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A NATIONAL ECONOMY SECTOR MODEL LINKING KOREAN AGRICULTURE AND NONAGRICULTURE

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KASS Working Paper No. 74-7

Korean Agricultural Sector Study

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

A National Economy Sector Model Linking Korean Agriculture and Nonagriculture

INTRODUCTION

In KASS Working Paper 74-3[1] I presented preliminary ideas for a model of Korea's national economy which would interact with the Korean Agricultural Simulation Model, KASM. The present paper describes the model which has evolved from those preliminary ideas and which is currently being parameterized and computerized.

The next section describes in broad terms the National Economy Model (NECON) and its role as a component of KASM. Succeeding sections detail the assumptions and equations of NECON, links with KASM, data needs (including a presentation of data collected to date), and tasks remaining in order to incorporate NECON within KASM.

OVERVIEW OF THE NATIONAL ECONOMY MODEL

The aggregated national economy model (NECON) is designed to operate as a part of the detailed agricultural sector model (KASM) to project endogenously the important interactions between the agricultural and nonagricultural sectors of the Korean economy. These interactions include:

a) agriculture's demands for investment goods and production inputs -- e.g., machinery, tools, construction, chemical fertilizers, pesticides, etc.;

b) farm household demands for consumer goods -- e.g., household appliances, clothing, drugs and cosmetics, radios, health services, etc.;

c) agricultural input prices;

d) non-farm household demands for food commodities; and

e) nonagricultural labor requirements.

These linkages are discussed in detail in the mathematical description of NECON (next section).

NECON disaggregates the economy into 16 sectors. The behavior of the first sector, agriculture, is an aggregation of the behavior of the agricultural sector as projected in detail by KASM. Interaction between agriculture and the 15 nonagricultural sectors takes place through the input-output model in the production component. Table 1 relates NECON's 16 sectors to the Bank of Korea's 56-sector classification[2] and to aggregations frequently made by the Economic Planning Board (except that the trade sector is not usually considered social overhead capital).

This 16-sector classification emphasizes the major agricultural intermediate input and investment goods industries: chemical fertilizers, machinery, fuels and construction. Pesticides are included in the "other chemicals" sector. Currently, KASM does not interact significantly with the construction sector. However, this interaction will become much more important when J. H. Lee's yield and input demand model[3] -- which includes such large-scale public investment projects as irrigation, drainage and land consolidation -- is incorporated as a component of KASM.

TABLE 1
Korean Sectoral Classifications

Economic Planning Board Aggregations		Korean Agricultural Sector Study 16 Sectors		Bank of Korea 56 Sectors
1. Agriculture	1. Agriculture	1. Agriculture	AG	1. Rice, barley and wheat (polished) 2. Vegetables, fruits and other grains 3. Industrial crops 4. Livestock breeding and sericulture 6. Fishery products
		2. Forestry	FOR	5. Forestry products
2. Mining	2. Mining	3. Mining	MIN	7. Coal 8. Metallic ores 9. Non-metallic minerals
3. Manufacturing	3. Heavy and chemical manufacturing	4. Chemical fertilizers	CHF	26. Chemical fertilizers
		5. Others chemicals	OCH	24. Inorganic chemicals 25. Organic chemicals 27. Drugs and cosmetics 28. Other chemical products
		6. Machinery	MA	37. Non-electrical machinery 38. Electrical machinery 39. Transportation equipment
		7. Fuels	FU	29. Petroleum refining and related products 30. Coal products
		8. Other heavy manufacturing	OHM	20. Lumber and plywood 21. Wood products and furniture 22. Paper and paper products 31. Rubber products 32. Non-metallic mineral products 33. Iron and steel 34. Primary iron and steel products 35. Non-ferrous metal ingot and primary products 36 Fabricated metal products
	4. Light manufacturing	9. Food processing	FP	10. Slaughtering, dairy products and fruits processing 11. Canning and processing of sea foods 12. Grain polishing and milling 13. Other food preparations 18. Beverages 15. Tobacco
		10. Textiles	TX	16. Fibre spinning 17. Textile fabrics 18. Apparel and fabricated textile products
		11. Other light manufacturing	OLM	19. Leather and leather products 23. Printing and publishing 40. Measuring, medical and optical instruments 41. Miscellaneous manufacturing
4. SOC and services	5. Social overhead capital	12. Trade	TRD	50. Wholesale and retail trade
		13. Transportation and storage	TS	49. Transportation and warehousing
		14. Construction	CON	42. New buildings and maintenance 43. Public utilities and other construction
		15. Utilities	UT	44. Electric utilities 45. Water services 48. Communications
	6. Services	16. Other services	OS	46. Financing and insurance 47. Real estate 51. Government services 52. Social services 53. Other services 54. Office supplies 55. Business consumption 56. Unclassifiable

On the output side, agricultural product industries are aggregated into food processing and textiles.

NECON is composed of seven components which interact with each other and with KASM as indicated in Figure 1. Detailed descriptions of KASM appear elsewhere[4,5], so they will not be repeated here. The seven NECON components are:

1. Foreign trade and public demand, which projects
   a. world price indices
   b. export demands
   c. consumption, investment and intermediate import coefficients based on import substitution policies
   d. public consumption and investment

2. Consumption, which projects
   a. private consumption demand
   b. total consumption demand
   c. domestic consumption
   d. consumption imports

3. Investment, which projects
   a. private net investment
   b. gross investment
   c. domestic investment goods demand
   d. investment goods imports

4. Production, which projects
   a. domestic output
   b. production imports
   c. unit value added

5. Labor, which projects
   a. labor requirements
   b. wages paid

6. Price, which projects
   a. commodity producer price indices
   b. commodity market price indices

7. Accounting, which projects
   a. aggregate price indices
   b. unit profits and variable costs
   c. changes in capacity utilization
   d. income -- farm, non-farm; nominal, real; total, disposable; aggregate, per capita

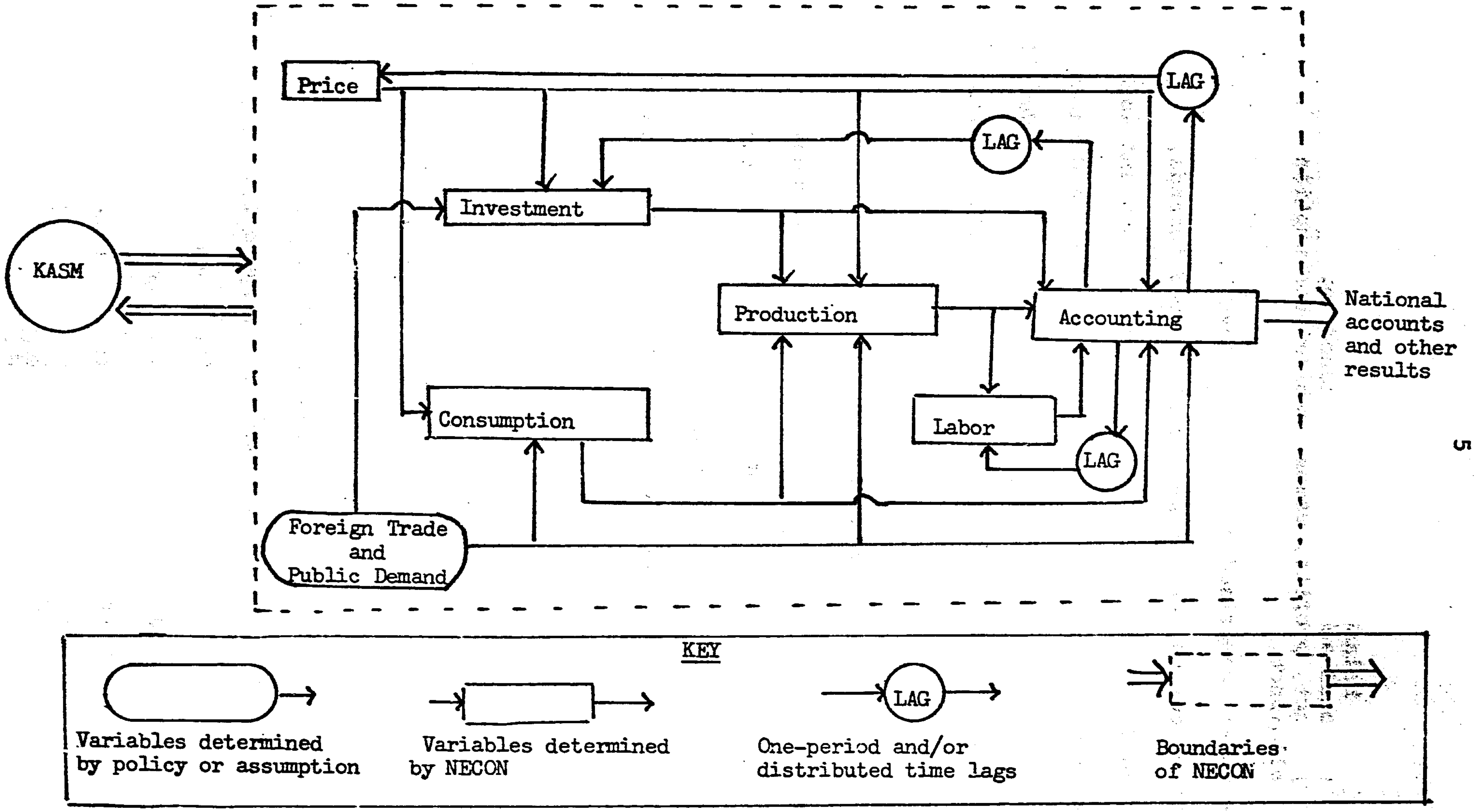

Figure 1

THE KOREAN NATIONAL ECONOMY MODEL (NECON):
Internal Interactions and Interactions
With the Agricultural Sector Model (KASM)

e. trade balance
f. national accounts -- value added, gross domestic product, profits, wages, capital consumption allowance.

The model, comprised of the above seven components, is driven by agricultural input demands, food demands, export demand projections, world price projections and such policies as public consumption, public investment and taxes. The next section describes each of these components in detail, presenting assumptions and equations and interactions with one another and with KASM.

THE NATIONAL ECONOMY MODEL IN DETAIL

After each component of the national economy model (NECON) has been described, links with variables of the agricultural sector simulation model (KASM) will be specified. The next section will then detail NECON's data requirements.

Foreign Trade and Public Demand (FTPD)

The FTPD component computes import coefficients for consumer goods, investment goods and intermediate inputs to production based on policy-determined import substitution coefficients. In addition, export demand and world price indices are projected, as are policy-specified public consumption demand and public investment (Figure 2).

