A Social-Economic Development Model Korean Applications

By Suleimen I. Cohen*

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I. Introduction

In the past, development planners, mainly economists and statisticians from advanced countries, have identified development with growth. A superficial view, but very prevalent circa 1960, was that infusions of capital and foreign exchange, if large enough, are alone sufficient to induce such an economic growth.

To the surprise of many observers, performances in different LDCs have regularly shown that in spite of the reasonable growth rates achieved, unemployment and poverty have increased while improvements in living conditions for large groups of the population are known to have stagnated in other countries, which information has brought a revived interest by development planners in alternative development aims with a more humane content. It was also becoming increasingly evident that planning could not disregard the demands for a more equitable distribution of income and employment, and demands for immediate expenditures on objectives relating to human welfare such as higher standards of nutrition, housing, health, edu-

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cation. These demands were initiated by the more articulate and organized sections of the public, and supported by the growing influence of the social standards endorsed by inter-governmental organizations. Experience soon taught, moreover, that achievement of the economic objective of self-sustaining growth in production per capita may require that non-economic factors be taken into account. Recently, therefore, many interested scholars have started to devote more attention to the above problems. Thus, the terms 'social development', 'social planning', 'basic needs approach' and the like began to become current. The necessity of incorporating the 'social' element in the various tasks of planning has led to the writing of special chapters on social aspects in plans, to social divisions in national planning offices, and to courses in social planning.

In spite of this recent acceleration of engagement in social planning, it can be stated with confidence that there is at present no operational framework of social planning which can be integrated in development planning. There is a flood of definitions and concepts on basic needs, social indicators, social aims, means and effects, but most of them lack the quantitative substance which is a basic requirement for effective planning.

Our contribution in this area can be described as an effort to broaden the scope of present development planning practices so as to allow a more humane formulation of development objectives, the design of better implementable instruments and the incorporation of additional relationships. By a more humane formulation of development objectives we mean taking into account both monetary and selected non-monetary aspects of welfare, as well as the planning of these aspects for separate social groups, so as to allow the study of redistributionary—and anti-poverty policies. The instruments to be studied will cover most of the revenue and expenditure items of the government budget, while the kind of additional relationships to be incorporated may contain elements of a multi-disciplinary nature.

This paper falls into eight sections. In the second section we give the main features of the incorporation of social aspects in the economic model. In the third section we describe the model and its functioning. Sections four to seven examine and analyze a few selected results from an application of the model to Korea. Primarily for reasons of data availability the Korean economy was selected as a test case for the model. The model was esti-

mated on the basis of data for the sixties and employed to simulate development up to 1980. Section eight summarizes the results of comparisons between different structures of the model.(1)

II. Main Features of a Social-Economic Development Model

For the model-builder in particular and the development planner in general, the main questions posed relate to:

1. which aim variables should be incorporated, how should they be operationally represented and which are the controllable variables?

2. how are the aim variables directly formed and how do they directly affect the rest of the economy?

The answer to the first question should lie in distinguishing between *social groups* of common interest and listing the aims for each group seperately. Since such aims can be of a *monetary* nature (i.e. income) or a *non-monetary* nature (i.e. health) appropriate social indicators representing both types of aims are required.

By formulating aims and means in terms of social groups, social planning endeavors to eliminate a large element of value-judgement from the present planning tradition. Generally speaking, the least involvement in politics is assured when the economist works with sufficiently flexible models, a greater number of aim variables, even more so for controllable variables, and preferably with group-wise distinctions of the benefits and burdens related to aim and controllable variables.(2) The macro-welfare function of the policy-maker would then read:

$$T=T(Y_1^1, \cdots, Y_A^1, Z_1^1, \cdots, Z_B^1; Y_1^0, \cdots, Y_A^0, Z_1^0, \cdots, Z_B^0)$$

where the Y's and Z's refer to aim and controllable variables, respectively; lower indices refer to type of aim variable: $a=1, \cdots, A$, and controllable variable: $b=1, \cdots, B$; and upper indices refer to social groups: $o=1, \cdots, O$.

Concretely, in introducing into the model a division of the total popula-

(1) Because of space considerations the exposition is at times short and selective. The interested reader is referred to a fuller treatment in Cohen (1975).

(2) For a discussion of the uses that can be made of the social groups approach in development models, especially in relation to the distribution of power in society, see Cohen(1977, 1 and 1977, 2).

tion into social groups with more or less homogeneous interests there was very little of a choice. Available data on consumption, expenditure, employment and labour supply for social groups in most developing countries do not go beyond a disaggregation into wage-earners, salary-earners, and the large group of employers, self-employed and family workers. A division into these three groups is consequently followed in the model. The three groups carry the indices $o=11$, 12 and 13, respectively.(3)

The aim variables which are incorporated in the model can be described now. Two reports of the UNITED NATIONS (1966 and 1971) were particularly helpful in making the selection. To start with, it is customarily agreed that income is the most representative quantitative indicator of welfare. If the income per capita received by each group should reflect the welfare of that group, then the national or macro-welfare function can be written in terms of the *disposable income per capita* of the three groups: Y_1^{11}, Y_1^{12} and Y_1^{13}.

It is also generally accepted that to be employed is an aim in its own rights. In addition, under certain conditions the provision of employment within a certain group may eliminate excessive income inequalities and prevent unnecessary political unrest. By defining the unemployed as those who are seeking work for pay, that is, potential employees, we consider the planning of *employment proportions* for wage-earners and salary-earners only; hence the introduction of Y_2^{11} and Y^{12}_2 in the macro-welfare function. Our definition excludes unemployment among the group of employers and the self-employed.

While income and employment can be considered as acceptable proxies for the welfare of groups 12 and 13, they may not be sufficient for planning the welfare of the lowest income group of the population, which coincides in most less developed countries with the group of rural and urban wage-earners and which we have so far identified by group 11. As it usually happens, due to the unwillingness of most people to vote for income trans-

(3) Of course it may be rightly argued that the group of employers, self-employed and family workers is a very heterogeneous group and cannot have common interests. This group usually contains the richest and some of the poorer parts of the population, and its distribution between rural and urban areas is even more subtle. Data on the constituents of this group are very scarce, however.

fers, the policy-makers may not be able to secure what in their view appears to be an acceptable disposable income per capita of the poorest group Y_1^{11}. Moreover it may not be possible in the near future to raise the employment rate of this group, Y_2^{11}, to acceptable levels. Given the above circumstances, it has become the task of governments to supplement income and employment policies of the less fortunate by additional policies aiming at the satisfaction of their nutritional needs and the betterment of their living conditions in terms of housing, health and education.

Concretely, if we define low income people as group 11, then the nutritional aim should apply solely to that group. Accordingly, the aim or target variable of *average daily intake of calories per capita* should refer to group 11 only, e.g., Y_{11}^{11}. Similarly, benefits of housing, in the form of (higher) *average number of rooms per capita*, are relevant as a target variable only if they should refer to group 11, e.g., Y_{13}^{11}. For education we take the *primary enrolment ratio*. Any increase in this ratio, although referring to the whole population, thus Y_{15}, tends to benefit primarily the children of the lowest income group. With respect to health needs we have selected the *national survival rate* as a target variable, Y_{14}, partly because available data do not make possible the division of health benefits by social groups, but mainly because the characteristic external effects which accompany health levels in the whole nation, make it more desirable to formulate this aim for the whole nation.(4)

Summarizing, we shall select the following nine aim variables, defined as far as necessary in terms of social groups:

wage earners: 11	salary earners: 12	employers etc.: 13	whole nation
disposable income per capita Y_1^{11}	disposable income per capita Y_1^{12}	disposable income per capita Y_1^{13}	survival rate Y_{14}
employment rate Y_2^{11}	employment ratio Y_2^{12}		primary school enrolment ratio Y_{15}
daily intake of calories per capita Y_{11}^{11}			
number of rooms per capita Y_{13}^{11}			

(4) The national survival rate is 1 minus the national death rate.

Introduction of these aim variables requires the incorporation of suitable means. The model contains a large range of elements which can be considered as controllable by government, but the analysis will be concentrated on budgetary instruments only: these are either revenue items in the form of direct taxes and others, or government expenditure in the form of current allocations to the various sectors carrying the index $g=11,\cdots, 18$; and public investment denoted by *ZINV*. We shall make use of the following controllable variables, distinguished as far as necessary by social groups:

wage-earners: 11	salary-earners: 12	employers etc.: 13	whole nation
tax levy Z^{11}	tax levy Z^{12}	tax levy Z^{13}	other revenue *ZIND*
food subsidies Z_{11}			general allocations Z_{12}
rent subsidies Z_{13}			health allocations Z_{14}
			primary educational allocations Z_{15}
			secondary educational allocations Z_{16}
			higher educational allocations Z_{17}
			training-on-the job allocations Z_{18}
			public investment *ZINV*

The second question relates to the *cause and effects of the introduced aim variables*. Before answering this question it is useful to describe briefly the type of model we employ. We develop a *combined* model which integrates the input-output and macro-economic models into one single consistent equation system. The potential use of combined models in development planning has been suggested by a number of authors.(5) Published works on combined models are still in their infancy, however.(6)

The classification in sectors followed bears the emphasis we lay on the services sectors. Out of the ten sectors classified, three are non-services and seven are services.(7)

Because of the inclusion of income and employment formation in the model it follows that the model should incorporate the demand for and

(5) F. Fisher *et al.*, (1965).

(6) The oldest attempts seem to have appeared in Japan (1965) and Byung-Nak Song (1972).

