscript 1 = small farmers

2 = medium and large farmers

APW = area per worker
 ARQ = area quality
 ARS = area size
 FER = fertilizers
 INC = investment in construction
 INM = investment in machinery and equipment
 INS = investment in stocks
 INT = investment in transport equipment
 IRR = irrigation
 LDS = labour demand, skilled

LDU = labour demand, unskilled
 LES = excess labour, skilled
 LEU = excess labour, unskilled
 LSS = labour supply, skilled
 LSU = labour supply, unskilled
 MIS = migration, skilled workers
 MIU = migration, unskilled workers
 PRA = productivity per hectare
 TEC = disembodied technical progress
 XDM = domestic production (gross)

Production functions for extractive industries

In general, mining is large scale business, where production is supply or demand determined. Production is highly capital intensive and access to investment goods is no reason for the substitution of capital by labour or vice versa. Fixed input coefficients, through possibly changing over time owing to technical progress, seem to be the best approach.

Production in the merchandise and service sectors

Because of essential difference between the formal sectors in this group (sectors 16 - 19) and the informal service sector, the two groups will be discussed separately.

Production in the formal sectors is rather demand or government policy oriented. Investment largely consists of constructs, although e.g. in case of banking and communication. Machinery other than those necessary for buildings, must be taken into account. For all these sectors substitution between capital and labour is rather irrelevant.

The informal sectors almost by definition do not require capital goods. The un(der)employed and the self employed in this sector must be treated as a residual, a reservoir in the cities, with two ways in and out: the manufacturing and formal service sector in the cities or the rural areas through migration. "Production" is largely demand oriented, but the size of this sector may add pressure to increase output.

Demand for investment goods

Demand for investment goods must be divided into replacement investment and net investment. Afterwards investment by destination must be transformed into investment by origin which can be fit into final demand. We shall discuss the various components.

Ideally replacement investment is derived from gross output using coefficient in value added from the input-output table. It may be necessary, however, to adjust this procedure, relating replacement investment to capital stock or lagged investment.

Net investment has been discussed above. It may be derived from production-increases, using the production function. If supply of capital for investment is limited in some sectors, it may be necessary to reduce investment. If aggregate supply of capital is insufficient because of lack of funds from savings and other sources, it is necessary to reduce overall investment.

Distribution of this reduction over the sectors must take account of total investment requirement per sector and a factor representing the power of a sector to attract limited supply of financial resources, be they domestic or foreign.

After arriving at gross investment being replacement plus net investment by destination a matrix has to be determined redistributing gross investment by destination to gross investment by origin, similar to the matrices used in theoretical dynamic input-output models. Thus gross investment can be included in a column for final demand in the input-output analysis. Information on the transformation matrix partially must be obtained from micro studies.

Consumption and savings

Basically the consumption functions are quite simple. Consumption, savings and direct taxes are the composing parts of expenditure. Marginal savings quotes and direct tax ratios to income differ per social group and should therefore be dealt with in a rather disaggregated way. This allows for effects of redistribution of income on consumption and savings patterns. The model may be formulated as follows:

$$T_g = \tau_0 + \tau_1 YW_g$$

$$S_g = \sigma_0 + \sigma_1 (YW_g - T_g)$$

where S_g = savings of social group g , $g = 1, \dots, G$

T_g = income taxes of social group g

YW_g = total income of groups g

The last concept, total income of group g , will be presented at a later stage, as it requires labour as well as wages and operating surplus. Possibly G must be adjusted for average income levels. Now consumption expenditure can be directly related to income minus savings and taxes. In order to arrive at consumption data per sector of production, consumption functions should be set up for each sector i , $i = 1, \dots, n$.

We should allow for possible influence of prices, resulting in consumption shifts from one sector to another.

$$C_{i,g} = \alpha_{i,g} + \beta_{i,g} (YW_g - S_g - T_g) + \lambda_{i,g} p_i$$

where $C_{i,g}$ = consumption of products of sector i by social group g

and p_i = price of the product of sector i .