Import substitution coefficients for consumer goods, ISC, are projected as in Figure 3 by Equation (1), where ISCF and ISCR are policy parameters. Similar equations

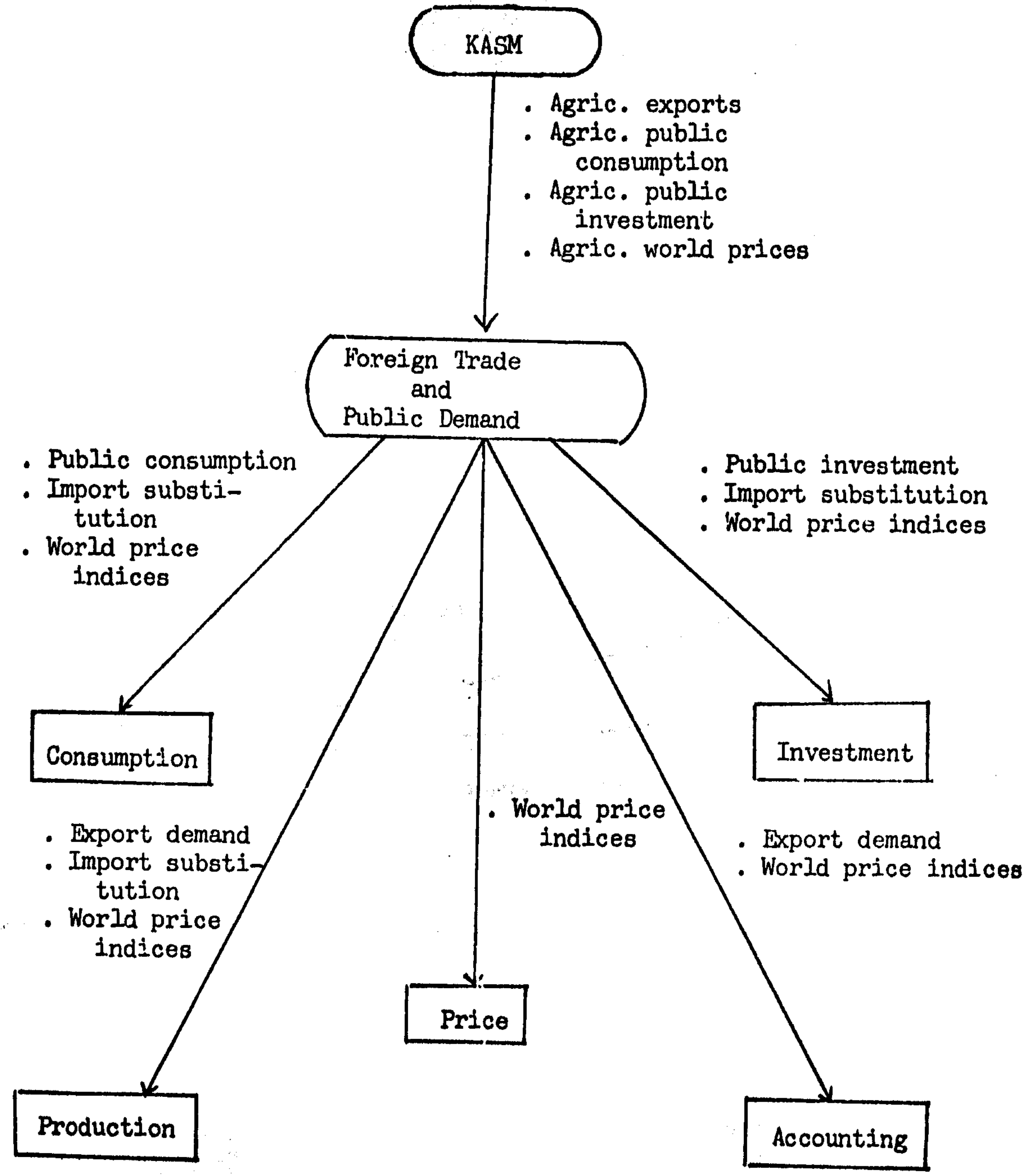

Figure 2

Inputs and Outputs of the Foreign Trade and Public Demand Component

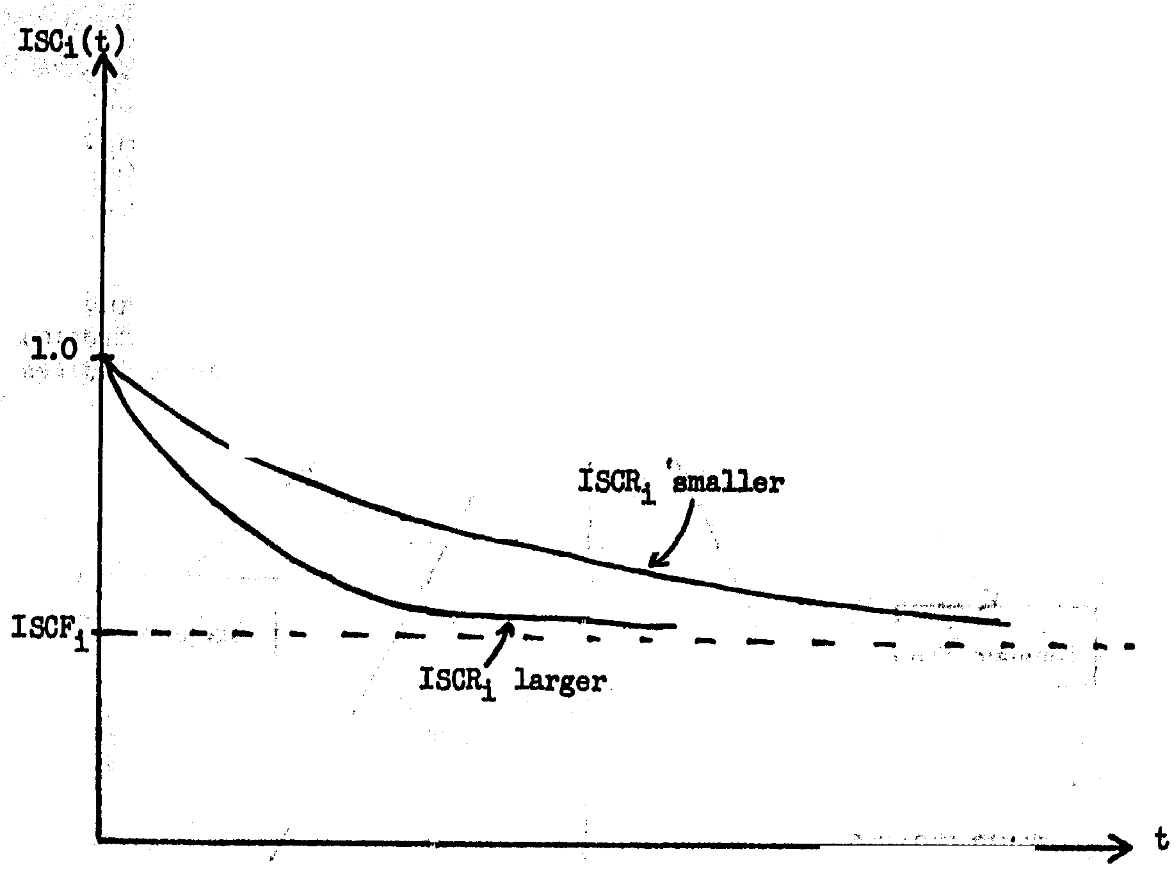

Figure 3

Projection of Import Substitution
Coefficients for Consumer Goods

project import substitution coefficients for investment goods (ISI) and intermediate inputs (ISP).

(1) $ISC_i(t) = ISCF_i + (1-ISCF_i)e^{-ISCR_i t}$, $i=1,2,\ldots,16.$

ISC, then, is the proportion of the 1970 level of competitive imports which have <u>not</u> been replaced by domestic production.

Import coefficients are computed by Equations (2)-(4) as non-competitive import coefficients plus competitive import coefficients after accounting for import substitution. The subscripts i and j = 1, 2, ..., 16.

(2) $PMC_{ij}(t) = PMCN_{ij} + ISP_i(t)(PMCT_{ij}-PMCN_{ij})$

(3) $IMC_i(t) = IMCN_i + ISI_i(t)(IMCT_i-IMCN_i)$

(4) $CMC_i(t) = CMCN_i + ISC_i(t)(CMCT_i-CMCN_i)$

where

PMC_{ij} = intermediate input import coefficient (except for j=1 -- see Equation (113)) -- won imports of commodity i per unit won output of commodity j

IMC_i, CMC_i = investment and consumer goods import coefficients, respectively (except for i=1 -- see Equation (25)) -- won imports of commodity i per unit won demand for commodity i

PMCT, IMCT, CMCT = total import coefficients in 1970

PMCN, IMCN, CMCN = non-competitive import coefficients in 1970

ISP, ISI, ISC = import substitution coefficients (Equation (1)).

World price indices, export demands, public consumption and public investment are not computed by NECON but are projected by "arbitrary" assumption using the table look-up function TABEL. The projections are "arbitrary" because they are determined outside the model, either by independent analysis of future export markets, for instance, or truly arbitrarily by assuming anything the analyst wants. Essentially, exports are assumed to be known at certain points in time, and TABEL linearly interpolates between those times. For equally spaced time points, VXD_i is the vector of assumed exports at those points, SXD is the first time point, DXD is the common difference between time points, and KXD is the number of points.

Equations (5)-(8) compute world price indices, exports, public investment and public consumption for nonagricultural sectors, where values for agriculture (including processed food, sector 9) come from KASM. Values are at constant market prices; the production component converts to producer prices for the final demand vector.

$$\text{(5)}\quad PWLD_i(t) = \begin{cases} TABEL(VPWLD_i, SPWLD, DPWLD, KPWLD, t) & \text{for } i \neq 1,9 \\ APWLD(t) & \text{for } i=1,9 \end{cases}$$

$$\text{(6)}\quad XDM_i(t) = \begin{cases} TABEL(VXD_i, SXD, DXD, KXD, t) & \text{for } i \neq 1,9 \\ AXU(t)/PWLD_1(t) & \text{for } i=1 \\ AXP(t)/PWLD_9(t) & \text{for } i=9 \end{cases}$$

$$(7)\quad CDPM_i(t) = \begin{cases} TABEL(VCDP_i,SCDP,DCDP,KCDP,t) & \text{for } i\neq 1,9,12 \\ AGCDPU(t) & \text{for } i=1 \\ AGCDPP(t) & \text{for } i=9 \\ 0 & \text{for } i=12 \end{cases}$$

$$(8)\quad IVPU_i(t) = \begin{cases} TABEL(VIVPU_i,SIVPU,DIVPU,KIVPU,t) & \text{for } i\neq 1 \\ AGIVPU(t) & \text{for } i=1 \end{cases}$$

where

PWLD = world price index

APWLD = aggregate world price index for agricultural commodities (Equation (100))

XDM = export demand at world prices -- constant won/year*

AXU, AXP = unprocessed and processed agricultural exports at world prices, respectively (Equation (102)) -- current won/year

CDPM = public consumption demand at market prices -- constant won/year

AGCDPU, AGCDPP = public consumption of unprocessed and processed agricultural commodities at market prices, respectively (Equation (103)) -- constant won/year

IVPU = public investment -- constant won/year

AGIVPU = public investment in agriculture (Equation (104)) -- constant won/year.

Note that consumption of trade services (i=12) at market prices is 0, since consumption of other commodities at market prices includes the trade margin.

Consumption

The consumption component computes private per capita and total demand for domestic and imported consumer goods

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* "Constant won" means at 1970 prices, while "current won" means at time t prices.

required by the production component and for national accounting (Figure 4).

The food consumption component of KASM projects farm and non-farm demand for 19 agricultural commodities and one aggregate nonagricultural commodity. In order to maintain consistency under sequential (rather than simultaneous) solution of the two consumption components (KASM's and NECON's), we assume all interaction between food and non-food demand (i.e., via cross elasticities) takes place in the food demand model of KASM. In this consumption component, then, the aggregate non-food consumption expenditure computed in KASM is disaggregated among the 14 non-food sectors.

Adopting the same consumption function formulation as in KASM[6], we begin with the elasticity concept:

$$(9)\quad \frac{dC}{C} = \varepsilon^{p} \frac{dP}{P} + \varepsilon^{x} \frac{dX}{X}$$

which, in difference equation form for simulation, becomes

$$(10)\quad \frac{C(t)-C(t-DT)}{C(t-DT)} = \varepsilon^{p} \frac{P(t)-P(t-DT)}{P(t-DT)} + \varepsilon^{x} \frac{X(t)-X(t-DT)}{X(t-DT)}$$

where DT is the simulation time increment, the integration step size. Upon rearranging terms, considering n commodities and introducing the total expenditure constraint, we have