(7) h=Index of sectors. 1=agriculture, f. & f., 2=mining and manufacturing, 3=housing, 4=health, 5=primary education, 6=secondary education, 7=higher education, 8=vocational training, 9=other services, 10=capital goods producing sector. The words educational sectors and educational levels will be used synonymously.

supply of manpower by skilltypes.(8) Particularly for the specification of manpower supply (but also for the demand for teaching personnel) the educational sectors require as comprehensive a treatment as the non-educational sectors.

In contradistinction to the demand for and supply of manpower by skill-types, there are the demand for and supply of labour by social groups. The two are closely related. In addition, there are the income, consumption and aim variables by the social groups.(9)

On the causes and effects of the aim variables it will be seen that the levels of income among the social groups determine how much is consumed privately of each good or service. This private consumption together with the public allocations are major determinants of final demand by sector, and therefore, production by sector, the demand for and supply of labour by skill-type and social group. In this manner rates of employment and labour productivity are determined. In the meantime, these two rates are assumed to play the dominant roles in the formation of the factor income accruing to each social group. As a result, the circular formation of the distribution of income, consumption, production and employment is obtained.

Another category of aims is represented by the satisfaction of (higher) nutritional, housing and basic educational levels for the poorest social group, Y_{11}^{11}, Y_{13}^{11} and Y_{15}, and (better) health levels for the whole nation, Y_{14}. The formation of these variables depends on the parts of income spent on the private consumption of these components and government allocations devoted to that purpose.

Regarding the effects of variables of living conditions, the model attempts to integrate what various studies have already established, namely, that higher levels of the variables Y_{11}^{11}, Y_{13}^{11}, Y_{14} and Y_{15} increase the productivity of labour, that is, would result in decreased requirements of manpower per unit of output. Studies on the effects of higher nutrition show that the higher energy produced allows the labourer to work near his full capacity.

(8) q=Index of skill types wherein 1=occupational categories comprising I.S.C.O. Major Groups 3/9, which is briefly called 'low skill'. 2=occupational categories comprising I.S.C.O. Major Groups 0/2, which is briefly called 'high skill'.

(9) o=Index of social groups, 11=wage-employees, 12=salary employees, 13=employees, self-employed and family-workers.

Similarly, due to higher health levels, labour is saved by less morbidity while the quality of work made was found to increase. The housing effect is not yet as clear, although a few studies which have shown a positive influence on labour productivity from rehousing projects can be singled out. The combined effects of the above factors are usually considered to be more crucial at *low income levels* but may not hold at higher incomes. Regarding the effects of living conditions on the supply of students and manpower, health levels, in the form of survival rates, are of particular significance in this respect.

III. The Model

In this section the individual equations are first described after which the functioning of the whole system is discussed with the help of an arrow-chart giving the interactions between the variables.

Some of the notations used required comment. First, small Latin letters denote indices. Goods and services by consumption item are denoted by g, and by sector of production are denoted by h. For the distinction between social groups and occupational qualifications, the indices o and q, are used respectively. Secondly, capital Latin letters denote variables. Thirdly, Greek letters denote parameters.

Since there are variables and parameters which relate to two indices at the same time; we attach 1) the g and h indices—e.g. commodities—to the right-hand bottom, and 2) the o and q indices—e.g. persons— to the right-hand top of the variable or parameter concerned.

Finally, unless otherwise specified, all variables refer to t and are measured at the end of a period of six years. All monetary variables are expressed in constant prices of 1965, in 10^{12} won. Demographic variables are in 10^{6} persons.[10]

Sectoral output

Eq. 1 defines gross output by sector as consisting of deliveries of intermediate goods plus deliveries of investment goods, plus increase in stocks, plus public final consumption goods, plus private final consumption goods,

(10) As a result, Y_1^0 becomes in million won per person, Y_{11}^{11} is in thousand calories p.p., Y_{13}^{11} is rooms p.p.

plus exports, less competitive imports. In this equation it is assumed that: 1) deliveries of intermediate goods are proportionately related to the output of the receiving sector, 2) only sector 10 delivers investment goods ($I_h=0$ for $I_h=1,\cdots,9$), 3) increase in stocks is proportional to output, 4) converter coefficients γ'_{hg} are used to convert public final consumption of good or service g into sector h, there are eight categories and services $g=11,\cdots,18$,(11) 5) similarly converter coefficients γ_{hg} convert private final consumption of good or service g into sector h, there are five categories of goods and services $g=11,\cdots,15$,(12) 6) the sector's exports form a proportion ν_h of total exports ($\sum\nu_h=1$), 7) the sector's competitive imports form a proportion μ_h of total competitive imports($\sum\mu_h=1$).

$$V_h=\sum_{h'=1}^{10}\alpha_{hh'}V_{h'}+I_h+\beta_h V_h+\sum_{g=11}^{18}\gamma'_{hg}Z_g+\sum_{g=11}^{15}\gamma_{hg}\sum_{o=11}^{13}C_g^o+\nu_h N-\mu_h M \qquad h=1,\cdots,10 \quad (1)$$

V_h=gross domestic output of sector h
I_h =gross fixed capital formation produced and delivered by sector h
$\sum_o C_g^o$=sum of private consumption of good g by all social groups o
M=total imports of competitive goods
N=total exports of goods and services, exogenous
Z_g=government consumption expenditure on good or service g, exogenous

Sectoral product

Eq. 2 gives value added as a proportion of the gross output by sector

$$X_h=\alpha_{oh}V_h \qquad h=1,\cdots,10 \quad (2)$$

X_h=gross value added of sector h

Total product

Eq. 3 sums the gross value added by sector to give GDP

$$X=\sum_{h=1}^{10}X_h \quad (3)$$

X=gross domestic products at market prices.

Investment requirements

Eq. 4 specifies that deliveries of investment goods by the capital goods producing sector, i.e. sector 10, is equal to the sum of the quantities of

(11) Food, miscellaneous, housing, health and four types of education.
(12) Food, miscellaneous, rent, health and all education.

capital goods needed by each sector for its future expansion. Deliveries of capital goods are a function of the increase in output of the user's sectors over a period of 6 years, with a gestation period of equal length and a capital coefficient $\beta_{10h'}$,

$$I_{10,t-6} = \sum_{h'=1}^{10} \frac{\beta_{10h'}}{6} (V_{h'} - V_{h',t-6}) \qquad (4)$$

Investor's behaviour

This equation formulates a function for private investment, i.e. $I_{10} - ZINV$, where

$ZINV$=government investment expenditure, exogenous.

Empirically, private investment is found to be explained by expectations on profit rates (or employer's income or the GDP as proxies)[13] and the rate of interest. Additional explaining variables can be enumerated such as liquid reserves, foreign commitments and government activity. If we take besides the GDP additional explaining variables which can be assumed exogenous to the model the function can be approximated as follows:

$$I_{10} - ZINV = \tilde{\beta} + \beta' X + f \text{ (other explanatory variables assumed exogenous)} \qquad (5)$$

It may be pointed out that the model includes relationships of the capital formation based on both technical requirements (eq. 4) and investment behaviour (eq. 5). There are very few examples known of multi-sector models which include the latter, the exception being Japan (1965) and Byung-Nak Song (1972), quoted earlier in the context of combined models. In general, more reality is built in the models when both equations are incorporated. In short-term econometric models it is more common to have both.

Demand for manpower skills

There are quantitative and qualitative elements in this demand, as represented by the first and second terms respectively, in eq. 6. The quantity demanded would depend on technically calculated rates of sectoral manpower inputs per unit of production $\tilde{\delta}_h^q$, δ_h^q and the sectoral products X_h. The effect of higher labour qualities in the form of higher nutritional,

(13) Our attempt to explain private investment by income of the group of employers etc. using Korean data gave very poor results. With GDP as explaining variable the results were statistically more reliable and economically meaningful.

housing and health levels of the relevant workers can be interpreted to mean increased labour inputs; consequently, substitution possibilities may occur between labour quality and quantity. The potential of the newly created manpower inputs would depend on 1) the size of the augment in the working capacity of the relevant worker(which means that a positive labour productivity effect may apply more at lower skills than at higher skills; given the latters already reached levels of welfare they are seemingly less relevant for the effect), 2) the number of relevant workers whose working capacity is thereby positively affected. It may suffice here to formulate the potential productivity effects of higher nutritional, housing and health levels in a general way(14) only, i.e. $f(Y_{11}^{11},\ Y_{13}^{11},\ Y_{14})$.

$$D^q=\sum_{h=1}^{10}(\tilde{\delta}_h^q+\delta_h^q X_h)+f(Y_{11}^{11},\ Y_{13}^{11},\ Y_{14}) \qquad q=1,2$$

D^q=employment of manpower with skill type q.

The coefficients of $\tilde{\delta}_h^q$ and δ_h^q should ideally give the technically calculated rates of manpower inputs. These coefficients are to be estimated from prior knowledge. Practically, such technical rates are no where to find. Instead, the closest approximation available are the input rates implicit in development plans (the Korean Second Five Year Plan), say $\tilde{\delta}_h^{q\prime}$ and $\delta_h^{q\prime}$, (see eq. 6 below). In these circumstances we shall assume the technical requirements to be a linear function of the plan requirements with parameters $\tilde{\delta}^{q\prime}$ and $\delta^{q\prime}$, values of which have to be found from regressions. To account for the fact that the potential effects of higher labour quality have still to be realized, the potential is multiplied by a realization coefficient $\delta^{q\prime\prime}$ which is to be regressed.

$$D^q=\tilde{\delta}^{q\prime}+\delta^{q\prime}\sum_{h=1}^{10}(\tilde{\delta}_h^q+\delta_h^q X_h)+\delta^{q\prime\prime}\{f(Y_{11}^{11},\ Y_{13}^{11},\ Y_{14})\} \qquad q=1,2 \qquad (6)$$

Determination of total enrolments

Financial resources available to a certain school determine the number of pupils that can be enrolled. Since the model solves for the value added of the educational sectors (the financial resources available to education) it becomes possible to tie these financial resources to the created enrolment

(14) For the details of this function as well as eq. 8 and 9 the reader is referred to Cohen(1975).

places. It is well-known that in developing countries enrolment is limited by the available finance and not the other way round. For a given educational budget and unit costs, the number of enrolments follows.

$$E_h=\varepsilon_h+\varepsilon_h X_h \qquad h=5,\cdots,8 \tag{7}$$

E_h=total enrolments in educational level h, $h=5,\cdots,8$.