After deriving consumption functions per sector for each social group, total consumption of this social group C_g should equal the sum of the consumption components per sector.

$$C_g = YW_g - S_g - T_g$$

It may be necessary to include prices of key sectors in the savings equation of the low-income social groups, because e.g. a high increase in food prices may decrease savings in urban areas.

In cases where data and relationships for depreciation are very poor, it may be more appropriate not to distinguish between gross and net investment and to introduce the concept of gross savings including both net savings and expenditure on replacement investment. However, this is a rather unattractive way out.

International trade

The international trade part is one of the most important parts of the model. It describes relationships and sensitivity to developments in other countries and regions and as such it makes the country concerned part of world wide developments. On the other hand, exports and imports may be heavily influenced by the domestic scene and may be elements of policy formulation and implementation.

Focussing on exports first, it is clear that exports largely are demand oriented. Import needs in importing countries must be considered major causes for export levels. Aiming at the possibility of including such issues as traditional export promotion and export oriented industrialization, it is necessary to analyze exports at the sectoral level. Besides, as one importing region grows faster than others and on the other side the issue of growing trade between developing countries comes to the fore, it is very important to focus on bilateral trade flows as well. If data or computational limitations prohibit analyzing bilateral trade flows at the sectoral level, it may be possible to analyze bilateral trade on broad sectoral levels and to design a device for disaggregation at a later stage. In such a case one might come up with the following classification by broad sectors (tradables only)

- a - agriculture (sectors 1 - 3)
- b - mining (sectors 4 - 5)
- c - manufacturing (sectors 6 - 7)
- d - chemical industries (sector 8)
- e - other manufacturing (sectors 9 - 11)
- f - merchandise and transport (sectors 16 - 18)
- g - services (sector 19).

The device for disaggregation must contain national, international and sectoral consistency requirements. For some sectors it may be necessary to explain exports as supply oriented or supply constrained. Certain constraints are necessary for any sector, because of slow changes in manufacturing structure.

At the import side it is fashionable to distinguish between competitive imports and complementary (non-competitive) imports. A problem occurs in defining whether a product (output of a sector) is competitive or not and if it is competitive whether importing that particular product results from insufficient capacity or from inappropriate capacity, which is more a qualitative criterium.

The role of these three elements of imports is rather different. Complementary imports may be related directly to domestic production e.g. rubber imports into Korea. Competitive imports may emerge from domestic supply insufficiencies (shortage of rice) or from e.g. inadequate technology (imports of cars). Treatment of these two parts of competitive imports must be different; where the first part is introduced to bridge the gap between demand and supply at the sectoral level, the second part may be related to such factors as income, balance of payments position and industrial development in the country concerned.

Let us first describe an example of the kind of analysis useful for the model. A hypothetical situation for three sectors is presented in table 4.4. The international trade part is represented as follows. Complementary imports are used by intermediary sectors according to fixed coefficients and occur in a row

$$m^n = \hat{b}q$$

where m^n = complementary imports

$\hat{b}$ = diagonal matrix of input coefficients

q = total output

$\hat{}$ = diagonal matrix of the sector indicated.

Competitive imports for intermediary sector are mentioned in brackets and are subdivided into m^{i1} (quantitative constraints) and m^{i2} (qualitative constraints). Similarly, competitive imports for final demand (m^f) are subdivided into m^{f1} and m^{f2} . Given the state of technical development

$$m^{i2} = M^{i2}q$$

where the coefficient matrix must be considered carefully because technical developments in the region will reduce M^{i2} . A similar analysis may be done for m^{f2} .