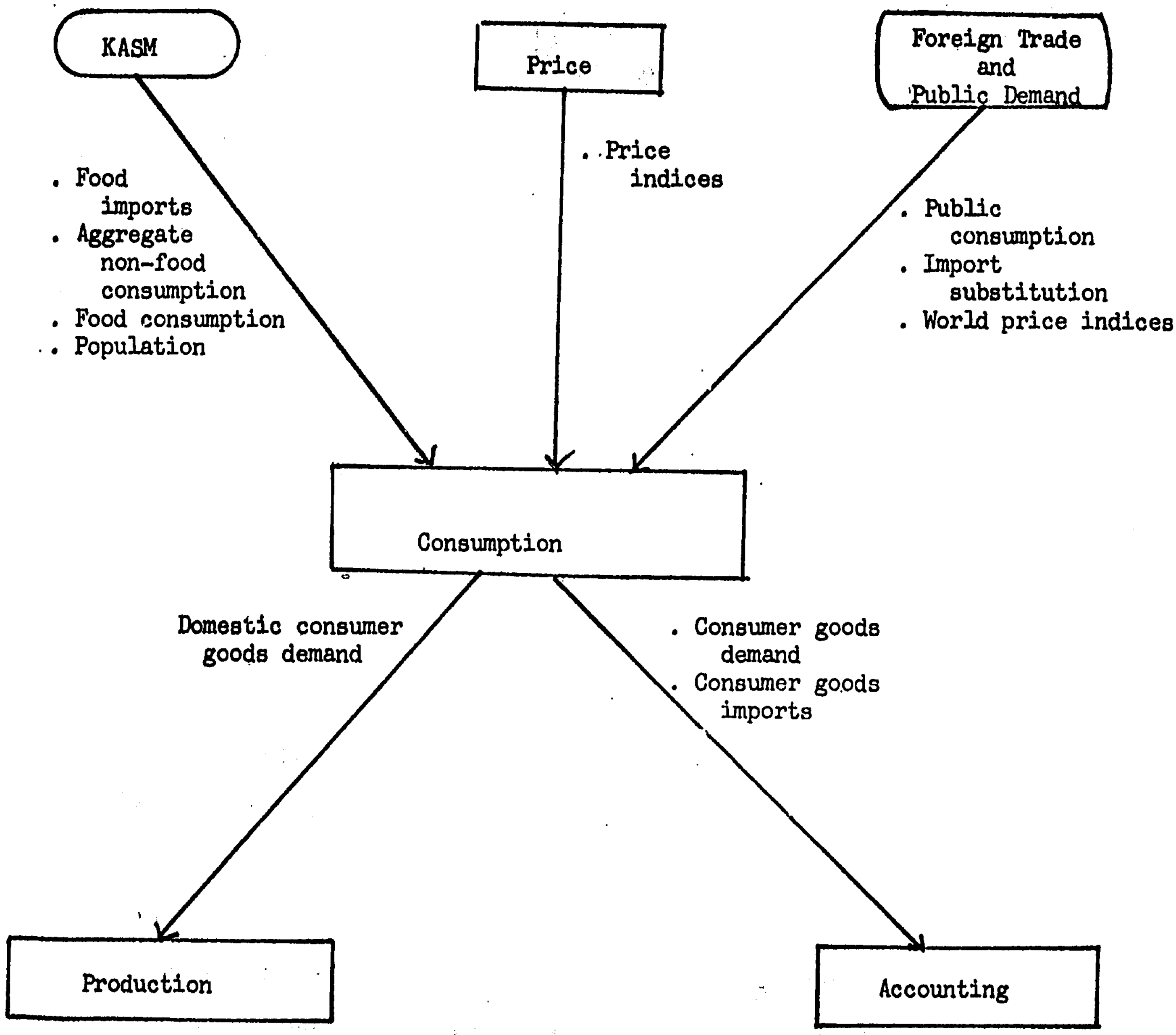

Figure 4

Inputs and Outputs of the Consumption Component

$$(11)\quad C_i(t) = C_i(t-DT)\left\{1 + \sum_{j=1}^{n} \varepsilon^p_{ij} \left[\frac{P_j(t)}{P_j(t-DT)} - 1\right]\right.$$

$$\left. \varepsilon^x_i \left[\frac{X(t)}{X(t-DT)} - 1\right]\right\} \quad \text{for } i=1,2,\ldots,$$

$$\sum_{i=1}^{n} C_i(t) = X(t).$$

Assuming the homogeneity conditions hold, i.e.

$\varepsilon^x_i + \sum_{j=1}^{n} \varepsilon^p_{ij} = 0$ for each i, (11) reduces to

$$(12)\quad C_i(t) = C_i(t-DT)\left[1 + \sum_{j=1}^{n} \varepsilon^p_{ij} \frac{P_j(t)}{P_j(t-DT)} + \varepsilon^x_i \frac{X(t)}{X(t-DT)}\right]$$

$$\sum_{i=1}^{n} C_i(t) = X(t).$$

(12) is a system of n+1 equations in n unknowns (the C_i). Solution is obtained by introducing an additional unknown, in effect assuming that adjustments in per capita consumption to satisfy the total expenditure constraint occur in the expenditure term of the consumption function in proportion to the expenditure elasticity ε^x_i. Preserving the homogeneity condition, this may be accomplished by replacing total expenditure, X, in the consumption function by an "effective" expenditure S•X. We finally have

$$(13)\quad C_i(t) = C_i(t-DT)\left(1 + \sum_{j=1}^{n} \varepsilon_{ij}^{p} \frac{P_j(t)}{P_j(t-DT)} + \varepsilon_i^{x} \frac{S(t)X(t)}{S(t-DT)X(t-DT)}\right)$$

$$\sum_{i=1}^{n} C_i(t) = X(t).$$

Because of the homogeneity condition, and because we are dealing in consumption in value terms, (13) gives us consumption at (t-DT) market prices. Multiplying by the market price index ratio to convert to current prices and using variable names actually used in the model, the constrained consumption function is (subscript k indexes consumer classes, in this case farm and non-farm)

$$(14)\quad PCDM_{ik}(t) = \frac{MPC_i(t)}{MPC_i(t-DT)}\, PCDM_{ik}(t-DT)\left(1 + \sum_{\substack{j=2\\ j\neq 9}}^{16} EP_{ijk} \frac{MPC_j(t)}{MPC_j(t-DT)} + EX_{ik} \frac{SN_k(t)APCD_k(t)}{SN_k(t-DT)APCD_k(t-DT)}\right) \quad \text{for } i\neq 1,9$$

$PCDM_{ik}(t)$ = see Equations (105) and (106) for i=1 and 9

$$(15)\quad \sum_{\substack{i=2\\ i\neq 9}}^{16} PCDM_{ik}(t) = APCD_k(t)$$

where

PCDM = per capita consumption at market prices -- current won/person-year

MPC = consumers' market price index, a weighted average of the domestic market price index and the world price index (Equation (59))

EP = matrix of own- and cross-price elasticities

EX = vector of expenditure elasticities

SN = expenditure constraint parameter (Equation(16))

APCD = total non-food expenditure (Equation (107)) -- current won/person-year.

Everything on the right-hand side of (14) is known except $SN_k(t)$. Substituting (14) into (15), then, we can solve for $SN_k(t)$ by

$$(16)\quad SN_k(t) = \frac{K_1}{K_2}$$

where

$$K_1 = APCD_k(t) - \sum_{\substack{i=2 \\ i\neq 9}}^{16} \frac{MPC_i(t)}{MPC_i(t-DT)} PCDM_{ik}(t-DT) \left[1 + \sum_{\substack{j=2 \\ j\neq 9}}^{16} EP_{ijk} \frac{MPC_j(t)}{MPC_j(t-DT)} \right]$$

and

$$K_2 = \frac{APCD_k(t)}{SN_k(t-DT)\,APCD_k(t-DT)} \sum_{\substack{i=2 \\ i\neq 9}}^{16} EX_{ik} PCDM_{ik}(t-DT) \frac{MPC_i(t)}{MPC_i(t-DT)}$$

It is a simple matter, then, to substitute SN as computed in (16) back into (14) to get PCDM.

A simplification of (16) is derived from the conditions for consistency between KASM and NECON. To simplify the notation in the derivation, let's write (14) and (15) in vector-matrix form:

$$(17)\quad PCDM_k(t) = MPCR(t)[AO_k(t) + A1_k(t)MPC(t) + A2_k(t)SN_k(t)APCD_k(t)]$$

$$(18)\quad \vec{1}^T PCDM_k(t) = APCD_k(t)$$

where

$$MPCR_{ij}(t) = \begin{cases} MPC_i(t)/MPC_i(t-DT) & \text{for } i=j \\ 0 & \text{for } i \neq j \end{cases}$$

$$AO_{ik}(t) = PCDM_{ik}(t-DT)$$

$$A1_{ijk}(t) = EP_{ijk}\,\frac{PCDM_{ik}(t-DT)}{MPC_j(t-DT)}$$

$$A2_{ik}(t) = EX_{ik}\,\frac{PCDM_{ik}(t-DT)}{SN_k(t-DT)APCD_k(t-DT)}$$

$\vec{1}$ = a column vector of ones.

Substituting (17) and the KASM equation for APCD into (18), and recognizing that $\vec{1}^T MPCR = MPC\vec{R}$, where $MPC\vec{R}$ is the row vector of price ratios, we get

$$(19)\quad MPC\vec{R}(t)\,[AO_k(t) + A1_k(t)MPC(t) + A2_k(t)SN_k(t)APCD_k(t)]$$

$$= AMPCR_k(t)\,[AOF_k(t) + A1F_k(t)MPF(t) +$$

$$A1N_k(t)AMPC_k(t) + A2F_k(t)SF_k(t)Y_k(t)]$$

where

$AMPCR_k(t) = AMPC_k(t)/AMPC_k(t-DT)$, the non-food market price ratio

$AOF_k(t) = APCD_k(t-DT)$

$A1F_{ik}(t) = EPF_{ik}APCD_k(t-DT)/MPF_i(t-DT)$, a row vector, where EPF_i is the cross-price elasticity of the aggregate non-food commodity for the i^{th} food commodity

$MPF_i(t)$ = market price of food commodity i -- won/MT

$A1N_k(t) = AEP_k(t)APCD_k(t-DT)/AMPC_k(t-DT)$

$A2F_k(t) = EYN_kAPCD_k(t-DT)/SF_k(t-DT)Y_k(t-DT)$, where EYN is the aggregate non-food income elasticity

AMPC = aggregate consumers' non-food market price index (Equation (121))

AEP = aggregate non-food own-price elasticity. (Equation (123))

$SF_k(t)$ = income constraint parameter in the food demand model of KASM

$Y_k(t)$ = per capita income -- current won/person-year

k = indexes consumer classes, i.e., farm and non-farm.

Assuming correspondences between the intercept terms -- AO and AOF -- and the non-food price terms -- A1·MP and A1N·AMPC -- implies that the expenditure term A2·SN·APCD incorporates the income effect A2F·SF·Y and the food price effect A1F·MPF. Thus, we have

$$(20)\quad \vec{MPCR}(t)AO_k(t) = AMPCR_k(t)AOF_k(t)$$

$$(21)\quad \vec{MPCR}(t)A1_k(t)MPC(t) = AMPCR_k(t)A1N_k(t)AMPC_k(t)$$

$$(22)\quad \vec{MPCR}(t)A2_k(t)SN_k(t)APCD_k(t) = AMPCR_k(t)[A1F_k(t)MPF(t) + A2F_k(t)SF_k(t)Y_k(t)].$$

We will use (20) and (21) below (Equations (120)-(123)) to compute AEP, AMPCR and AMPC for use by KASM. Here, solving (22) for the scalar SN,

$$(23)\quad SN_k(t) = \frac{AMPCR_k(t)[A1F_k(t)MPF(t)+A2F_k(t)SF_k(t)Y_k(t)]}{\vec{MPCR}(t)A2_k(t)APCD_k(t)}$$

$$= \frac{APCD_k(t)-AMPCR_k(t)[AOF_k(t)+A1N_k(t)AMPC_k(t)]}{\vec{MPCR}(t)A2_k(t)APCD_k(t)}$$

$$= \frac{K_3}{K_2}$$

where

$$K_3 = APCD_k(t) - \frac{AMPC_k(t)}{AMPC_k(t-DT)} APCD_k(t-DT) \left[1 + AEP_k(t) \frac{AMPC_k(t)}{AMPC_k(t-DT)} \right]$$

and K_2 is as defined in Equation (16).

In its computerized form, the model is simplified by the assumption, following the 1970 input-output data, that $PCDM_{4k} = PCDM_{14k} = 0$ for all time. This says that chemical fertilizers are not consumed, and construction is considered investment rather than consumption. In addition, $PCDM_{12k} = 0$ for all time because the private consumption demand for trade services is entirely made up of trade margins, which are included in the market price. In computing private consumption demand at producer prices, however, trade and transportation margins are separated out and accounted to those sectors. Consumption of domestically produced goods at producer prices is needed for the final demand vector of the production component.