New entrants

With so many available places for total enrolments in a school and so many leaving the school, the number of new entrants becomes known. The following definition of total enrolments specifies, therefore that total enrolments is past enrolment less those leaving due to dropping out, graduation or death, plus the new entrants. After applying several approximations the final form of the definition is the following.

$$E_h=\phi'_h E_{h,t-6}+\phi''_h J_h+\phi'''_h J_{h,t-6} \qquad h=5,\cdots,8 \tag{8}$$

all $\phi_h=f$(rates of graduation, dropouts, survival by educational level i.e. L_h).

J_h=new entrants in educational level h, $h=5,\cdots,8$.

Supply of manpower skills

This depends partly on the previous stock and on various flows of students leaving the school system to join the labour force. These flows are of a varied nature and depend on the one hand on combined rates of graduation, dropouts, participation, retirement and survival; and on the other hand, on the past flows of new entrants to various educational levels. For manpower of the lower skill, the flow of uneducated persons becomes relevant and these can be related to much earlier births not passing through the educational system. The final form of this equation is approximated as follows:

$$S^q=\phi^q S^q_{t-6}+\phi'^q R_{t-12}+\sum_{h=5}^{8}\phi^q_h J_h+\sum_{h=5}^{8}\phi'^q_h J_{h,t-6} \qquad q=1,2 \tag{9}$$

all ϕ^q, $\phi^q_h=f$(rates of participation, graduation, dropouts, retirement, survival by manpower skills i.e. L^q).

S^q=Supply of manpower with skill type q.

R_{t-12}=lagged births, exogenous.

Unemployment among wage employees and salary employees

It is essential to convert the demand for and supply of manpower by skill

types into labour by social groups. This is done under several assumptions. Commonly, unemployment data are collected from compulsory insurance schemes, trade unions or employment offices. In this context, persons in unemployment are defined as workers whose contract of employment has been terminated, temporarily suspended or is to be started for the first time, and who are seeking paid work at the prevailing market wage rates. As such, the state of involuntary unemployment, often defined as simply unemployment, occurs exclusively among employees and potential employees. The employer's case is different. An employer who losses his old business, waits to start a new business, and has no intention of becoming an employee, will fall among employment occurs among employees it cannot occur among employers. It is further assumed that unemployment among wage employees would correspond to unemployment among the lower skills, while that for salary employees with higher skills.

$$S^o - D^o = S^q - D^q \qquad o,q = 11,1;\ 12,2 \qquad (10)$$

D^o=Employment of labour of social group o.

S^o=Supply of labour of social group o.

Supply of wage employees and salary employees

This equation contains the fair assumption that supply of wage employees is concentrated in the supply of manpower with lower skills, while that of salary employees with higher skills.[15]

$$S^o = \tilde{\sigma}^o + \sigma^o\ S^q \qquad o,q = 11,1;\ 12,2 \qquad (11)$$

Income determination of wage employees and salary employees.

After testing alternative formulations two main factors appeared to be the most relevant for explaining the variances in earnings. (1) The long run progress of the remuneration rate follows that of the labour productivity rate. (2) Annual movements in the remuneration rate are sensitive to the supply and demand forces of the labour market. The employment rate (or its reciprocal) reflects these forces.

$$X^o/D^o = \tilde{\xi}^o + \xi^o(X/D^o) - \xi^{o\prime}(S^o/D^o) \qquad o = 11,\ 12 \qquad (12)$$

X^o=Gross income of social group o

(15) The model does not contain variables of the supply of employers since the model can function without them. It is evident, however, that they form the remainder of the labour force.

Income of the group of employers etc.

Eq. 13 defines GDP at market prices X as the sum of the gross incomes of the three social groups at factor cost $\sum_o X^o$ plus other exogenously given items of government income, *ZIND*. When eqs. 12 and 13 are taken together, one can consider the gross income of the group of employers, etc. to be obtained as a residual.[16]

$$X=\sum_{o=11}^{13} X^o+ZIND \tag{13}$$

ZIND=term standing for the gross government income from property and entrepreneurship at factor cost plus indirect taxes less subsidies, less net factor income from the rest of the world at market prices, exogenous.

Disposable incomes

Deducting direct transfer to government from gross income gives disposable income

$$Y^o=X^o-Z^o \qquad o=11,\cdots,13 \tag{14}$$

Y^o=disposable income of social group o

Z^o=net direct transfers to government form social group o, exogenous.

Private consumption of g by social group o

The private consumption component of the final demand (see eq. 1) is specified via consumption functions which assume these variables as linear functions of the disposable income of each social group. Five sorts of goods are identified.

$$C_g^o=\tilde{\gamma}_g^o+\gamma_g^o Y^o \qquad g=11,\cdots,15;\quad o=11,\cdots,13 \tag{15}$$

Aim variables of disposable income per capita and rates of employment

$$Y_1^o=Y^o/\pi^o P \qquad o=11,\cdots,13 \tag{16}$$

$$Y_2^o=D^o/S^o \qquad o=11,12 \tag{17}$$

π^o=proportion of population of social group o, P=total population.

Formation of nutritional levels

The derivation of calories from a certain amount of food expenditure

(16) Note that depreciation on private capital is included in the gross factor income of the group of employers, etc.

would require knowledge of the average cost per one calorie. For example,

$$\text{calories per capita} = \frac{\text{consumption expenditure on food per capita}}{\text{average cost per calorie}}$$

In this model, we are particularly concerned with the calories consumed per capita per day by the lowest income group, i.e. Y_{11}^{11}. Consumption expenditure on food by this group consists of a private component, C_{11}^{11}, plus public allocations of food directed to this group, Z_{11}. Consumption expenditure of food per capita per annum is, therefore, $(C_{11}^{11}+Z_{11})/\pi^{11}P$. The average annual cost per calorie per day can be assumed to be a linear function of the general level of living of the group, represented by the income per capita of the group, thus $\hat{\phi}_{11}^{11}+\phi_{11}^{11}\ Y_1^{11}$. Usually the unit cost tends to increase rapidly as the general level of living approaches higher levels, owing to the gradual shift in the pattern of food composition from cheap food articles to more expensive food articles with the same calorie content. As a result, the above equation can be written as:

$$Y_{11}^{11}=\frac{(C_{11}^{11}+Z_{11})/\pi^{11}P}{\hat{\phi}_{11}^{11}+\phi_{11}^{11}\ Y_1^{11}}$$

It can be rewritten for estimation purposes in the form of eq. 18, in which $\hat{\phi}_{11}^{11}$ and ϕ_{11}^{11} are the parameters which require estimation from regressions.

$$(C_{11}^{11}+Z_{11})/(\pi^{11}PY_{11}^{11})=\hat{\phi}_{11}^{11}+\phi_{11}^{11}\ Y_1^{11} \tag{18}$$

Formation of housing levels

In similarity with the above formulation, a definition for the supply of rooms per capita for the lowest income group can be written wherein the numerator is the rent expenditure per capita and the denominator stands for the average rent per room (assumed a function of income per capita). Rewriting the definition gives

$$(C_{13}^{11}+Z_{13})/(\pi^{11}PY_{13}^{11})=\hat{\phi}_{13}^{11}+\phi_{13}^{11}\ Y_1^{11} \tag{19}$$

Formation of health levels

Following the preceeding formulations the survival rate for the whole

nation can be defined in terms of a numerator (the health expenditure per person) and a denominator(the average health costs of avoiding one death). Rewriting gives

$$\left(\sum_{o=11}^{13} C_{o\,14}+Z_{14}\right)/PY_{14}=\hat{\phi}_{14}+\phi_{14}\left(\sum_{o=11}^{13} Y^o/P\right) \tag{20}$$

Survival rates for manpower with different skill types

These are assumed to be proportional to the survival rate for the whole poplulation.

$$L^q=\lambda^q Y_{14} \qquad q=1,2 \tag{21}$$

Survival rates for pupils at different educational levels.

$$L_h=\lambda_h Y_{14} \qquad h_h=5,\cdots,8 \tag{22}$$

Total population.

Taking zero migration, the present population depends on the previous population, births and deaths.

$$P=\psi P_{t-6}+\psi' R \qquad \text{all } \psi=f(Y_{14}) \tag{23}$$

Enrolment rate

$$Y_{15}=E_5/P \tag{24}$$

There remain two equilibrium equations, one relating to the *balance of payments* stating the equality of total exports plus net foreign capital inflow to the sum of competitive and noncompetitive imports

$$M+\sum_{h=1}^{10} \mu'_h V_h=N+F \tag{25}$$

F=net foreign capital inflow,

and the other relating to the *government budget* which states that all direct transfers and other incomes received by the government plus its budgetary deficit should equal government expenditure on consumption and investment.

$$\sum_{o=11}^{13} Z^o+ZIND+BUGF=\sum_{g=11}^{18} Z_g+ZINV \tag{26}$$

$BUGF$=budgetary deficit.