	1	2	3	q^i	m^{i1}	m^{i2}	f^d	e	f	m^f	m^{f1}	m^{f2}	q
sector 1	40 (10)	10 (5)	5 (0)	55 (15)	8	7	100	70	170	10	8	2	200
sector 2	20 (4)	20 (10)	10 (0)	50 (14)	5	9	65	20	85	21	5	16	100
sector 3	10 (0)	10 (0)	5 (0)	25 (0)	0	0	25	0	25	0	0	0	50
sub-total	70 (14)	40 (15)	20 (0)	130 (29)	13	16	190	90	280	31	13	18	350
value added	120	40	30	190	-	-	-	-	-	-	-	-	-
m^n	10	20	0	30	-	-	-	-	-	-	-	-	-
q	200	100	50	350	-	-	-	-	-	-	-	-	-

Table 4.4 Input-output table for a hypothetical situation.
(competitive imports for intermediary sectors are presented in brackets)

where m^n = non-competitive imports
 q^i = total intermediary deliveries per sector, irrespective of domestic or foreign origin
 q = total output per sector
 m^{i1} = competitive imports for intermediary sectors, caused by quantitative constraints
 m^{i2} = ditto, qualitative constraints
 f^d = domestic final demand
 e = exports
 f = total final demand
 m^f = imports for final demand
 m^{f1} = ditto, caused by quantitative constraints
 m^{f2} = ditto, qualitative constraints

$$m^{f2} = M^{f2} \cdot f$$

Technical developments will reduce M^{f2} . Income increase of the rich may increase f and thus push m^{f2} upwards, but balance of payments deficits may constrain m^{f2} and thus may reduce f . Finally, m^{i1} and m^{f1} are residuals, because q is capacity determined.

$$m^{i1} + m^{f1} = q^i + f - m^{i2} - m^{f2}$$

At this stages prices come to the fore possibly reducing f rather than increasing m^i .

Total imports, thus determined may create balance of payments problems because exports i^e don't match with total imports i^m (i = unity vector)

$$i^m = i^m{}^n + i^m{}^{i1} + i^m{}^{i2} + i^m{}^{f1} + i^m{}^{f2}$$

Besides, at the sectoral level, import needs may be too high to be fully satisfied. It needs to be analyzed at the country level which group or sector is going to carry the burden of imbalances in production, exports and imports. It may result in more foreign aid, more foreign investment, adjustments in government income and expenditure, changes in consumption and investment, changes in prices etc. At a later stage we will touch more in detail upon such aspects of closure of the model.

Finally, the consistency must be dealt with carefully. World exports by sector and on aggregate must equal world imports by sector and on aggregate. Systematic discrepancies arising from the system of reporting must be taken into account.

The input-output structure

At this stage we have discussed all elements of the input-output structure. They are put together in table 4.5.

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Data must be obtained from various sources because regular input-output tables do not provide all necessary information in particular about

- intermediate deliveries to and from the service sectors
- three types of imports - non-competitive

- competitive - insufficient

- inadequate

- labour, by sector, by social group
- owners, by sector, by social group
- consumption, by sector, by social group
- government expenditure, by sector
- investment by origin, by destination, by social group.

Data about the above variables must be obtained from such sources United Nations' Production Statistics, FAO agricultural statistics, ILO employment statistics, social accounting matrices, census data and micro studies.

For the non-value added part of deliveries to intermediate sectors fixed input-output coefficients may be derived. Regional input-output tables may be calculated in the same way as in the ESCAP-FUGI project (cf. chapter 3). While value added on aggregate may be assigned a fixed input-output coefficient, the composing parts of value added by sector may change overtime. This has been pointed at in the discussion about production. Given sectoral labour demand, wages, net indirect taxes and depreciation, operating surplus may act as a residual rather than following total output by way of a fixed input-coefficient. Apart from the value added sectors, input-output coefficients will not change dramatically owing to technical progress and resource constraints. The latter phenomenon may result in limited growth for certain sector if imports of resources required is not sufficiently feasible because of financial reason or limited availability.