Total consumption at consumers' market prices, consumption imports at import prices and domestic consumer demand at producer prices are

$$(24)\quad CDM_i(t) = \sum_{k=1}^{2} PCDM_{ik}(t)TPOP_k(t) + MPC_i(t)CDPM_i(t)$$

$$(25)\quad CM_i(t) = \begin{cases} CMC_i(t)\,CDM_i(t)\,PWLD_i(t)/MPC_i(t) & \text{for } i \neq 1,9 \\ \dfrac{AM(t)}{CDM_1(t)+CDM_9(t)}\,CDM_i(t) & \text{for } i=1,9 \end{cases}$$

$$(26)\quad DCD_i(t) = \begin{cases} \dfrac{CDM_i(t) - CM_i(t)}{1+TDMGC_i \dfrac{P_{12}(t)}{P_i(t)} + TPMGC_i \dfrac{P_{13}(t)}{P_i(t)}} & \text{for } i \neq 12,13 \\ \displaystyle\sum_{\substack{j=1 \\ j\neq 12}}^{16} DCD_j(t)\,TDMGC_j \dfrac{P_{12}(t)}{P_j(t)} & \text{for } i=12 \\ CDM_{13}(t)-CM_{13}(t)+\displaystyle\sum_{\substack{j=1 \\ j\neq 13}}^{16} DCD_j(t)\,TPMGC_j \dfrac{P_{13}(t)}{P_j(t)} & \text{for } i=13 \end{cases}$$

where

- CDM = consumption demand at consumers' market prices -- current won/year
- TPOP = population (Equation (108)) -- persons
- CDPM = public consumption demand at consumers' market prices (Equation (7)) -- constant won/year
- CM = consumption imports at import prices -- current won/year
- CMC = consumer goods import coefficients (Equation (4))
- MPC = consumers' market price index (Equation (59))
- PWLD = world price index (Equation (5))
- AM = agricultural imports (Equation (109)) -- current won/year

DCD = domestic consumption demand at producer prices -- current won/year

TDMGC, TPMGC = consumer goods trade and transportation margins, respectively, at constant producer prices -- constant won of margin/ constant won of consumption

= producer price index (Equation (57)).

Equation (26) assumes, again following the 1970 input-output data, that the trade and transportation margins for the transportation sector (i=13) are zero, i.e., transportation consumption at market prices is the same as at producer prices. Note that (25) first deflates CDM to constant prices (CDM_i/MPC_i), determines imports at constant world prices ($CMC_i CDM_i/MPC_i$), and finally inflates to current world prices with PWLD. In (26), then, (CDM_i CM_i) represents domestic consumption at domestic market prices.

Investment

The investment component computes net and gross investment, demands for investment goods and investment goods imports as requred by the production component and for national accounting (Figure 5).

First, the proportional rate of change of private net investment in nonagricultural sectors is postulated to be a function of the proportional rates of change of profits per unit output and capacity utilization:

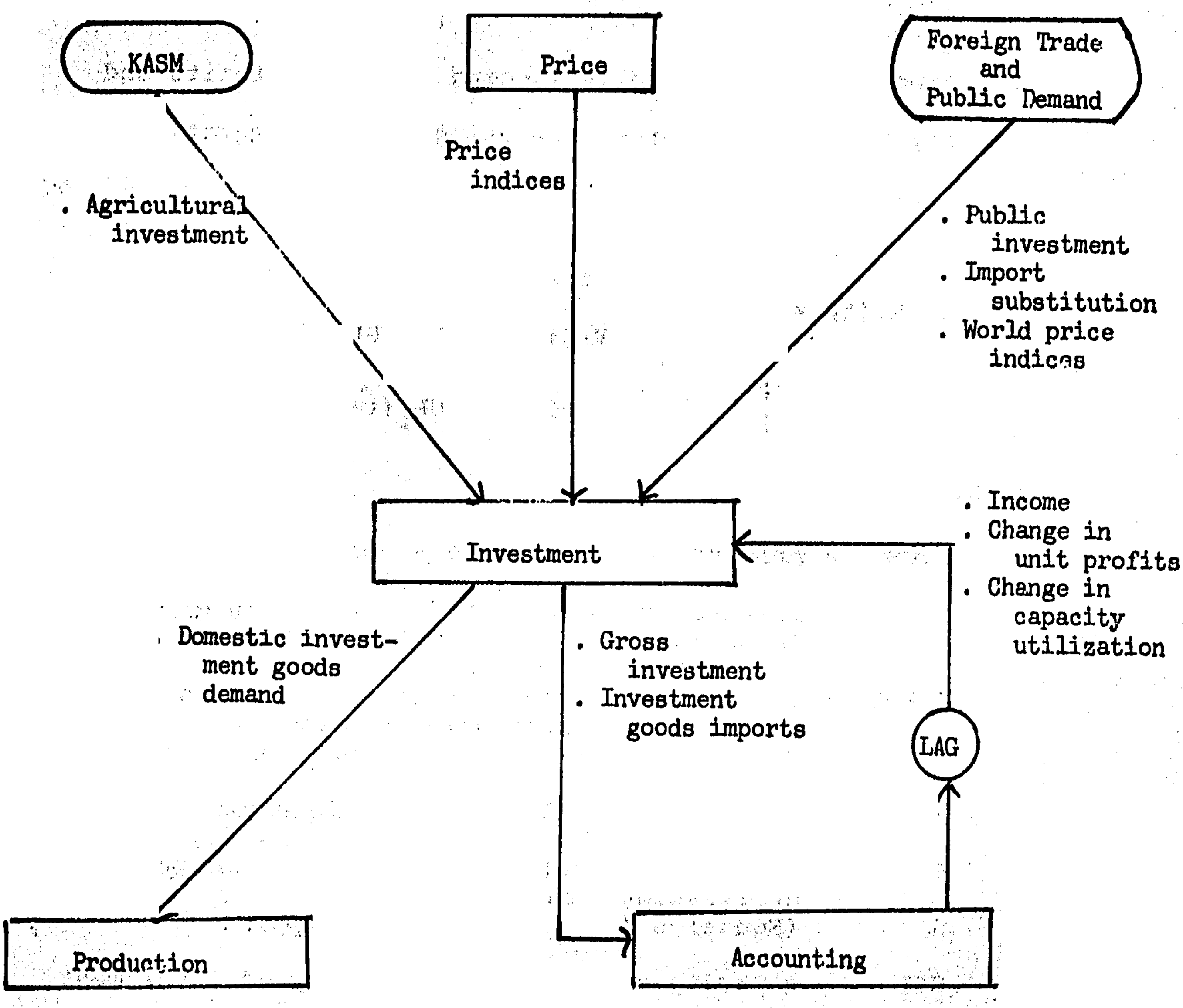

Figure 5

Inputs and Outputs of the Investment Component

$$(27)\quad \frac{1}{IVPR_i(t)} \cdot \frac{dIVPR_i(t)}{dt} = PEI_i \frac{1}{PPU_i(t)} \frac{dPPU_i(t)}{dt} + CEI_i \frac{1}{CU_i(t)} \frac{dCU_i(t)}{dt}.$$

Rewriting (27) exponentially lagging the unit profits and capacity utilization terms, and using Euler integration for simulation,

$$(28)\quad IVPR_i(t) = \begin{cases} AGIVPR(t) \text{ for } i=1 \\ IVPR_i(t-DT)\,[1+DT(PEI_i DPPUL_i(t-DT) \\ \quad +CEI_i PDCUL_i(t-DT))] \text{ for } i\neq 1 \end{cases}$$

where

IVPR = private net investment -- constant won/year

AGIVPR = private net investment in agriculture (Equation (110)) -- constant won/year

DPPUL = proportional rate of change of profits per unit output, exponentially averaged (Equation (67)) -- proportion/year

PEI = profitability elasticity of investment

PDCUL = proportional rate of change of capacity utilization, exponentially averaged (Equation (94)) -- proportion/year

CEI = capacity utilization elasticity of investment.

Essentially, (27) and (28) postulate that changes in private net investment are driven by changes in profits per unit output and by changes in capacity utilization (measured indirectly as discussed below in the accounting component). Modeling thusly the causal basis of net investment is an attempt to avoid many of the problems associated with modeling current investment (per usual practice[7,8]) as a function of future changes in output, i.e., what investment must be at time t to enable a change in output at time $t+\tau$, where τ is a gestation lag. One practical problem with the usual approach is the use of changes in actual output rather than capacity output. There is general agreement that capacity output would be the proper concept to use, but difficulties in defining and measuring it reliably lead to the use of actual output in its place.

Even if capacity output changes are used -- and especially when using actual output changes -- logical problems may arise in projecting the cause, investment, as a function of the effect, output changes. That is, if output = f(investment), we don't in general have an inverse function investment = f^{-1}(output).

Investment in residential construction is treated separately[9] as a function of population and real income:

$$(29)\quad RESCON(t) = RCI(TPOP_1(t)+TPOP_2(t))^{EPRC}(RTYDL(t))^{EYRC}$$

where

RESCON = residential construction -- constant won/year

RCI = constant coefficient

EPRC = population elasticity of residential construction

$TPOP_1$, $TPOP_2$ = farm and non-farm populations, respectively (Equation (108))

EYRC = income elasticity of residential construction

RTYDL = real disposable income, exponentially averaged (Equation (85)) -- constant won/year.

Gross investment at current prices, then, is the investment goods price index times the sum of private and public net investment and depreciation in the previous period. Residential construction is added to investment in the service sector (i=16) since the latter includes the "ownership of dwellings" sector of the 1970 input-output classification.

$$(30)\quad GIV_i(t) = \begin{cases} PIG_i(t)\left[IVPR_i(t)+IVPU_i(t)+\dfrac{CCA_i(t-DT)}{PIG_i(t-DT)}\right] & \text{for } i\neq 16 \\ PIG_i(t)\,[IVPR_i(t)+IVPU_i(t)+RESCON(t) \\ \qquad +\,CCA_i(t-DT)/PIG_i(t-DT)] & \text{for } i=16 \end{cases}$$

where

GIV = gross investment -- current won/year

PIG = investment goods price index (Equation (33))

IVPU = public investment (Equation (8)) -- constant won/year

CCA = depreciation, capital consumption allowance (Equation (63)) -- current won/year.

The B matrix is used to convert from sector investment to demands for investment goods, where B_{ij} is demand for investment good i per unit investment in sector j. Of course, we must therefore have $\sum_{i=1}^{16} B_{ij} = 1$. B is computed in nominal terms based on 1970 incremental capital-output ratios and current price indices.

$$(31)\quad B_{ij}(t) = \frac{ICOR_{ij}P_i(t)}{\sum_{k=1}^{16} ICOR_{kj}P_k(t)} \qquad \text{for } i,j=1,2,\ldots,16$$

where $ICOR_{ij}$ is the incremental capital-output ratio, i.e., demand for investment good i per unit change in output of sector j. If later versions of KASM can generate agriculture's demands for investment goods corresponding to the NECON sectors, (31) can be replaced for j=1 by

$$(32)\quad B_{i1}(t) = \frac{AGID_i(t)}{GIV_1(t)}$$

where $AGID_i$ is agriculture's demand for the i^{th} investment good (in current won/year) and where $\sum_{i=1}^{16} AGID_i(t) = GIV_1(t)$.

The columns of the constant B matrix (i.e., B(0)) are used as weights in computing the investment goods price index for each sector (MPI is the investors' market price index, a weighted average of domestic market price and world price indices -- Equation (60)):

$$(33)\quad PIG_j(t) = \sum_{i=1}^{16} B_{ij}(0)MPI_i(t).$$

Investment goods demands at current investors' market prices, then, are:

$$\text{(34)}\quad ID_i(t) = \begin{cases} \sum_{j=1}^{16} B_{ij}(t)GIV_j(t) & \text{for } i \neq 14 \\ \sum_{j=1}^{16} B_{ij}(t)GIV_j(t) + PIG_{16}(t)RESCON(t)[1 - B_{i16}(t)] & \text{for } i = 14. \end{cases}$$

Notice that the residential construction portion of investment in the service sector (i=16) is all allocated to the construction sector (i=14). This implies that $ICOR_{i16}$ must exclude the "ownership of dwellings" sector for all i.

Finally, imports of investment goods at import prices and demand for domestically produced investment goods are computed in a similar fashion as are consumer goods demands

$$\text{(35)}\quad IM_i(t) = IMC_i(t)ID_i(t)PWLD_i(t)/MPI_i(t)$$

$$\text{(36)}\quad DID_i(t) = \begin{cases} \dfrac{ID_i(t) - IM_i(t)}{1+TDMGI_i \dfrac{P_{12}(t)}{P_i(t)} + TPMGI_i \dfrac{P_{13}(t)}{P_i(t)}} & \text{for } i \neq 12,13 \\ \sum_{\substack{j=1 \\ j \neq 12}}^{16} DID_j(t)TDMGI_j \dfrac{P_{12}(t)}{P_j(t)} & \text{for } i = 12 \\ \sum_{\substack{i=1 \\ i \neq 13}}^{16} DID_j(t)TPMGI_j \dfrac{P_{13}(t)}{P_j(t)} & \text{for } i = 13 \end{cases}$$

where

ID = demand for investment goods at investors' market prices -- current won/year

IM = investment goods imports at import prices - current won/year

IMC = investment goods import coefficients (Equation (3))

PWLD = world price index (Equation (5))

DID = domestic investment goods demand at producer prices -- current won/year

TDMGI, TPMGI = trade and transportation margins, respectively, for investment goods -- constant won of margin/constant won of investment goods

P = producer price index (Equation (57)).