The predetermined variables in the model are government income sources

Z^0, *ZIND*, government expenditure Z_g, *ZINV*, total exports N and births R, plus all the lagged endogenous variables. All other variables are endogenous. The model is determinate counting 78 equations in 78 unknown variables. This form of the model wherein variables controlled by government are considered exogenous and the aim variables are unknowns is usually described as the analytical form.

Figure 1 gives the causal ordering[17] of the analytical form after appropriate linearization of nonlinearities in the model. Predetermined variables are enclosed within rectangles, the unknowns are not. For simplicity the non-educational sectors are denoted by $\underline{h}$ and the educational sectors by $\bar{h}$.

We shall now follow the arrows and comment briefly on the structure of the chart. From government income and expenditure we obtain the budgetary deficit, *BUGF*(26). Although variables relating to private consumption expenditure and to total investment are not yet known, let us *visualize* for the moment that these C^o_g and I_{10} are given. Inserting these, together with government current expenditure and sectoral exports, we obtain the production of non-educational sectors such as agriculture, manufacturing, etc. $V_{\underline{h}}=V_1,\cdots, V_4, V_9, V_{10}$, and the production of education, $V_{\bar{h}}=V_5,\cdots, V_8$; (1). Inserting these we obtain the value added of these sectors, $X_{\underline{h}}$ and $X_{\bar{h}}$ (2). Summing these we get the total gross domestic product of the nation, X. (3). Similarly, the balance of trade deficit, F, is obtained from (25).

The attention can now be directed to the relations which determine the production of manpower. Inserting the value added of educational sectors, $X_{\bar{h}}$, we obtain enrolments of students $E_{\bar{h}}$ (7). Inserting these we obtain the new entrants into education $J_{\bar{h}}$ (8). Inserting the latter we obtain the supply of manpower by skill types, S^q (9). These are translated into supplies by social groups, S^o, via (11). We have so far traced manpower supply. We may also begin from the value added of the various sectors, obtain the demand for manpower by skill type, D^q, (6); and translate these into demand for manpower by social groups, D^o, (10). Finally,employment rates are defined in terms of the supply and demand for manpower by social group, Y^0_2, (17).

The model is extended to income formation by social groups. Labour

(17) Simon (1953).

productivity and unemployment rates determine the gross income of wage earners and salary earners, X^o, o=11, 12, (12). The factor income of the group of employers, X^{13}, is obtained as a residual, (13). After deduction of taxes we get disposable income by social groups, Y^{11}, Y^{12}, and Y^{13}, (14). Inserting these disposable incomes in the consumption functions (15), we obtain the private consumption expenditure by good or service C_g^o, which happens to be the starting point from which we began at the top of the chart. Another variable with which we started, I_{10}, is determined by X.

It may be recalled that another category of aims is represented by the satisfaction of basic needs of nutrition, housing, health and education. The chart is now extended to account for: 1) the formation of indicators describing these aims, and 2) their effects on the rest of the model.

First, the formation of a particular indicator depends on the part of private consumption and government allocations devoted to the augment of that indicator and Y_1^o, as in eqs. 18, 19 and 20, see upper left corner of the chart. Second, the effects of the variables Y_{11}^{11}, Y_{13}^{11}, and Y_{14} are reflected in an increase in the productivity of workers. This would result in decreased requirements of manpower, according to the formulation of eq. (6). Besides, health levels, in the form of survival rates, also play a role in influencing the supply of students, (8), and manpower, (9); see chart.

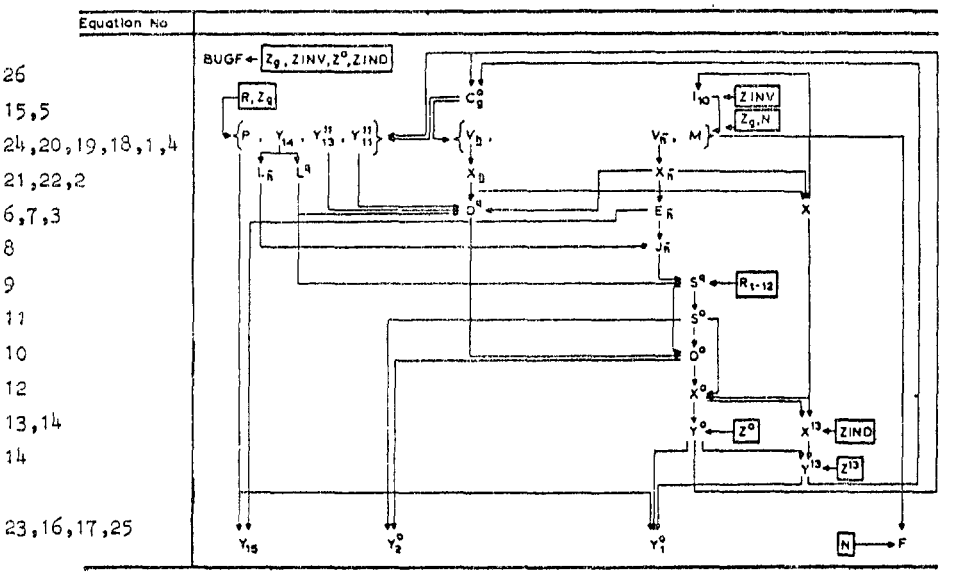

Fig.1. Analytical form (h=1, · · ·, 4, 9 10 ; h=5, · · ·, 8)

It is clear from this chart that except for the variable of budgetary deficit, *BUGF*, the main variables of the analytical form have to be solved simultaneoulsy. This highly interdependent structure does not have the well-known merits of simple structures.

IV. Estimates

The model contains coefficients whose estimation fall into two categories; technical or institutional coefficients to be estimated from prior knowledge, usually occuring in definitional equation; and structural parameters to be estimated from regressions, usually occuring in behavioural equations. Several insights derived from estimation of the model may be pointed out.

The basic data for the estimation of the first category are Korean single-year data, especially the input-output tables of 1963 and 1966, estimates of Korean capital and inventory in 1968, and data on the progress of cohorts of pupils at various educational levels, participation in the labour force, retirement and survival. Estimates here were made with the object of maintaining consistency for 1968. In several instances Asian data, especially Japanese, were employed to supplement the Korean data.

The estimation of structural parameters was done by the method of OLS for an observation period of ten years starting from 1960. The data used are Korean time series of household surveys, labour surveys and national accounts, made consistent to each other. All estimates selected are econometrically viable and are in conformity with expectations based on economic theory.

Manpower demand

Several tests for eq. 6 are shown below. Three comments can be made. See also Sec. 3, description of eq. 6.

$$D^1 = \underset{(.1159)}{.6597} + \underset{h}{.9445\sum}(\tilde{\delta}_h^{1\prime} + \delta_h^{1\prime} X_h) \qquad r = .951 \qquad (6.1)$$

$$D^1 = \underset{(.0603)}{.8005} + \underset{h}{1.1290\sum}(\tilde{\delta}_h^{1\prime} + \delta_h^{1\prime} X_h) - \underset{(.1874)}{1.0433}\{f(Y_{11}^{11},\ Y_{13}^{11},\ Y_{14})\} \qquad R = .992 \qquad (6.2)$$

$$D^2 = \underset{(.1058)}{-.1289} + \underset{h}{1.3152\sum}(\tilde{\delta}_h^{2\prime} + \delta_h^{2\prime} X_h) \qquad r = .978 \qquad (6.3)$$

$$D_2 = \underset{(.1383)}{-.1083} + \underset{h}{1.3505\sum}(\tilde{\delta}_h^{2\prime} + \delta_h^{2\prime} X_h) - \underset{(.0627)}{.0275}\{f(Y_{11}^{11},\ Y_{13}^{11},\ Y_{14})\} \qquad R = .979 \qquad (6.4)$$

1. In explaining manpower demand for the low skill, D^1, introduction of labour quality as an independent variable accounts for an additional explanation of .04, which is relatively high. The regression coefficient of labour quality possesses the right sign and is highly significant. For high skill there app ears to be no significant labour productivity effect of higher labour quality, thus confirming our expectations. Estimates in versions (6.2) and (6.3) are selected.

2. Transforming the selected coefficients of 1.2908 and 1.3152 at mean values into elasticities of the realized manpower employment D^0 with respect to the planned requirements $\sum_h(\tilde{\delta}_h^{q'}+\delta_h^{q'}X_h)$, $q=1,2$ gives 1.0918 and 1.2234 for skills 1 and 2, respectively. These imply that a 1 per cent increase in planned requirements of manpower skills has been implemented with 1.1 per cent to 1.2 per cent increase in actual employment. For the past period, the derivation of manpower input rates from planned requirements $\tilde{\delta}_h^{q'}$, and $\delta_h^{q'}$ can be described to underestimate the actual manpower absorption, the discrepancy between planned and realized being higher in the case of the high skill than in that of the low skill.

3. Turning now to the selected coefficient of $\delta^{1''}=-1.0433$, $(\delta^{2''}=0)$,[18] an addition of 1 per cent to the average of the labour quality term (average relating to nutrition, housing and health) is found to substitute for −.3478 million labourers (i.e. $-1.0433\div 3$). Or, at mean values, a reduction of −4.6 per cent in labour demand. During the past period, 1960—8, the labour quality term has gone up annually on the average, by 1.0 percentage point, and at the calculated elasticity it can be stated that the rise in labour quality contributed about a 5 per cent reduction in low-skilled labour employment. High skilled was uneffected.