Determination and influence of prices and wages in general will be discussed at a later stage. Here we will pay attention to the effect of prices on input-output coefficients. Since input-output tables are in value-terms, changes in relative prices will require adjustment in input-output coefficients. However, it would be too cumbersome to adjust current year's coefficients simultaneously with current years price changes. To reduce the complexity and the computational load of the model, input-output coefficients will be considered predetermined for the current year and adjusted for the following year. Current world developments heavily necessitate emphasis on this aspects for the energy sectors (sectors 4 and 5) and their influence on balance of payment because for most countries in the ESCAP-region, energy is one of the imported commodities.

Wages, prices and exchange rates

Although a complete general equilibrium model is hard to apply in the model system proposed here, wages, prices and exchange rates should take care of at least part of the clearing of the market. This particularly concerns supply and demand of labour, supply and demand of products (goods and services) and supply and demand of capital.

Wages are different for rural groups and for urban groups, partly because of the higher cost of living in urban areas. Wages are interdependent with prices, specifically food prices. Low wages in the rural areas are the basis for low food prices and for international competition in export of primary commodities. Not allowing rural wages and food prices to increase substantially, makes it possible to keep wages in the urban areas low and thus improve profitability and international competitiveness.

Above it is suggested to accept the fixed share of aggregated labour, profit, and other value added components, giving room for the various value added components to adjust simultaneously within this boundary. The adjustment mechanism is triggered off by changes in labour supply and demand, resulting in equilibrium wage rates which are effectuated in the informal tertiary and quaternary sectors together with the agricultural sector.

Wage rates in the informal tertiary sector should reflect the pressure on this sector exerted by residual workers pushed out of agriculture and pulled into the urban sector. Their total aggregated income should equal the purchasing power reflecting demand for tertiary and quaternary informal services; these services being produced without labour-saving capital equipment.

The urban pull should be dominated by the absorption capacity and wage rates of the large-scale urban sectors.

Prices and wages basically are interrelated through the input-output structure. For some (primary) sectors the domestic price level is based on world market prices for the commodities concerned. Duties and subsidies by the government may act as factors of adjustment. Similarly import prices are exogenous to the countries concerned and may be affected by the government as well. In each case it needs to be decided to what extent domestic production prices, final demand prices and intermediate delivery prices are related to that sector's import prices. Homogeneity of the sector and the functioning of competitive imports will play an important role. In most cases it must be assumed that final demand prices and prices of intermediate deliveries are equal and even may equal production prices.

Modelling the exchange rate is very complicated. It is very hard to draw up a model describing a relationship between the exchange rate and other variables such as balance of payments deficits or surpluses, inflation and policy elements such as the need to attract investment and savings from abroad.

On the other hand the exchange rate will have its influence on prices and thus on the international competitive position and on domestic prices.

Equilibrium, disequilibrium and closure of the model

Almost at the end of the description of the model it is necessary to concentrate on aspects of (dis)equilibrium and closure of the model. First we will concentrate on the sectoral level. While introducing international trade, it has been argued that insufficient domestic supply may be supplemented with imports to fill the gap. In many cases, a reduction domestic final demand is effectuated to fill part of the gap. This may be attained partly by an increase in prices, partly by not supplying the commodity concerned, thus stimulating the black market. Intermediate demand for competitive imports may be reduced as well, thus constraining total supply (domestic+ imported) and deliveries to intermediate sectors. These, in turn have to reduce production and the above described system starts again. In case of India, insufficient foreign exchange reduces import of fertilizers thus supplying only a limited amount of (domestic and foreign produced) fertilizers. This in turn limits production in agricultural sectors, where shortages are born by low income groups. The above story implies that insufficient (domestic + foreign) supply of a sector must be distributed over final demand by social group and deliveries to intermediate sectors. In all these cases a feed back from shortages at the macro or meso level must be included in the model affecting consumption, investment, total output etc. This requires a kind of a bargaining power mechanism for allocating insufficiencies. Result may be a tendency to increase capacity in the following years.