Production

Given final domestic demand, the production component computes output at current producer prices and unit value added for each sector (Figure 6).

Constraints on production -- particularly capacity constraints and skilled labor constraints -- are not directly considered in the model. The primary purpose of NECON -- to link agriculture with nonagriculture, rather than to project and analyze Korean industrial development -- does not justify the increased complexity and costs of a constrained model; e.g., some kind of programming algorithm for the production component, a population component disaggregated by skill level, and direct measurement of capacity. NECON does address the capacity problem indirectly by 1) making private net investment a function of capacity utilization (Equation (28)); and 2) making price increases also a function of capacity utilization (Equation (57)),

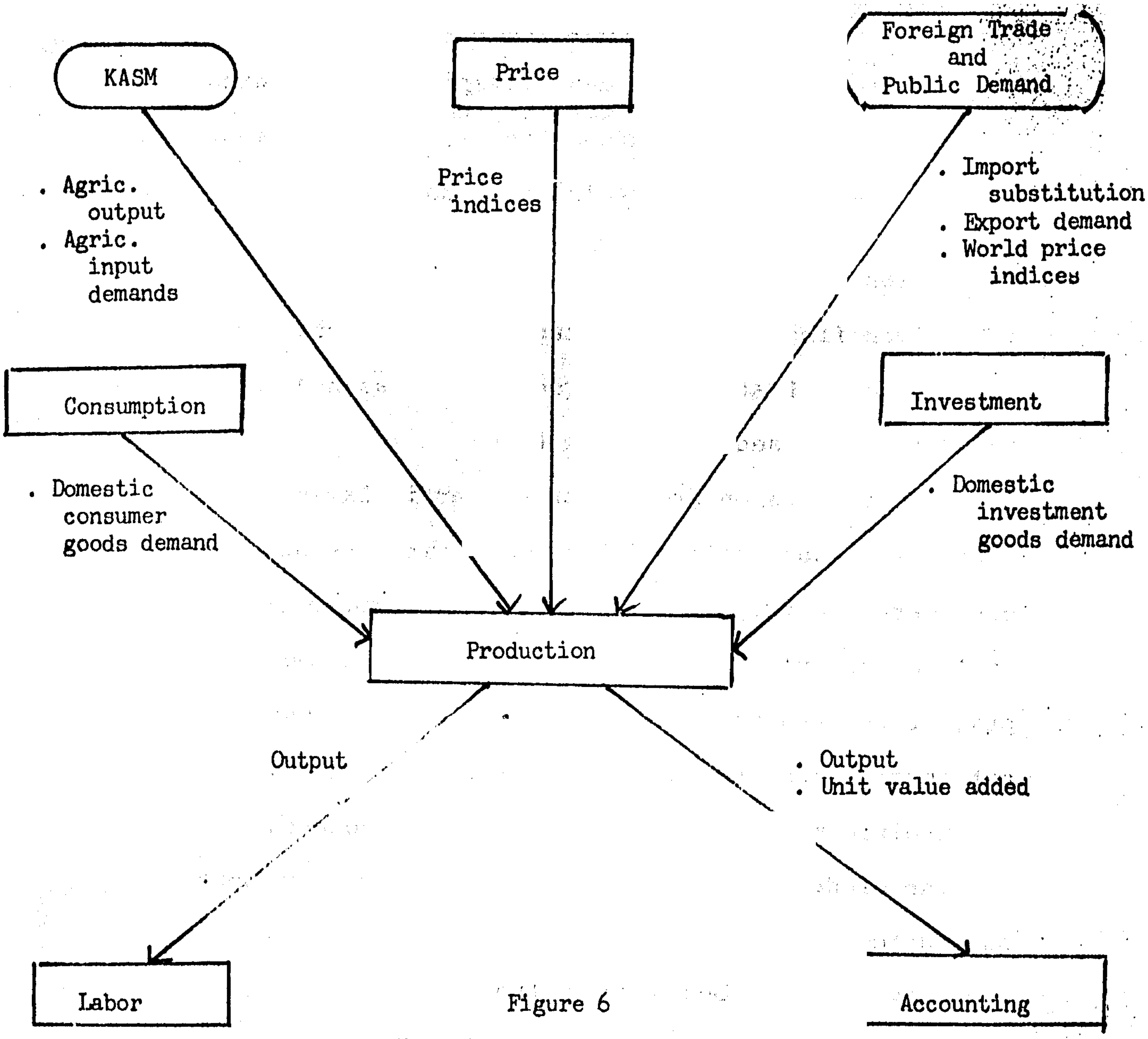

Figure 6

Inputs and Outputs of the
Production Component

whereby increasing utilization increases price which in turn decreases private consumption demand.

Final domestic demand for each sector's output is the sum of domestic consumption, investment goods demand and export demand. In the model as currently specified, it is assumed inventory changes <u>in the long run</u> sum to zero. Thus, inventory changes do not appear in the final demand vector. This assumption can be changed if necessary without too much difficulty since inventory coefficients exist[8,10]. In 1970, only about 1.5% of total output went to inventory changes[2].

$$(37)\quad FDD_i(t) = DCD_i(t) + DID_i(t) + XD_i(t) \quad \text{for } i=1,2,\ldots,16$$

where

FDD = final domestic demand at producer prices -- current won/year

DCD = domestic consumption demand at producer prices (Equation (26)) -- current won/year

DID = domestic investment goods demand at producer prices (Equation 36)) -- current won/year

XD = export demand at producer prices (Equations (39) and (43))-- current won/year.

Export demand at current producer prices, XD in (37), is derived from export demand at constant market prices, XDM in (6), by first recognizing that exports at <u>constant</u> producer prices, $\overline{XD}$, are given by

$$(38)\quad \overline{XD}_i(t) = \frac{XDM_i(t)}{1+TDMGX_i+TPMGX_i}$$

where TDMGX and TPMGX are export trade and transportation margins, respectively, in constant won of margin per constant won of export (at producer prices). To get exports at current producer prices, then,

$$(39)\quad XD_i(t) = P_i(t)\overline{XD}_i(t) = \frac{P_i(t)XDM_i(t)}{1+TDMGX_i+TPMGX_i} \quad \text{for } i\neq 12,13$$

where P is the producer price index.

Exports of trade and transportation are direct exports of those sectors plus <u>current</u> margins on exports from other sectors. Current export margins are derived from

$$(40)\quad P_i(t)\overline{XD}_i(t) = \frac{PWLD_i(t)XDM_i(t)}{1+TDX_i(t)+TPX_i(t)} \quad \text{for } i\neq 12,13$$

where TDX and TPX are <u>current</u> export trade and transportation margins, respectively. Combining (39) and (40),

$$(41)\quad TDX_i(t)+TPX_i(t) = \frac{PWLD_i(t)}{P_i(t)}(1+TDMGX_iTPMGX_i)-1 = Z_i(t).$$

Assuming for convenience that the two components of the total margin Z maintain constant relative shares of the total, we can write

$$(42)\quad TDX_i(t) = Z_i(t)\frac{TDMGX_i}{TDMGX_i+TPMGX_i}$$

$$TPX_i(t) = Z_i(t) - TDX_i(t).$$

Trade and transportation exports, then, are

$$(43)\quad XD_{12}(t) = P_{12}(t)XDM_{12}(t) + \sum_{\substack{j=1 \\ j\neq 12}}^{16} TDX_j(t)XD_j(t)$$

$$XD_{13}(t) = P_{13}(t)XDM_{13}(t) + \sum_{\substack{j=1 \\ j\neq 13}}^{16} TPX_j(t)XD_j(t)$$

where again we are assuming $TDX_{12}=TPX_{12}=TDX_{13}=TPX_{13}=0$ for all t.

For our purposes, we will assume the input-output coefficients for the 15 nonagricultural sectors (at constant prices) will not change over the time horizon of the model. Although this is certainly an unrealistic assumption, it is beyond the scope of KASS to project changes in the technological interdependence of Korean industry. If such projections are done by other researchers and made available to us, we can incorporate them into the model. In the meantime, results of our agricultural analyses will be interpreted in light of this assumption that nonagricultural technology will not change except in such a way as to leave the input-output coefficients unchanged. The fairly high degree of aggregation (16 sectors) will tend to reduce the errors introduced by this assumption relative to what they would be in a more disaggregated model. In addition, we do consider the effects of changes in relative prices, as we shall see.

The input-output coefficients for agriculture, on the other hand, will change in the model based on KASM projections.

$$(44)\quad A_{i1}(t) = \frac{AGINP_i(t)}{AGOUT(t)/P_1(t)}$$

where

A_{i1} = inputs of sector i per unit output of agriculture, at constant producer prices

AGINP = agricultural inputs at producer prices (Equation (111)) -- constant won/year

AGOUT = agricultural output at producer prices (Equation (112)) -- current won/year.

For the current version of KASM, A_{i1} is changed over time only for chemical fertilizers, other chemicals, fuels, other heavy manufacturing and other light manufacturing. The 1970 BOK coefficients are maintained for the other agricultural inputs and for the coefficients of the other sectors.

In matrix notation, output is

$$(45)\quad OUT(t) = [I-AD(t)]^{-1}FDD(t)$$

where

OUT = vector of sector outputs at producer prices -- current won/year

I = identity matrix

FDD = final demand vector at producer prices (Equation (37)) -- current won/year

AD = matrix of domestic intermediate input requirements at producer prices -- current won of input/current won of output

and where

$$(46)\quad AD_{ij}(t) = [A_{ij}(t) - PMC_{ij}(t)]\frac{P_i(t)}{P_j(t)}$$

where PMC is the matrix of total intermediate input import requirements (Equations (2) and (113)).

Finally, intermediate imports and unit value added are computed. For the former, (47) makes the conversion from producer prices to world prices, while for the latter, (48) assumes producers pay world prices for intermediate imports.

$$(47)\quad PM_i(t) = \sum_{j=1}^{16} PMC_{ij}(t)OUT_j(t)\frac{PWLD_i(t)}{P_j(t)}$$

$$(48)\quad VAU_j(t) = 1 - \sum_{i=1}^{16}\left(AD_{ij}(t) + PMC_{ij}(t)\frac{PWLD_i(t)}{P_j(t)}\right)$$

where

PM = intermediate imports at world prices -- current won/year

PWLD = world price index (Equation (5))

VAU = value added per unit output at current prices.

Labor

The labor component computes labor requirements and wages by sector and for nonagriculture in the aggregate (Figure 7).