Manpower supply

Eq. 7 fitted better for primary and secondary education than for higher education. In terms of relative current costs per student the three levels are related in the ratio 1.0 : 3.0 : 14.2, respectively. From eqs. 8 and 9 it appears that survival rates for students at the three levels amount to .9952, .9955 and .9943, resp., graduation rates reach .86, .63 and .64, resp., participation rates of school leavers in the labour force reach .41, .67 and .78 resp.

(18) See also Sec. 3, description of eq. 6.

Conversion of manpower supply by skill types into social groups (eq. 11) gives the following results.

$$S^{11} = -3.2723 + .7193\ S^1 \qquad r = .987$$
$$(.0450) \qquad \tilde{\delta}^2/\delta^2 = 3.18$$
$$S^{12} = .0070 + .8688\ S^2 \qquad r = .997$$
$$(.0239) \qquad \tilde{\delta}^2/\delta^2 = 1.76$$

Statistical performance is high by the criteria we use. For both wage earners and salary earners the correlation coefficients have very high values. Slope coefficients are highly significant with t-values above 15 and 36, respectively. Calculated elasticities of earner supply with respect to skill supply, evaluated at mean values, are found to be 2.2504 for wage earners (low skill), and .9872 for salary earners (high skill), which figures indicate the large future potential of low skill in providing earner labourers.

Income determination

Slightly different formulations for eq. 12 were tested and selected. So obtained, the elasticity of gross income of wage earners X^{11} with respect to the total product, calculated at mean values, is found to be higher than that for salary earners, which may indicate that economic growth in Korea favoured wage earners relatively more than salary earners. Both elasticities were above unity.

The calculated elasticities of gross income to unemployment give −.933 and −.177 for wage earners and salary earners. On the one hand, these results emphasize the greater dependence of the income of wage earners on the labour market situation. On the other hand, the remuneration of salary earners is known to be influenced to a large extent by salary scales which are not sufficiently sensitive to the employment situation in the labour market.

Consumption functions

Data fitted for the 15 consumption function of eq. 15 performed very well on all criteria examined. The equations fitted slightly better for groups 11 and 12 than 13; this is reasonable considering the heterogeneity of group 13 (employers etc.) and the fact that the consumption and income data for group 13 have been obtained as the residual after deducting figures for group 11 and 12 (obtained from surveys of households and labour) from national aggregates (available from national accounts). The estimates are in general

conformity with well-known changing patterns of consumption with rising incomes. Calculated consumption elasticities at mean values show for the three groups elasticities lower than one for food and housing, higher than one for health and education and about one for miscellaneous expenditure.

Formation of nutrition, housing and health

Eq. 18 explains the variance in unit cost of daily calories by the annual disposable income per capita. Since there were no sufficient Korean data on the daily calorie consumption available for testing the equation, we have relied on mixed data from cross-sections (from countries of the ECAFE), and time series(between 1957 and 1967). In total, twenty observations were employed.

The following regression results are obtained.

$$(C_{11}^{11}+Z_{11})/(\pi^{11}PY_{11}^{11}) = \underset{(.0019)}{.0051+.0498(Y^{11}/\pi^{11}P)} \qquad r = .986$$

It can be seen that the equation fits well. The unit cost of calories is fully explained by income per capita. The slope coefficient is highly significant and is positive in accordance with *a priori* expectations. Calculated elasticity of calorie cost with respect to income p.c., evaluated at mean values, gives .6, implying that a 1 per cent increase in income p.c. adds only .6 per cent increase to calorie cost.

By conducting a partial analysis, estimation of the above equation makes it possible to remark briefly upon the relative effectivity of using direct transfers (increasing Y^{11}) versus public allocation in kind (increasing Z_{11}) in the raising of the nutritional level. Besides the obvious fact that not all the income increase would be spent on food, there is the second and more important aspect that cost is a function of income; and increases in income are bound to increase the cost and diminish the purchasable calories. As a result, direct transfers can be shown to be less effective than public allocations in kind in raising calorie intake.[19]

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(19) The magnitudes involved can be demonstrated by rewriting the equation as

$$Y_{11}^{11}=\frac{\bar{\gamma}_{11}^{11}+\gamma_{11}^{11}Y^{11}+Z_{11}}{.00514\pi^{11}P+.0498Y^{11}}$$

Given γ_{11}^{11} and γ_{11}^{11} and calculating the mean values of $\pi^{11}P$, Y^{11}, and Z_{11}, an increase of one billion won in income Y^{11} leads to an increase of 4.4 calories p.p.p.d., Y_{11}^{11}. On the contrary,

From eq. 19 the calculated elasticity of the cost of room p.p. with respect to income p.c. evaluated at mean values is found to be .5891. This is practically equal to the elasticity found in the case of nutrition. From eq. 20, the calculated elasticity of survival cost with respect to income p.c. at mean values is found to be 1.0393, implying that growth in income p.c. accelerates, though marginally, the growth in the costs of avoiding death. From a comparison of the calculated elasticities for the formation of nutritional, housing and health levels the very tentative conclusion can be drawn that growth in income p.c. influences the rise of nutritional and housing standards more positively than health standards.

V. Projections

The degree of reliability of a whole system which contains reaction equations can be gathered from a comparison of the solutions of the model with observed values. Certainly, it is always feasible to contrast both values for year(s) of the observation period. Less feasible but more significant in an evaluation is the contrasting of both values for year(s) of the post-observation period. As a check on the representativeness of the system comparisons between solutions and observed values for the sixties show that the employed model represented the Korean economy fairly well. With respect to the post-observation periods it is noted that the predictions for the GDP and its composition for 1974 are closely identical to the values actually observed. We give below predictions for 1980 too.

More insight in the economic meaning of the solutions can be gained from Table 3.1 which relates the solution of particular variables to each other.

The outcome are such ratios as the aggregate capital coefficient, the aggregate labour coefficient, etc.; in aggregate analysis these relationships

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an increase of one billion won in public allocations to food Z_{11} allows the consumption of 14.8 additional calories p.p.p.d.

The equation suggests, too, that the most attractive measure is a combination of an increase in taxation(lower Y^{11}) and an equivalent increase in food allocations (raise Z_{11}). It can be calculated that such a combined policy raises Y_{11}^{11} by 10.3 calories. This policy has also the good quality of not disturbing the budgetary equilibrium. The evaluation of combined measures is dealt with at length and within the context of the whole model in section 6.

Table 1. Selected solutions

	1968	1974	1980
Distributive shares			
product(Agri: Manu: Capi: Serv)	.31:.20:.31:.18	.25:.24:.34:.17	.22:.24:.37:.17
enrolments (Primary: Secondary: Higher)	.76:.21:.024	.74:.24:.027	.71:.26:.033
skills (Low: High)	.92:.08	.9:.1	.87:.13
earners (Wage: Salary: Employer)	.33:.07:.6	.35:.09:.56	.36:.12:.52
Structural indicators			
capital coefficient	1.72	1.81	1.84
investment proportion	.28	.34	.39
private investment/public investment	2.86	5.26	6.63
domestic savings/foreign capital inflow	.57	.79	.94
labour coefficient(1)	8.43	5.14	2.70
capital-labour intensity	.20	.35	.68
Variables			
wage earners			
Y_1^{11} income per capita (2)	.0214	.0456	.0903
Y_2^{11} employment rate	.83	.92	.95
Y_{11}^{11} daily caloric consumption per capita	1740	>2290	>2290
Y_{13}^{11} rooms per capita	.14	.31	.68
Y_{14} survival rate (national)	.99	.991	.992
Y_{15} primary enrolment rate (national)	.18	.21	.29
salary earners			
Y_1^{12} income per capita (2)	.0397	.0681	.1225
Y_2^{12} employment rate	.97	.97	.98
employers *et al.*			
Y_1^{13} income per capita (2)	.0372	.0526	.1027
national			
income per capita (2)	.0353	.0596	.1151
Gini coefficient of income concentration	.483	.4669	.4658
General employment ratio (3)	.8536	.9332	.9604
Living conditions index (4)	.6377	.7651	.92

1) Number of workers per million won of gross value added, constant prices of 1965
2) Income in million won per person, constant prices of 1965
3) $(D^{11}+D^{12})/(S^{11}+S^{12})$
4) $\left\{ \frac{Y_{11}^{11}}{2.29} + Y_{13}^{11} + \frac{Y_{14}}{.28} + \frac{Y_{15}}{.995} \right\} \frac{1}{4}$

are assumed to remain constant, but these vary here. The appraisal of these ratios in the light of existing magnitudes permits an evaluation of the validity of the solutions of the model over the seventies.

There is an increasingly high growth rate of the GDP. Average annual growth rate of X amounts to 11.6%.[20] The investment proportion increases greatly from .24 to .34 and to .39 over three periods which is consistent with the high growth of X. On the financing of investment it may be pointed out that the ratio of domestic savings to foreign capital inflow increases from .57 to .74 and to .94. These solutions indicate that domestic savings are increasingly becoming more significant in the financing of total investment, as can be expected.

Solutions show a decreasing share of the agricultural product, an increasing share of the capital producing sector[21] while those of the manufacturing and services sectors tend to stabilize.

Solutions also show the share of primary enrolment in total enrolment to fall while the shares of secondary and higher enrolment rise. Concurrently, manpower becomes more of the skilled types and labour becomes more of the employee category.

The general labour coefficient which divides total demand for labour by the total product undergoes remarkable reductions in each period i.e. from 8.4 to 5.1 and to 2.7 in 1968, 1974 and 1980, reflecting the remarkable growth of labour productivity. At a stable marginal capital coefficient of about 1.8 the model shows that the excessive trend towards substitution of capital for labour via the product mix which factually existed in the sixties would continue further in the seventies, though presumably, at a lower pace.