Separate attention must be given to labour demand and supply. Excess supply appears as un(der)employment in the agricultural sector or in the informal urban tertiary and quaternary sectors. Even in developing countries in some cases, however, excess labour demand for some categories occurs e.g. highly skilled technicians. This may result in production functions and thus production capacity which is sub-optimal. On the other hand excess demand for unskilled labour may cause international migration, although this is not really important for developing ESCAP-countries. Attention had been paid already to the role of operating surplus balancing within the sectors.

Moving to the macro level, we will concentrate on the basic balancing equation representing the three gaps:

- the external trade gap: $(M-E)$
- the private investment -savings gap: $(I_p - S_p)$
- the public expenditure-income gap $(G-T)$

where

$$G - T = (S_p - I_p) + (M - E).$$

The above six variables have different degrees of accommodating imbalance. Private savings are determined prior to or simultaneously with private consumption, as was discussed in the relevant part of this section. Domestic private investment may be influenced in the medium term by prices, wages, subsidies, etc., but is largely determined by production prospects. Private foreign investments must be treated rather similarly, though they may be explained from such aspects as wage differentials and tax facilities. Export and imports have been discussed elaborately above; only competitive imports may be considered as accommodating variables. Only a small part of government expenditure and taxation may be called accommodating. Here is where additional finance can be brought in from internal and external borrowing (official development assistance and suppliers' credit). It is a matter of careful study to find out which variables take care of balancing the above equation. This may differ from country to country and from period to period.

Income distribution

Concerning income distribution, three aspects are important:

- how is income distribution measured
- which variables influence income distribution
- what is the role of income redistribution towards other variables.

We shall discuss these aspects in the context of our model.

Income distribution in many studies is measured as income distribution by size through such statistics as the Gini-coefficient or Shannon's entropy measure. The basis for these statistics is a division of households into income groups. Using average income per group and assuming (lognormal) distribution function, income distribution within groups and for total population can be derived.

Carrying out the above analysis in the context of our model implies doing a completely separate job. Endogenizing such work in the model by linking it to income by social groups (cf. table 4.3), and partly disaggregated by groups of sectors means a huge task, the benefits of which are not completely clear compared to the costs involved. Studies have shown that the size distribution of income is exceedingly stable, represented by a change in the Gini coefficient which is rarely more than a few percentage points cf. Adelman et.al. (1979).

Besides, it is concluded that the relative position of various socio-economic groups is more sensitive to policy changes than is the overall distribution.

Average income by social groups and income distribution between social groups may be derived from the model and its input-output structure by looking at value added, the bottom-left part of table 4.5. Special attention should be paid to average income for such groups as the rural landless unskilled labourers and the urban unskilled in the informal service sector. The level of average income for these groups may be as good a statistic to concentrate on as any other statistic for policy reasons.

Looking at income distribution in this way, it is important to find the most relevant variables influencing income for the above mentioned lowest income groups. Basic variables are wages/prices, production (functions), government policies (subsidies, taxes, basic needs provisions), population growth (labour supply etc.) and labour demand by other sectors. Thus, income distribution is determined by some variables in particular and by the model as a whole in general.

Which are the effects of income redistribution?
The most important effects are in the area of consumption (and savings). Consumption will move to a composition with a lower import content and a higher labour content, thus in turn influencing income distribution positively.

Influences of developments in non-ESCAP countries.

Classification of the world by regions in table 4.1, shows 7 regions (regions 14 - 20), which are relevant for the subject matter of this model only from the international trade and capital flows side. Perhaps with the exception of Japan, it may suffice to postulate exogenous (scenarios of) growth rates and handle these region rather similarly to the ESCAP-FUGI model in chapter 3. Treatment of Asian Centrally Planned Economies will create problems and will require solutions, which must be focussed upon separately at a later stage.

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