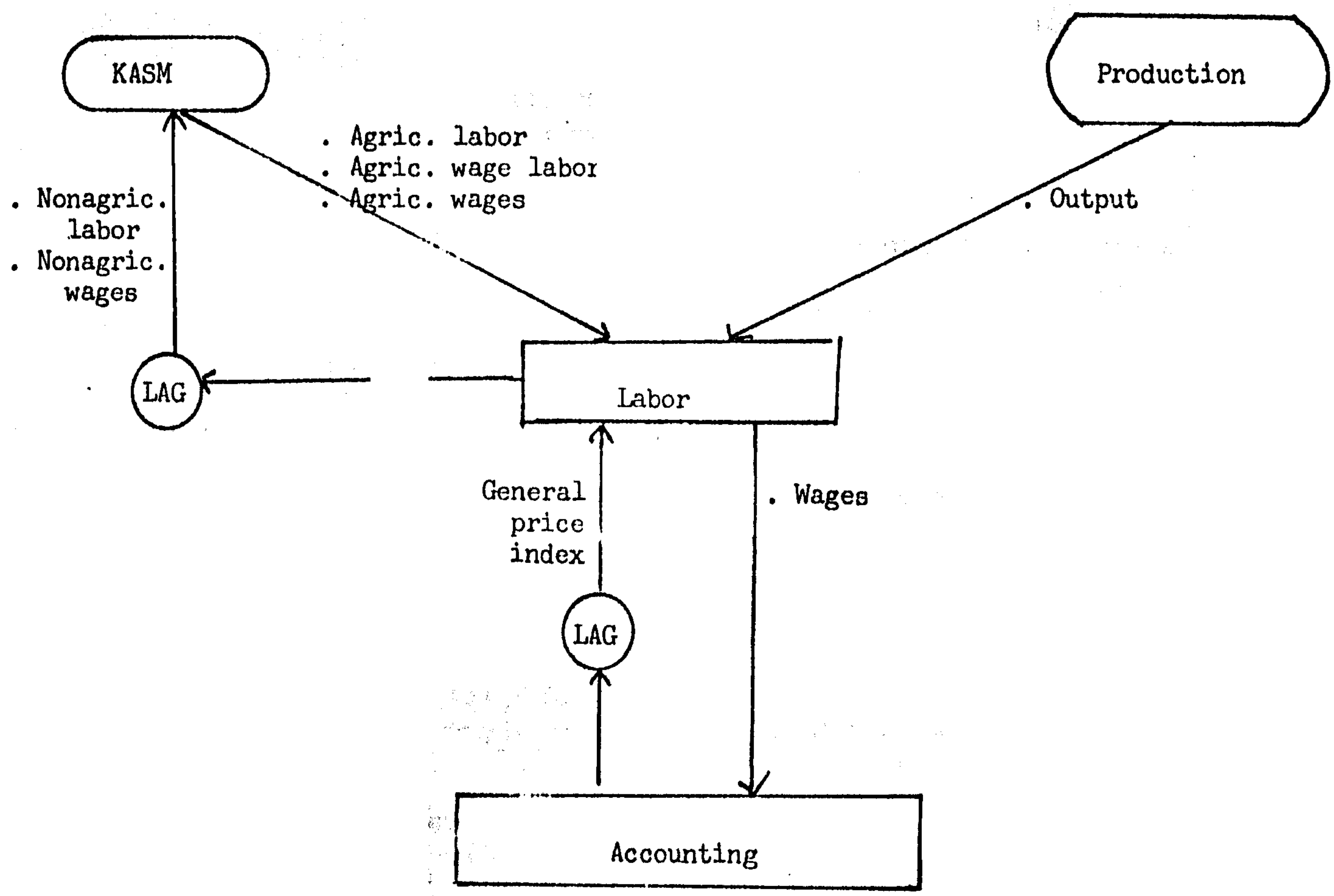

Figure 7

Inputs and Outputs of the Labor Component

Labor productivity is assumed to increase at a constant rate RL for each sector. A non-constant RL could also easily be assumed by independent projection. Thus, labor requirements per unit output are

$$(49)\quad \frac{1}{L_i(t)}\ \frac{dL_i(t)}{dt} = -RL_i \qquad \text{for } i \neq 1$$

where L is labor requirements in person-years/won. Labor requirements and the demand for wage labor, then, are

$$(50)\quad DL_i(t) = \begin{cases} L_i(t)\,OUT_i(t)/P_i(t) & \text{for } i \neq 1 \\ DLA(t) & \text{for } i = 1 \end{cases}$$

$$(51)\quad DWL_i(t) = \begin{cases} PWL_i\,DL_i(t) & \text{for } i \neq 1 \\ DWLA(t) & \text{for } i = 1 \end{cases}$$

where

DL = labor requirements -- persons

OUT = output (Equation (45)) -- current won/year

P = producer price index (Equation (57))

DWL = demand for wage labor -- persons

PWL = wage labor proportion.

Wages (including salaries, bonuses, etc.) are projected assuming real wages per unit output tend to be constant. Again, it would be easy to make other assumptions; however, it is beyond our scope to project nonagricultural wages endogenously as a function of other economic variables in the model. This would require a much more complex employment model.

$$(52)\quad WR_i(t) = \frac{DGPX(t-DT)\,WR_i(t-DT)}{1-DT\cdot RL_i} \quad \text{for } i\neq 1$$

$$(53)\quad W_i(t) = \begin{cases} WR_i(t)\,DWL_i(t) & \text{for } i\neq 1 \\ WA(t) & \text{for } i=1 \end{cases}$$

where

WR = wage rate -- current won/person-year

W = wages -- current won/year

DGPX(t) = GPX(t)/GPX(t-DT) where GPX is the general price index (Equation (76)).

DLA, DWLA and WA are agricultural labor requirements, wage labor demand and wages paid, respectively from KASM (Equations (114)-(116) below).

Finally, nonagricultural labor and wages are computed for use in the migration component of KASM.

$$(54)\quad DLN(t) = \sum_{i=2}^{16} DL_i(t)$$

$$(55)\quad WN(t) = \sum_{i=2}^{16} W_i(t).$$

Price

The price component (Figure 8) generates non-food producer and market price indices based on variable costs of production, capacity utilization, and trade and transportation margins.

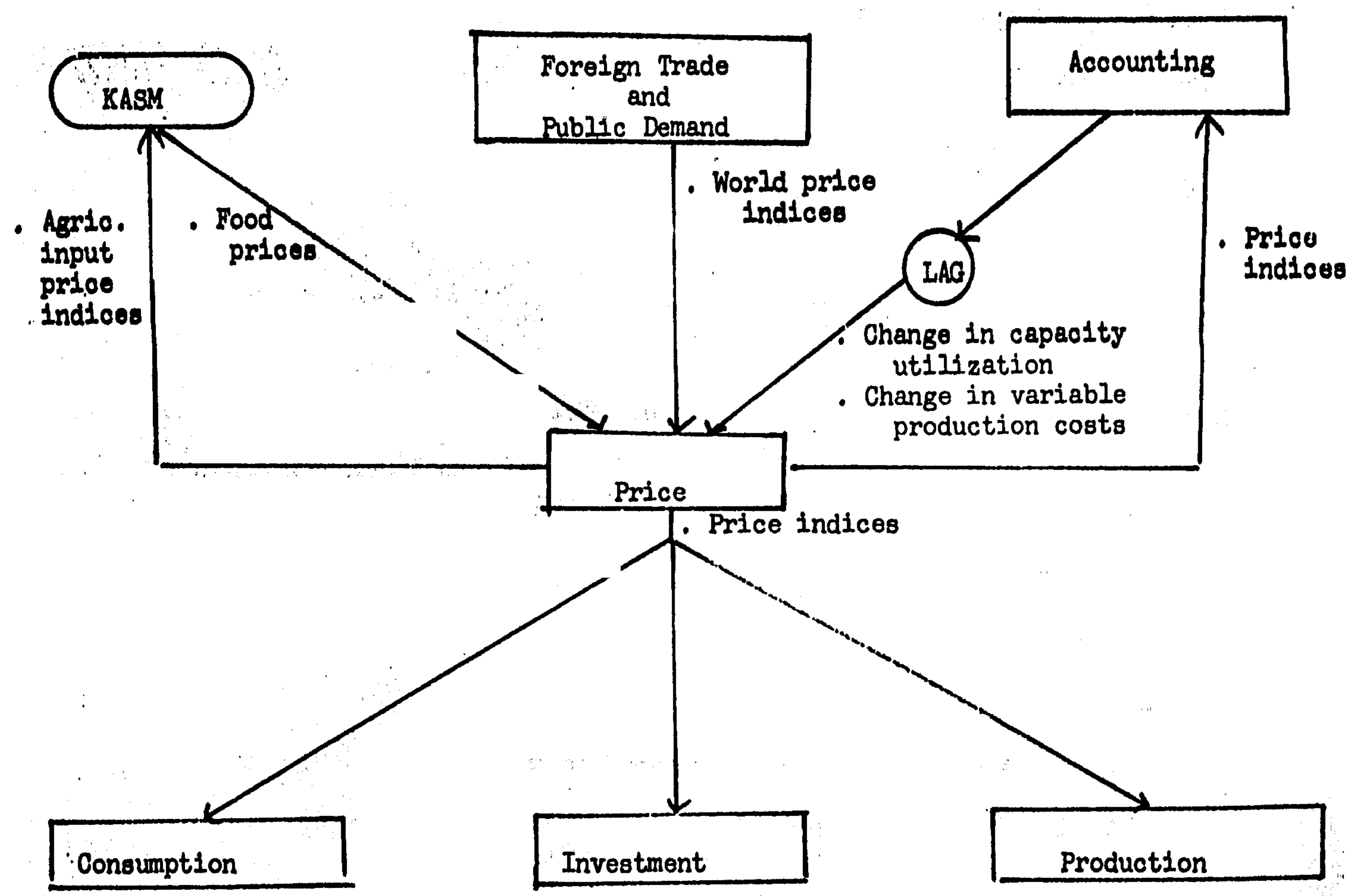

Figure 8

Inputs and Outputs of the
Price Component

Producer prices are postulated to change in response to changes in variable costs of production (a cost push factor) and to changes in capacity utilization (a demand pull factor). The latter is a demand pull factor because increasing capacity utilization implies output (i.e., demand, in this model) is increasing faster than capacity.

$$(56)\quad \frac{1}{P_i(t)}\frac{dP_i(t)}{dt} = UEP_i\frac{1}{CU_i(t)}\frac{dCU_i(t)}{dt} + CEP_i\frac{1}{COST_i(t)}\frac{dCOST_i(t)}{dt} \quad \text{for } i \neq 1,9$$

becomes in difference equation form for simulation

$$(57)\quad P_i(t+DT) = \begin{cases} \text{See Equation (118) for } i=1,9 \\ P_i(t)\,[1+DT(UEP_i PDCUL_i(t)+CEP_i PDCSTL_i(t))] \quad \text{for } i \neq 1,9 \end{cases}$$

where

- P_i = producer price index for sector i
- PDCUL = proportional rate of change of capacity utilization, exponentially averaged (Equation (94)) -- proportion/year
- UEP = capacity utilization elasticity of price
- PDCSTL = proportional rate of change of variable production costs, exponentially averaged (Equation (68)) -- proportion/year
- CEP = cost elasticity of price.

The domestic market price index for each commodity is a weighted average of the producer price indices for the commodity, for trade services and for transportation services.

$$(58)\quad MP_i(t) = \begin{cases} \dfrac{P_i(t)+P_{12}(t)TDMGC_i+P_{13}(t)TPMGC_i}{1+TDMGC_i+TPMGC_i} & \text{for } i\neq 1,9 \\ \text{See Equation (117) for } i=1,9 \end{cases}$$

where

MP_i = market price index for sector i

TDMGC, TPMGC = consumer goods trade and transportation margins, respectively.

Finally, the consumers' market price index and the investors' price index are weighted averages of the domestic market price index and the world price index, where the weights used are the consumer goods and investment goods import coefficients, respectively.

$$(59)\quad MPC_i(t) = CMC_i(t)PWLD_i(t) + (1-CMC_i(t))MP_i(t)$$

$$(60)\quad MPI_i(t) = IMC_i(t)PWLD_i(t) + (1-IMC_i(t))MP_i(t)$$

where

MPC = consumers' market price index

CMC = consumer goods import coefficients (Equation (4))

PWLD = world price index (Equation (5))

MPI = investors' market price index

IMC = investment goods import coefficients (Equation (3)).

Of course, equations (57)-(60) may be overridden if desired to test alternative price projections

Accounting

The accounting component (Figure 9) computes national accounts and other economic variables needed in other components of NECON, in KASM and as measures of system performance.

First, value added and its components for each sector are computed by (61)-(64). The indirect tax rate (net of subsidies) INTXR is -- except for agriculture, Equation (119) -- a constant policy parameter in the model; it could easily be made time varying if desired. Unit capital consumption allowance CCAU is also considered constant based on 1970 input-output data. Profits are defined as the "other value added" category of the input-output data, i.e., rents, interest, returns to entrepreneurs.