Results relating to the issues of growth, equity and the distribution of welfare on the three social groups are found in Table 3.1, too. In 1962 employers etc. had the highest income p.c., from 1968 onwards salary-earners have the highest income p.c. The group of wage-earners is the poorest, the income p.c. gap between them and salary-earners appears to widen while the

(20) This rate is higher than the average growth rate of 9.0% anticipated in the Fourth Five Year Plan 1977-1981.

(21) In consistency with the Fourth Five Year Plan.

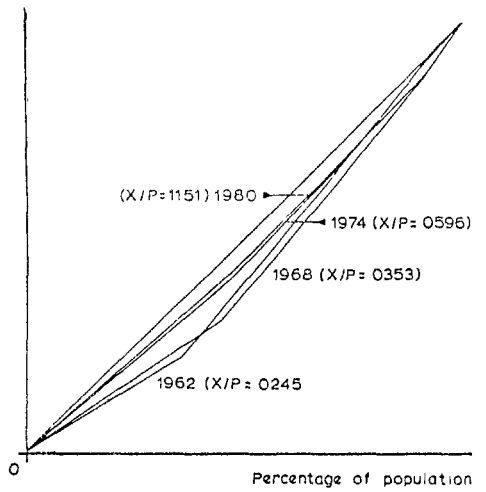


Fig. 2. Domestic product per capita and concentration of income.

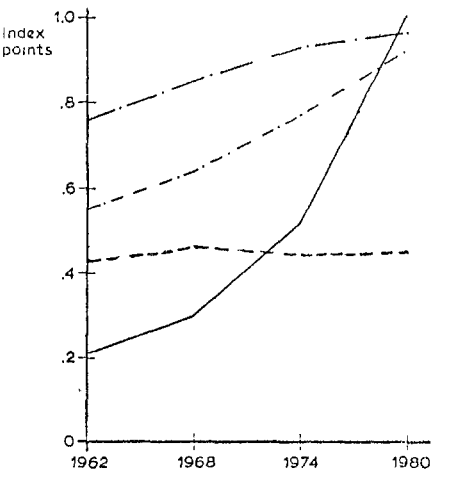


Fig. 3. Indices of income per capita, income equality, employment rate and living conditions; respectively, ·····, ·····

gap between them and the employers etc. appears to shrink. Between 1962 and 1968 there is a progress towards less income equality at the lower end, the progress occurs at an accelerated rate at the higher end of the income scale. For 1974 and 1980, Gini-coefficient of income concentration indicates a general progress towards more equality, though at a reduced rate. See Figures 2, 3. These results may be compared with those obtained from cross-country comparisions.[22]

Employment rates develop gradually towards fuller employment indicating that by 1980 unemployment is reduced to 5% for wage-earners and to 2% for salary-earners. The general employment rate reaches .96 in 1980.[23] See Fig. 3.

Finally, on the progress of general living conditions for the poorest group it may be observed that the indicator of calorie consumption p.d. p.p. Y_{11}^{11} is the first to reach its minimum requirements level i.e. 2,290, followed by the enrolment rate Y_{15} and the survival rate Y_{15}. The housing indicator Y_{13}^{11} is

(22) Refining on Kuznets, several authors, i.e. Adelman, Ahluwalia, Paukert, stated that there is a tendency for inequality to increase with growth until the approximate level of $500 GDP per capita is reached. Korea which had until 1974 a GDP per capita delow $500 testifies to the contrary.

(23) The general employment rate actually observed in 1974 was already .959, the model projects a value of .933.

the most remote from its 'satisfaction point'.[24] On Fig. 3 we review the progress of a composite index of the general living conditions with special reference to wage earners. This index is found to progress gradually to its maximum. By 1980, minimum needs as defined in this index are satisfied for 92 per cent.

VI. Multiplier and sector characteristics

As is well-known, by appropriate inversions and multiplications the *impact multiplier* of the system are attained.[25] These measure the immediate effect of a unit increase in the exogenous variables on the endogenous variable. More interesting are the *interim multipliers* of the system which give the effect of a sustained change in exogenous variable in period t on the exogenous variables in later periods.[26] It is important to define another notion of the multiplier. When a government makes plans in period t for a specific addition to public expenditure i.e. in housing, health or education, or in income taxes, this addition is not only sustained in later periods t' but also recurred in each period t'. There is an inherent commitment to maintain the extended services in later periods. Assuming that the magnitude of the manipulated addition in a particular exogenous variable in each period in the same, one obtains what one may call the *recurring* multipliers.[27] The results to be reviewed here will relate to the recurring multipliers as described above.

The planner is usually interested in three different but very interdependent

(24) These conclusions are in agreement with results of the Bari Loche world model for Latin America obtained in a different context, cf. Herrera (1974).

(25) The complete system can be written as

$$Xy_t = Yy_{t-m} + Zz_t$$

where X, Y and Z are matrices and y_t, z_{t-m} and z_t are column vectors of current endogenous, lagged endogenous and exogenous variables. The solution of the system can then be obtained for given values of column vectors y_{t-1}, and z_t, as

$$y_t = X^{-1}Y\ y_{t-1} + X^{-1}Zz_t \text{ or } y_1 = Ay_0 + Bz_1$$

A and B represent the impact multipliers.

(26) By repeated substitutions, the reduced form for consecutive periods is obtained too.

$$y_2 = A^2y_0 + AB\ z_1 + Bz_2$$

$$y_3 = A^3y_0 + A^2Bz_1 + ABz_2 + Bz_3$$

The interim multipliers for period 2 are AB and for period 3 are A^2B.

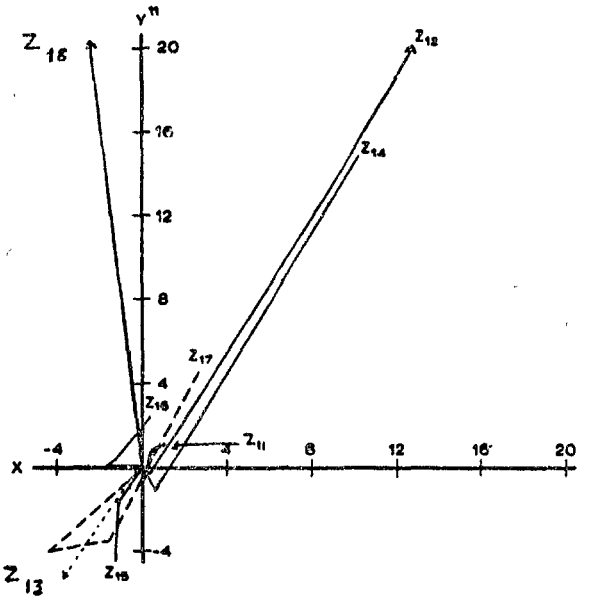
(27) The recurring multipliers are formed for period 2 by $(AB+B)$ and for period 3 by $(A^2B+AB+B)$.

applications of the multipier.

1. The multiplier effects of a unit increase in each of the budgetary items separately, keeping other items unchanged. The items relate to public consumption Z_g, $g=11,\cdots,18$, and public investment $ZINV$ on the expenditure side; and income taxes Z^o, $o=11,\cdots,13$ on the revenue side.
2. In real life, expenditure items are almost always combined in certain ways. Especially government allocations to consumption and investment are closely tied together. Often, an increase in public consumption of Z_g implies a certain proportionate increase in public investment $ZINV$. This relation between public expenditure on consumption and investment goods makes it essential to evaluate the combined multipliers of Z_g and $ZINV$.
3. It is obvious that raising public expenditure in the absence of an equivalent increase in public revenue leads to an increase in the budgetary deficit $BUGF$. Since in practice governments are anxious to find a source of revenue for each additional unit of expenditure, and thereby preventing $BUGF$ from increasing, it would seem desirable to evaluate also combined multipliers of expenditure and revenue.

Due to space considerations we shall only demonstrate the effectivity of multiplier combinations of the three types together. The multiplier effects of the described bundling of various budgetary items which are associated with increasing public allocations to food, housing, health or educational sectors etc. are shown in Fig. 4. Two effects are shown, one on the gross domestic product X and one on the income of the poorest population group Y^{11}. Effects on other welfare variables will not be discussed here, but in general, negative effects on income of the poorest group diminish the levels of social indicators achieved by the group. The kinks in Fig. 4 indicate the transition from one six-year period to another.

The results show that housing subsidies in the form of rent allowances affect both growth and equity in a negative way. The higher the educational level the higher are the positive effects on both growth and equity of allocations in these sectors. The most positive effects are those resulting from additions in public allocations to miscellaneous economic goods and services and health. The time pattern of the effects shows that negative earlier periods tend to become positive effects in later periods, and at an accelerated rate.



11 - food
12 - miscellaneous
13 - housing
14 - health
15 - primary ed.
16 - secondary ed.
17 - higher ed.
18 - training

Fig. 4. Growth and Equity Effects of Combined Public Allocations and Increased Public Revenue

The main mechanisms behind the described effects can be summarized. In this model the bottleneck to growth is capital (and not labour). Therefore, 1) government measures which exhaust the available investment goods lead to lower growth, and 2) measures which save on investment or increase the availability of investment goods lead to higher growth. Most government measures work in both directions. The final effects are the result of this interaction.

First, government allocations to consumption expenditure draw on available investment and are growth dampening as can be observed from the first kinks in Fig. 4. It may be added here that since the sectors receiving the allocations have different marginal capital coefficients the effects on growth are different.