(61) $VA_i(t) = VAU_i(t)OUT_i(t)$

(62) $INTX_i(t) = INTXR_iOUT_i(t)$

(63) $CCA_i(t) = CCAU_iOUT_i(t)$

(64) $PROF_i(t) = VA_i(t)-W_i(t)-INTX_i(t)-CCA_i(t)$

where

VA	=	value added -- current won/year
VAU	=	unit value added (Equation (48))-- won value added/won output

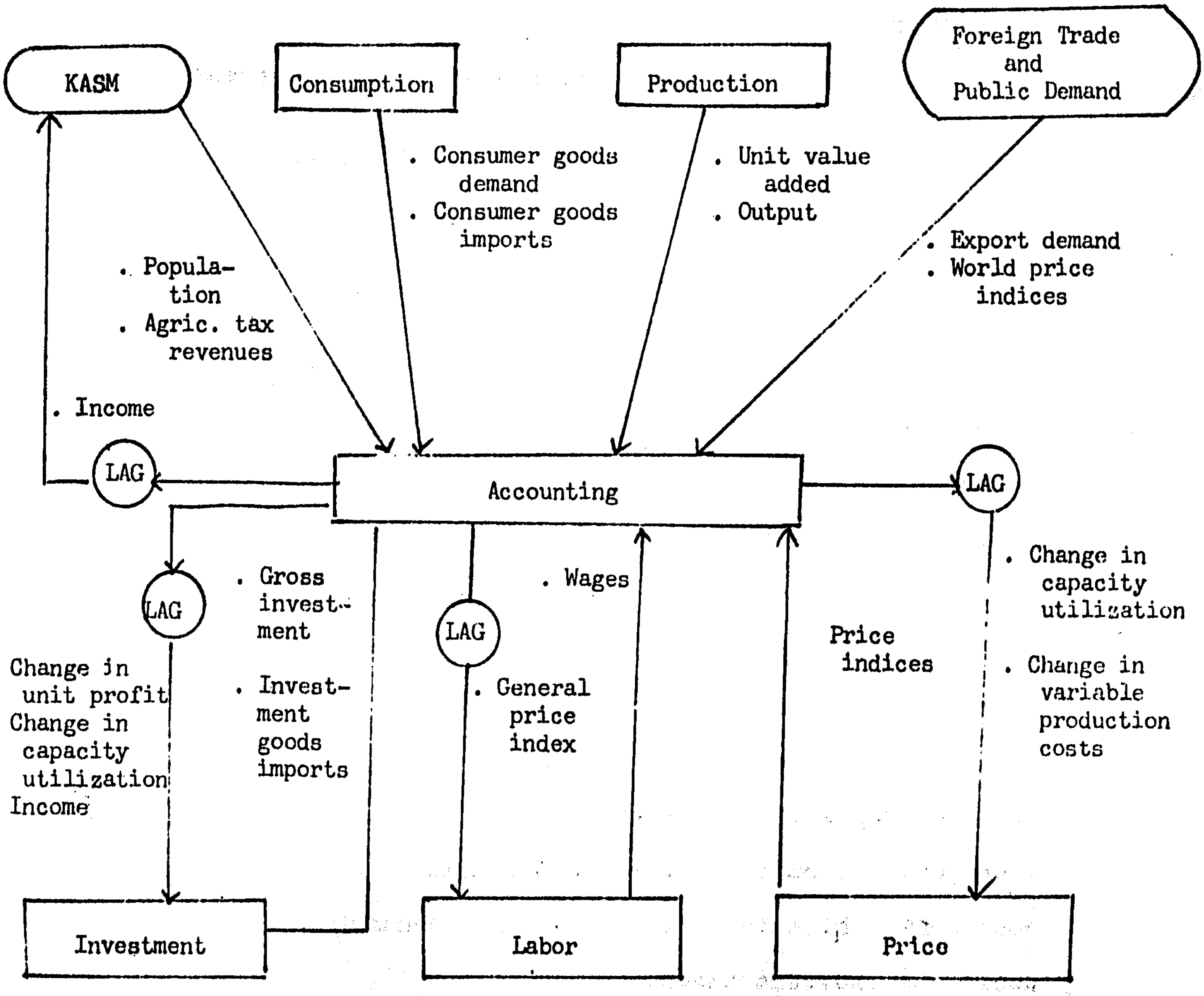

Figure 9

Inputs and Outputs of the
Accounting Component

OUT = gross output (Equation (45)) -- current won/year

INTX = net indirect taxes -- current won/year

INTXR = indirect tax rate (policy parameter)

CCA = capital consumption allowance -- current won/year

CCAU = unit capital consumption allowance

PROF = profits -- current won/year

w = wages paid (Equation (53)) -- current won/year.

The proportional rates of change of unit profits and of unit variable costs are exponentially lagged as a measure of expectation for the investment and price components, respectively (Equations (28) and (57)). Although (63) implies capital consumption is a variable cost (a commonly used formulation), in reality, considering it analogous to depreciation, it should more appropriately be treated as a function of the history of capital investment and the rates of depreciation of the various capital goods in stock. Thus, CCAU is omitted from the definition of unit variable cost COST, which is left to include intermediate inputs, wages and indirect taxes.

(65) $PPU_i(t) = PROF_i(t)/OUT_i(t)$

(66) $COST_i(t) = 1\text{-}VAU_i(t)+INTXR_i(t)+\dfrac{W_i(t)}{OUT_i(t)}$

$$(67)\quad PDEL \frac{dDPPUL_i(t)}{dt} + DPPUL_i(t) = \frac{1}{PPU_i(t)} \frac{dPPU_i(t)}{dt}$$

$$(68)\quad CDEL \frac{dPDCSTL_i(t)}{dt} + PDCSTL_i(t) = \frac{1}{COST_i(t)} \frac{dCOST_i(t)}{dt}.$$

where

PPU = unit profits -- won profits/won output

COST = unit variable costs -- won costs/won output

1-VAU = unit cost of intermediate inputs

DPPUL = exponentially lagged proportional rate of change of unit profits -- proportion/year

PDEL = lag time for unit profits -- years

PDCSTL = exponentially lagged proportional rate of change of unit costs -- proportion/year

CDEL = lag time for variable costs -- years.

Personal income is defined as wages plus profits (ignoring for our purposes the distinction between retained and distributed corporate earnings), and disposable personal income is that less income taxes, where the income tax rate YTXR is a constant policy parameter. Agricultural and nonagricultural income is converted to farm and non-farm income by assuming a time-varying proportion PFN of farm income from nonagricultural sources. PFN is projected by a table function which linearly interpolates between specified values at specified points in time; this may be treated as a policy assumption. Per capita farm and non-farm disposable income is also computed, but not shown here.

$$(69)\quad TY(t) = \sum_{i=1}^{16} W_i(t) + PROF_i(t)$$

$$(70)\quad YA(t) = W_1(t) + PROF_1(t)$$

$$(71)\quad YN(t) = TY(t) - YA(t)$$

$$(72)\quad YF(t) = \min\left[TY(t), \frac{YA(t)}{1-PFN}\right]$$

$$(73)\quad YNF(t) = TY(t) - YF(t)$$

$$(74)\quad YFD(t) = (1-YTXR)YF(t)$$

$$(75)\quad YNFD(t) = (1-YTXR)YNF(t)$$

where

TY	=	total personal income -- current won/year
YA	=	agricultural personal income -- current won/year
YN	=	nonagricultural personal income -- current won/year
YF	=	farm income -- current won/year
PFN	=	proportion of farm income from nonagricultural sources (policy variable)
YNF	=	non-farm income -- current won/year
YFD	=	farm disposable income -- current won/year
YNFD	=	non-farm disposable income -- current won/year
YTXR	=	income tax rate (policy parameter).

The food, non-food and general price indices, weighted by <u>real</u> output, are

$$(76)\quad GPX(t) = \frac{\sum_{i=1}^{16} P_i(t)\frac{OUT_i(t)}{P_i(t)}}{\sum_{i=1}^{16} \frac{OUT_i(t)}{P_i(t)}} = \frac{\sum_{i=1}^{16} OUT_i(t)}{\sum_{i=1}^{16} \frac{OUT_i(t)}{P_i(t)}}$$

$$(77)\quad FPX(t) = \frac{OUT_1(t) + OUT_9(t)}{OUT_1(t)/P_1(t) + OUT_9(t)/P_9(t)}$$

$$(78)\quad NPX(t) = \frac{\sum_{\substack{i=2\\ i\neq 9}}^{16} OUT_i(t)}{\sum_{\substack{i=2\\ i\neq 9}}^{16} \frac{OUT_i(t)}{P_i(t)}}$$

where

GPX = general price index

FPX = food price index

NPX = non-food price index

P = commodity producer price index

OUT/P = real output at producer prices -- constant won/year.

Foreign trade variables are imports, exports, trade balances and customs duties. The import tax rate is a constant policy parameter.

$$(79)\quad MD_i(t) = PM_i(t) + CM_i(t) + IM_i(t)$$

$$(80)\quad TMTX(t) = \sum_{\substack{i=2\\ i\neq 9}}^{16} TXMR_i MD_i(t) + AGTXMR(t)$$

$$(81)\ TRDBAL(t) = \sum_{i=1}^{16} [PWLD_i(t) XDM_i(t) - (1-TXMR_i) MD_i(t)]$$

where

MD = total sector imports, including customs duties -- current won/year

PM = intermediate imports (Equation (47)) -- current won/year

CM = consumption imports (Equation (25)) -- current won/year

IM = investment goods imports (Equation (35)) -- current won/year

TMTX = customs duties collected -- current won/year

TXMR = sector-specific import tax rate

TRDBAL = change in trade balance -- current won/year

PWLD = world price index (Equation (5))

XDM = exports at world prices (Equation (6)) -- constant won/year.

Total tax revenues and gross domestic product are computed in (82) and (83). GDP per capita, GDPP, is also computed but not shown here. In addition, total and per capita farm and non-farm disposable income are computed in real terms by dividing by the general price index GPX.

$$(82)\ TAXREV(t) = YTXR \cdot TY(t) + TMTX(t) + \sum_{i=1}^{16} INTX_i(t)$$

$$(83)\ GDP(t) = TMTX(t) + \sum_{i=1}^{16} VA_i(t)$$

where

TAXREV = tax revenues -- current won/year

YTXR = income tax rate (a policy parameter)

TY = total personal income (Equation (69)) -- current won/year

INTX = net indirect taxes (Equation (62)) -- current won/year

GDP = gross domestic product -- current won/year

VA = value added (Equation (61)) -- current won/year.

As a measure of economic performance, NECON computes 1-year, 5-year and 10-year annual percentage growth rates of real per capita GDP, where (84) is derived from the compound interest formula.

$$(84)\quad RGPR_n(t) = 100\left(\left(\frac{RGDPP(t)}{RGDPP(t-n)}\right)^{1/n} - 1\right)$$

where

$RGPR_n$ = n-year annual percentage growth rate of real per capita GDP -- percent/year

RGDPP = real per capita gross domestic product -- constant won/person-year.

The accounting component computes three income variables for use elsewhere in NECON and in KASM: exponentially averaged real disposable income, exponentially averaged farm and non-farm per capita disposable income, and an estimate of next period's farm and non-farm disposable income.

The residential construction function in NECON's investment component (Equation (29)) requires

$$(85)\quad YDEL\,\frac{dRTYDL(t)}{dt} + RTYDL(t) = RTYD(t)$$

where

RTYDL = exponentially averaged real disposable income -- constant won/year

RTYD = TYD/GPX = real disposable income in constant won/year, where TYD is nominal disposable income (YFD+YNFD) and GPX is the general price index (Equation (76))

YDEL = lag time -- years.

The consumption component in KASM requires exponentially averaged per capita income in the consumption function as a measure of consumer income expectations, or -- looking at it another way -- as a measure of "normal" income. This assumes that consumer behavior responds to changes in "normal" income rather than in actual income.

$$(86)\quad YDEL\,\frac{dYFDPL(t)}{dt} + YFDPL(t) = YFDP(t)$$

where

YFDPL = exponentially averaged per capita farm disposable income -- current won/person-year

YFDP = per capita farm disposable income -- current won/person-year.

Note that current income is used rather than real because the homogeneity postulate is assumed, i.e., <u>current</u> income and prices determine <u>real</u> consumption. Non-farm income

YNFDPL is computed in a similar way.

For the income constraint equation, on the other hand, actual income, rather than "normal" income, must be used. In the recursive simulation, however, income at time t is not known until after consumption is determined. That is, income depends on profits and wages (Equations (69)-(71), which in turn depend on output (Equations (50)-(53) and (61)-(64)), which depends on consumption (Equations (37) and (45)). Therefore, second-order Lagrange interpolations are used to project estimates of farm and non-farm disposable income at time (t+DT), based on income at time t, (t-DT) and (t-2DT). Essentially, we fit a parabola to pass through the three known points and extrapolate one time period for the estimate (Figure 10). The following discussion is in terms of farm disposable income YFD; the same procedure is followed for non-farm income YNFD.