Second, at the same time, government allocations to consumption expenditure are usually associated with *autonomous* public investment commitments. These increase the availability of investment goods and enhance growth in later periods, as in Fig. 4. In addition, those government allocations which are associated with higher autonomous public investment have more positive effects on growth than the others which explains why allocations to miscell-

aneous, health and higher educational goods and services have more pronounced positive effects on growth.

Regarding the Y-axis, the reduced product in the first period(s) decreases the demand for manpower and the income accruing to earners Y^{11}. These effects change sign as the product increases in later periods. One exception is the allocation to training programmes. These allocations are associated with little or no autonomous investments which explains the absence of positive growth effects. But since these programmes stand for retraining and promoting labour from low skill to high skill, they decrease the supply of the low skill and increase the supply of the high skill and, therefore, tend to equalize income throughout all periods.

According to these results, a more equal distribution of income plus growth can be expected from allocations to the services sectors only in the *longer run*; remembering, of course, that the immaterial welfare of the receiving population is already increased by these allocations *since the beginning*, the material welfare of the paying groups being reduced. Impatient governments show often little readiness to wait for longer runs and prefer to concentrate more on investment in industrial sectors.[28]

The specification of the model does not allow reflecting on the growth and equality characteristics of public allocations to other outlets than the so-called "social" outlets of food, housing, health and various educations. An analysis of these characteristics for other sectors would be possible if the miscellaneous allocations Z_{12} were disaggregated further. This would have necessitated the disaggregation of the "economic" sectors, especially the mining and manufacturing sector in the model, into at least its two-digit classification. Given the main purposes of the model such refinements would have expanded the model unproportionately.

In an attempt to give a more complete picture of the growth and equality characteristics of all important Korean sectors, we shall supplement the analytical results of the model with a static comparison of some of the main "economic" sectors. The growth character of a sector can be represented

(28) These considerations may suggest that in countries where foreign assistance is still important, this assistance can play an increasingly important role in financing allocations to food, housing, health and education. Especially when recognizing that social allocations are the safest means of reaching the less privileged, this becomes an attractive form in which foreign assistance can be transmitted.

by the growth rate it has achieved during a certain period. As a tentative measure of income equality in a specific sector one may calculate per sector the average wage rate of a production worker as a proportion of the average value added per working person. Sectors with high growth rates and high indices of income equality usually contain an institutional set-up which facilitates redistribution with growth.

Results of such a comparison for Korea are summarized in Fig. 5. The horizontal axis represents the growth rate of the sectoral production over 1970—72. The vertical axis represents the equality measure described above for 1971. A sector which guarantees both a higher growth and more equality above the average should be in the right-hand quarter, and though very

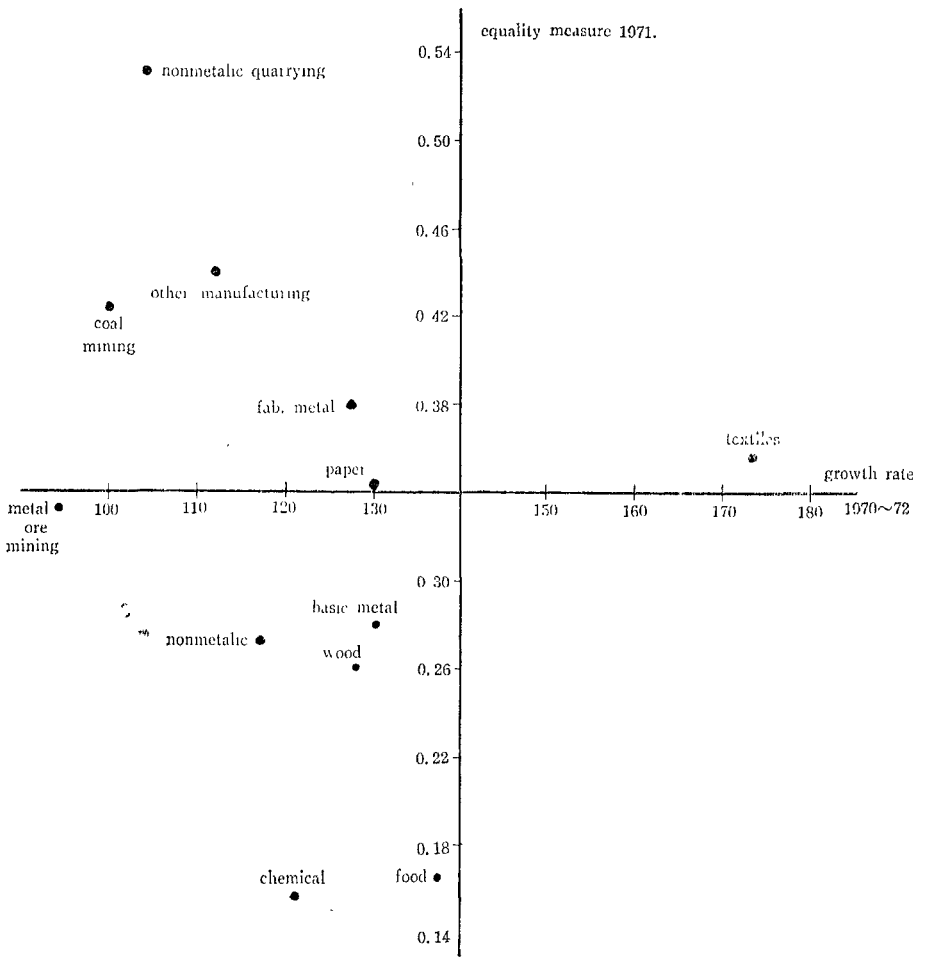


Fig. 5. Sectoral patterns with regard to growth and equality: Korea

tentative, it is important to identify such a sector as being specially attractive, and recommends itself for government stimulation. In Korea, the textiles sector appears to be such a sector. Paper, fabricated metal, other manufacturing, coal mining and quarrying show above average equality but below average growth. The remaining sectors are least attractive.[29]

In passing, it is remarkable to point out that the growth and equity effects of allocations to "economic" sectors and "social" sectors have in common the absence of repercussions in the lower right-hand quarter. This quarter stands for effects which can be associated with "exploitative activities" i.e. highest in growth but lowest in equality. This common feature is obtained in spite of the different analytical tools employed in appraising the economic and social sectors. In this respect it is significant to remark that the double positive picture which the Korean economy gives in terms of growth and equality at the aggregate level (see previous section) is also manifested at the more disaggregated sectoral levels (this section).

As a closing statement to this section it may be pointed out that in formulating development policy, national or international, it can be instructive to find out which countries have which exploitative activities and avoid them, but at the same time study how their structures can be adapted into desirable ones.

VII. Income Policies, Role and Effects

In conformity with accepted uses, the analytical form of the model treats

(29) These suggestions require further study. It is important to know whether this pattern holds for other years and other countries and how the rank of these sectors is affected when indirect effects characteristic of input-output analysis are considered. Fig.5 has also implications for international development policies. Conventional notions of the international division of labour advocate the shift of labour-intensive sectors to labour-rich countries (developing countries). These notions are often criticized on the ground that when a particular sector is to be shifted, then one shifts together with it the growth and institutional bases of the sector; depending on the sector, these bases can be advantageous or detrimental to future development in the developing country. Technological bases of different sectors can promote or dampen technological growth (i.e. electronics versus leather goods). Similarly, particular sectors have institutional bases which can increase or decrease income equality. It is desirable, therefore, that in proposals for an international division of labour, the principle of comparative advantage should be reformulated to consider simultaneously the desire in developing countries to take over sectors which promote technological growth and income equality.

aim variables as unknown and instruments as given. The complete policy form is usually described as the reverse, with all aim variables taking the form of fixed targets and instrument variabes becoming unknown.

Now an interesting situation arises when a model contains a substantial number of aim variables which require fixation, as in the comprehensive model studied here. The question presents itself whether there exists a certain meaningful ranking that can tell us whether specific aim variables should be fixed *first*, and *which others* should follow *later*.

The answer to this question runs along the following lines. Granted for the moment that there are no political preferences which dictate the form in which the model is to be used or specify the aim variables that have to be fixed first before others, we may inquire, on purely technical grounds, into the most logical selection procedure. It is a common-sense argument that in such a situation we should put side by side the matrix structures of a number of conceivable alternative policy forms and select that one which possesses the simplest structure to serve as a starting point. It logically follows also that after starting with the simplest structure one should extend it later to more complex structures. In this way the analytical form of the model is adapted in a step-wise manner to the fixation of targets for more aim variables of a more complex nature until the complete policy form is approached. For our particular purpose, we shall consider that as we move to forms whose mathematical structure fall into a larger number of orders, we approach a simpler structure. By shuffling rows and columns we can triangulate the particular structures of alternative forms and observe which structure is simpler.

Application of this procedure shows that the policy form which couples income targets with tax instruments happens to produce the simplest structure, and, as a result, constitutes the most suitable *first* policy problem. This coupling of incomes to taxes can be considered the natural core of the planning model. This problem is shown in Fig. 6 (compare Fig. 1 which gives the analytical form with Fig. 6 standing for the simplest policy form).

In addition, the analysis shows that after this first policy form, the most logical step is that in a *second* round such supplementary aims as higher nutrition, housing, education etc., for the poorest social group can be fixed,

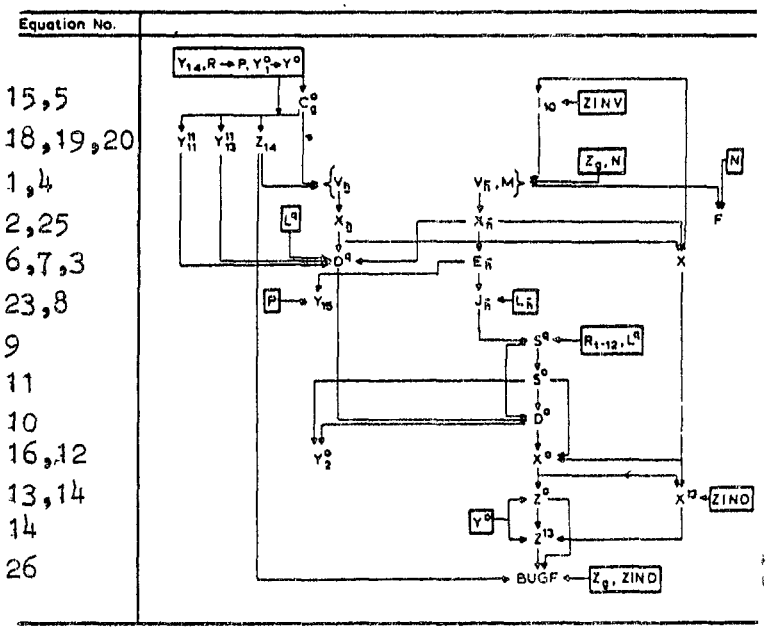


Fig. 6. Policy form with fixed disposable idcomes ($\underline{h}=1,\cdots,4,9,\ 10;\bar{h}=5,\cdots 8$)

public allocations towards these ends being the instruments; while in a *third* round the planning of employment targets and manpower balances can be introduced, making use of public allocations to educational as well as non-educational sectors.

The first policy form in which for each social group incomes are fixed and taxes are made unknown, has been simulated too. The following three alternative strategies of income redistribution were run.

Table 2—1. Alternative strategies

(Y_1^q billion won per thousand persons)

	Analytical projections			Strategy 1			Strategy 2			Strategy 3		
	1968	1974	1980	1968	1974	1980	1968	1974	1980	1968	1974	1980
Y_1^{11}	.0214	.0456	.0903	.0221	.0463	.0909	.0221	.0463	.0909	.0221	.0463	.0909
Y_1^{12}	.0397	.0681	.1225	.0397	.0681	.1225	.0366	.0654	.1202	.0397	.0681	.1225
Y_1^{13}	.0372	.0526	.1027	.0372	.0526	.1027	.0372	.0526	.1027	.0364	.0519	.0965

Table 2 gives the consequences of each of these strategies. The following conclusions can be drawn.

1. The first strategy which stipulates an increase in the disposable income

Table 2—2. Consequences of alternative strategies of fixing targets of income.
(In billion won and thousand persons)

	Strategy 1			Strategy 2			Strategy 3		
	1968	1974	1980	1968	1974	1980	1968	1974	1980
X_1	.27	−.56	−2.65	−.05	−.39	−1.27	.4	.32	.13
X_2	−.53	−1.26	−3.08	−.29	−.6	−1.36	−.25	−.33	−.49
X_{10}	−1.7	−3.37	−7.58	−.54	−1.23	−3.00	−.18	−.33	−.74
$\sum_{h=3}^{9} X^h$	.5			--.16			−.2		
X	−2.47	−6.22	−15.68	−1.03	−2.6	−6.57	−.23	−.59	−1 48
F	9.15	11.36	16.94	1.18	2.1	4.44	.01	.30	.83
D^1	−12.31	−30.26	−75.5	−5.14	−12.66	--31 61	−.03	−1.73	−5.99
D^2	−1.32	−3.08	−7.52	−.74	−1.48	--3.34	−.69	−.86	−1.28
S^1	.35	.8	1.94	.55	.64	1.02	1.06	.84	.72
S^2	−.002	−.24	−.81	−.003	−.37	−.84	−.008	−.71	−1.35
D^1-S^1	−12.66	−31.06	−77.44	−5.69	−13.3	−32.63	−1.09	−2.57	−6.71
D^2-S^2	−1.32	−2.84	−6.71	−.74	−1.11	−2.5	−.68	−.15	.07
$BUGF$	12.47	16.22	25.68	1.03	2.6	6.57	.23	.59	1.48

of wage earners without affecting the disposable income of other groups is seen to carry a number of shortcomings in other respects; an increasingly lower GDP which at the end of the third period involves a reduction of −15.68 b.w., higher requirement of foreign capital inflow +16.94 b.w., higher budgetary deficit +25.68 b.w. In addition, this strategy causes unemployment for both manpower types.

2. The second strategy, which transfers income from salary earners to wage earners partly reduces the above strains and can be described to satisfy more readily eventual restriction on solutions of unknown variables, e.g. for D^o-S^o, $o=1,2$; X; F; and $BUGF$.

3. The third strategy, which transfers the income from employers etc. to wage earners, can be described to be the most plausible of the three on the grounds of satisfying most closely eventual constraints on employment contraction, total product, foreign-capital inflow requirements and the budgetary deficit.

4. In a comparison between the three strategies, it is evident that redistribution of income away from employers is more effective than other forms of income redistribution. In this connection, it may be observed that historically, too, in the process of development a trend is often observed towar-

ds a larger income share for wage and salary earners at the cost of the income share of the group of employers etc.

VIII. Additional Remarks

The empirical investigation of the model in both its analytical and policy forms allows of making a few observations of a general nature. In a comparison between the multiplier effects of (the common) exogenous variables in both the analytical and policy forms it is found that for most unknowns the effects can be substantially different between the two forms. This testifies to the high sensitivity of the reduced form to the particular specification of the model structure.

Table 3 gives impact multipliers for the first period representing the consequences of sudden changes in the non-controllable variables for several unknowns. The same change in total exports, N, leads to opposite effects on foreign capital inflow F depending on whether the structure of the model is analytical or policy. The effects of changes in lagged births, R_{t-12}, show similar divergencies.

Table 3. Selected impact multipliers (for 1968) of non-controllable variable in the analytical and policy forms.

	Total exports Analytical	N Policy	Lagged births Analytical	R_{t-12} Policy
X	.0632	.073	.0051	0
F	.0223	−.0373	.0015	0
D^1	−.1968	−.49	.9901	0
D^2	−.0426	−.0429	.0167	0
S^1	.1758	.1872	1.8414	1.8677
S^2	−.0014	−.0013	.0002	0

It is also worthwhile to investigate and compare the predictive performances of the analytical and policy forms. The proposition by Tinbergen(1970) that highly-ordered model structures give solutions which are more reliable than the outcome of model structures with less orders cannot be supported. Compare the performances in columns 4 and 8 in Table 4, below. The comparison shows a prediction advantage for the analytical over the policy form. The results are surprising but consistent with the nature of the aim

variables and instrument variables. The reason being that in the analytical model the unknown aim variables of disposable income have a bigger base, so that an absolute error in the unknown becomes a relatively small one. But in the policy model, where income taxes are the instrument variables, and which have a smaller base, an absolute error in their prediction can become relatively speaking a very high one. In general, in most economic models aim variables carry higher values than instrument variables.

Table 4. Predictive performance of the analytical and policy forms

Analytical	Observed 1968	Solution 1968	Obs.÷Sol. 1968	Policy	Observed 1968	Solution 1968	Obs.÷Sol. 1968
Y^{11}	.33	.2973	.9009	Z^{11}	.008207	−.0454	wrong sign
Y^{12}	.1288	.1287	.9992	Z^{12}	.007	.0058	1.21
Y^{13}	.4941	.5187	1.0502	Z^{13}	.044353	.0884	.5

Finally, although simpler structures involve less computational time in solution and inversion than more complex ones, such economies appear to be not significant in the present context, given the relatively small size of the applied models. For what it may worth, there is the advantage for the policy form of eliminating the otherwise non-linear shape of individual relationships in the analytical form.

References

Byung-Nak Song, Planning Model Combining Interindustry and Aggregate Models, Working Paper No. 7211, Korean Development Institute, Seoul, 1972.

Cohen, S. I., *Production, Manpower and Social Planning*, Rotterdam University Press, 1975.

Cohen, S. I., Development Models with Different Decision-Makers, in Polish Academy of Science and World Future Studies Federation "Future Research, Planning and Decision-making," Proceedings of a conference held in Jablonna, 1977.

Cohen, S. I., *Agrarian Structures and Agrarian Reform*, forthcoming, 1977.

Fisher, F. *et al.*, Price and Output Aggregation in the Brookings Econometric Model in Deusenberg, J., *et al.* eds., *The Brookings Quarterly Econometric Model of the U.S.*, North-Holland Publishing Co., Amsterdam, 1965.

Herrera, A. *et al.*, Latin American World Model, Fundación Bariloche, 8 volumes, presented in the Second Symposium on World Models at the International Institute of Applied Systems Analysis, Luxenburg, 1974.

Japan, *Econometric Models for Medium-Term Economic Plan 1964—68*, Economic Planning Agency, Government of Japan, Tokyo, 1965.

Simon, H. A., "Causal Ordering and Identifiability," in Hood, W. C. and Koopmans, T. C. eds., *Studies in Econometric Method*, Cowles Commission Monograph, No. 14, New York, 1953.

Tinbergen, J., "Planning and Economic Forecasting," in International Institute of Quantitative Economics: Research Priorities in Quantitative Socio-Economic Development Planning, Montreal, 1970.

United Nations, *Preliminary Report of Targets on Social Development*, ECOSOC, 1966.

United Nations, *Second United Nations Development Decade, A System of Overall Review and Appraisal of the Objectives and Policies of the International Development Strategy*, ECOSOC, 1971.