For an unknown function $y = f(x)$ and given three points $(x_i, y_i) = (x_i, f(x_i))$, $i = 0,1,2$, satisfying the function, the second-order Lagrange interpolation polynomial $p(x)$ passing through those three points is given by

$$(87)\quad p(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}\, f(x_0) + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}\, f(x_1) + \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)}\, f(x_2).$$

(87) is constructed so that $p(x_i) = f(x_i)$, and $p(x)$ is then used as an approximation of the unknown $f(x)$.

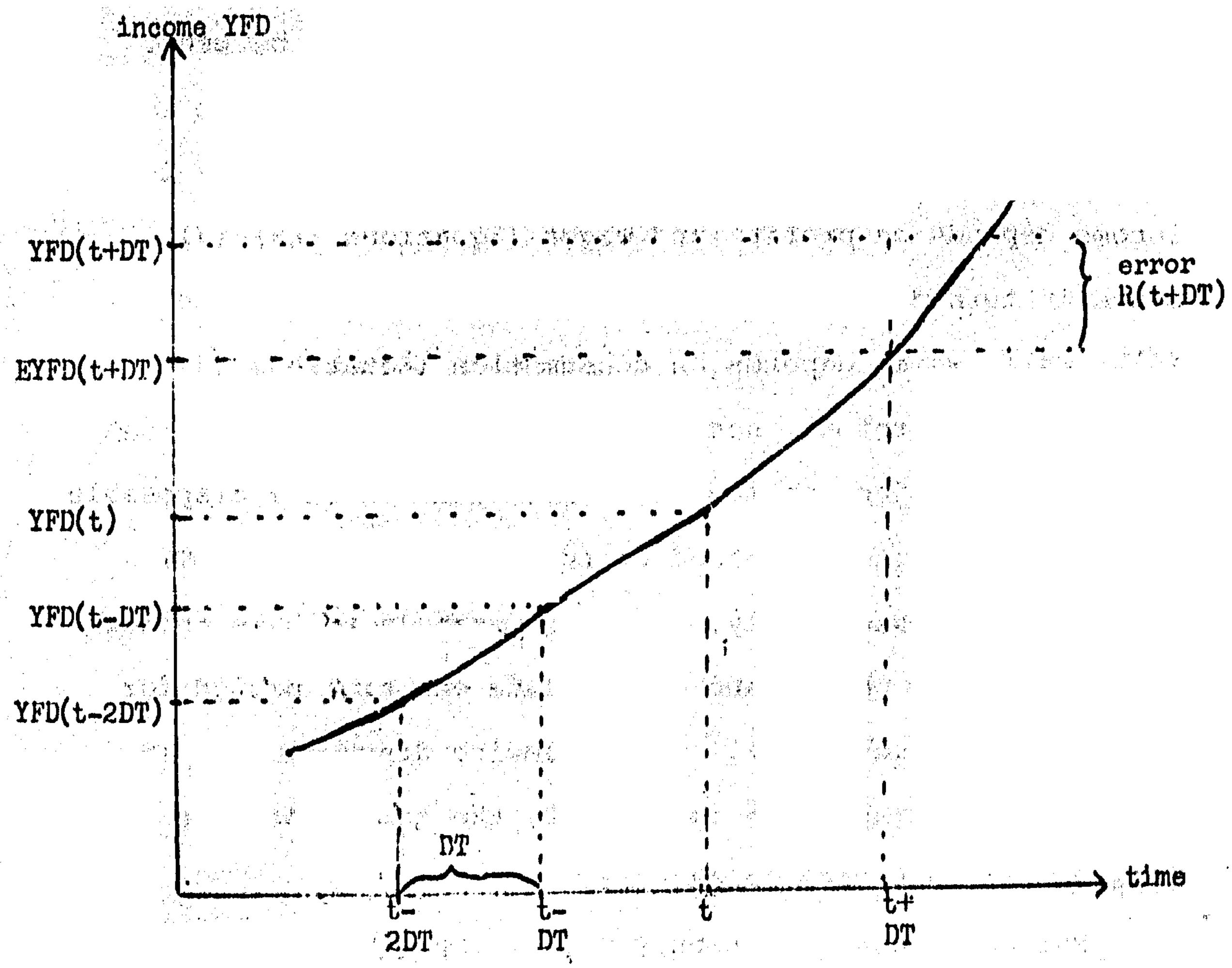

Figure 10

Using Lagrange Interpolation to Project Income

In our situation, x_0 = t-2DT, x_1 = t-DT, x_2 = t, and f(•) = YFD(•), where YFD is current farm disposable income. We are trying to project an estimation of YFD(t+DT), call it EYFD(t+DT). Therefore, x = t+DT and p(x) = EYFD(t+DT).

$$(88)\quad \mathrm{EYFD}(t+DT) = \frac{(2DT)(DT)}{(-DT)(-2DT)}\,\mathrm{YFD}(t-2DT) + \frac{(3DT)(DT)}{(DT)(-DT)}\,\mathrm{YFD}(t-DT) + \frac{(3DT)(2DT)}{(2DT)(DT)}\,\mathrm{YFD}(t)$$

$$= \mathrm{YFD}(t-2DT) + 3(\mathrm{YFD}(t)-\mathrm{YFD}(t-DT)).$$

Of course, EYFD(t) ≠ YFD(t) in general. How much of an error will there be? The error R is difficult to predict analytically; however, we do know[11] an upper bound on the magnitude of the error can be found from

$$(89)\quad |R(x)| \le \left|\frac{(x-x_0)(x-x_1)(x-x_2)}{3!}\right| \cdot \max_{\tau\varepsilon I}\left|\left.\frac{d^3\mathrm{YFD}(x)}{dx^3}\right|_{x=\tau}\right|$$

$$= DT^3 \max_{\tau\varepsilon I}\left|\left.\frac{d^3\mathrm{YFD}(x)}{dx^3}\right|_{x=\tau}\right|$$

where I is the time interval [(t-2DT), (t+DT)]. This doesn't help much either since we can't know d^3YFD(t)/dt^3 without knowing YFD(t) as an explicit function of time. (If we knew that, we wouldn't need to approximate EYFD in the first place!)

But, to get some feeling as to the magnitude of the error, let's assume YFD just happens to grow exponentially over the time period I, i.e.,

(90) $YFD(s) = YFD(s_0)e^{\alpha(s-s_0)}$ for $s \varepsilon I$

where $s_0 = t-2DT$. Then

(91) $\dfrac{d^3YFD(s)}{ds^3} = \alpha^3 YFD(s_0)e^{\alpha(s-s_0)}$ for $s \varepsilon I$

which reaches its maximum in I at the upper end of I, or when $s = x = t+DT$. So,

(92) $|R(t+DT)| \leq DT^3\alpha^3 YFD(t-2DT)e^{\alpha 3DT}$

Since $YFD(t+DT) = YFD(t-2DT)e^{\alpha 3DT}$, the proportional error PR is

(93) $PR(t+DT) = |R(t+DT)|/YFD(t+DT) \leq DT^3\alpha^3$

where α is the exponential growth rate of nominal income over the time period I, i.e., (t-2DT) to (t+DT), and DT is the simulation time increment.

Thus, with DT = 1 year as it currently is in KASM, a 20% growth rate of current income would give us at most a .8% error in our estimate of YFD(t+DT). Reducing DT by a factor of 2 would cut the error by a factor of 8. If income were growing linearly (or quadratically) over the period I rather than exponentially, (88) would give no error at all.

If we subtract the actual error at t, EYFD(t) - YFD(t), from the projection EYFD(t+DT) -- in effect treating the error as carry-over or carry-under income -- the result would be equivalent to a third-order Lagrange interpolation polynomial and would reduce the error by a factor of 5 (in this hypothetical case of 20% exponential growth).

Finally, the accounting component computes the exponentially averaged proportional rate of change of capacity utilization, PDCUL, needed for the private net investment function (28) and for the price function (57).

$$(94)\quad \mathrm{CUDEL}\frac{d\mathrm{PDCUL}_i(t)}{dt} + \mathrm{PDCUL}_i(t) = \frac{1}{\mathrm{CU}_i(t)}\,\frac{d\mathrm{CU}_i(t)}{dt}$$

where CUDEL is the lag time in years and CU is the proportion of capacity utilized (or capacity utilization rate).

Kim and Kwon[12] analyzed past levels and trends of capacity utilization rates in Korean manufacturing with the important objective of demonstrating the shortcomings of concentrating on the formation of capital stock as the key to economic growth without due regard to the potential benefits of increasing the flow of capital services. They tested various regression models for explaining capacity utilization, and achieved R^2s ranging from .57 to .76; relative factor intensity, industrial concentration and public finance were most often the most significant variables.

For our purposes, it is beyond the scope of NECON to be concerned with the problems of capacity utilization and its measurement and prediction -- of which there are many[10,12].

Han attempted to measure capacity output, but dismissed his results as unreliable. Kim and Kwon measured the utilization rate using electricity consumed relative to rated horsepower of installed machinery.

Fortunately, we do not need to know capacity utilization for NECON but only its proportional rate of change (see Equation (94)), which we can infer indirectly from other variables in the model. Defining the capacity utilization rate of sector i as

$$(95)\quad CU_i(t) = \frac{OUT_i(t)}{CO_i(t)}$$

where OUT is actual output as in (45) and CO is capacity output, then differentiating (95) with respect to time and dividing by CU, we get

$$(96)\quad \frac{1}{CU_i(t)}\,\frac{dCU_i(t)}{dt} = \frac{1}{OUT_i(t)}\,\frac{dOUT_i(t)}{dt} - \frac{1}{CO_i(t)}\,\frac{dCO_i(t)}{dt}.$$

The first term on the right can be determined directly from (45), and the second term can be derived indirectly if we assume a constant capital-<u>capacity</u> output ratio α. This is an admittedly unrealistic assumption, although more realistic than assuming (as is often done) a constant capital-<u>actual</u> output ratio. The problem is reduced even further by the fact that, as we shall see, we need not assume a specific value for α, only that one exists.

Defining capacity output, then, as

(97) $CO_i(t) = CAPSTK_i(t)/\alpha_i$

where CAPSTK is accumulated capital stock in constant won,

(98) $$\frac{1}{CO_i(t)} \frac{dCO_i(t)}{dt} = \frac{1}{CAPSTK_i(t)} \frac{dCAPSTK_i(t)}{dt}$$

where α drops out. Now, defining

(99) $$\frac{dCAPSTK_i(t)}{dt} = DCSN_i(t) - \frac{CCA_i(t)}{PIG_i(t)}$$

where

DCSN = the rate of additions to capital stock, a distributed lag (gestation) of $GIV_i(t)/PIG_i(t)$ -- constant won/year

CCA = capital consumption allowance = depreciation (Equation (63)) -- current won/year

GIV = gross investment (Equation (30), -- current won/year

PIG = investment goods price index (Equation (33)),

we can easily compute (assuming we know $CAPSTK_i(0)$) the proportional rate of change of capital stock needed for (94).

<u>KASM-NECON Interface</u>

Finally, we need a detailed specification of the links between KASM and NECON. First, agricultural variables needed by NECON.

The foreign trade and public demand component needs the world price index for agricultural commodities, APWLD

(Equation (5)); exports of processed and unprocessed agricultural commodities, AXP and AXU (Equation (6)); public consumption of processed and unprocessed agricultural commodites, AGCDPP and AGCDPU (Equation (7)); and public investment in agriculture, AGIVPU (Equation (8)).

(100) $APWLD(t) = WWP(t)/WWP(0)$

where WWP is average world price of agricultural commodities in current won/MT computed from

(101) $$WWP(t) = \frac{\sum_{i=1}^{19} |VALDEF_i(t)|}{\sum_{i=1}^{19} |DEFCIT_i(t)|}$$

where VALDEF and DEFCIT are deficits for commodity i in current won/year and MT/year, respectively, from KASM.

(102) $AXU(t) = PAXU|VALDF1(t)|$

$AXP(t) = |VALDF1(t)| - AXU(t)$

where PAXU is the proportion of agricultural exports unprocessed, and VALDF1 is the negative of agricultural exports in current won/year.

(103) $AGCDPU(t) = PACDPU \cdot PUCDAG(t)/CPFI(t)$

$AGCDPP(t) = (1-PACDPU)PUCDAG(t)/CPFI(t)$

where PACDPU is the proportion of public consumption of agricultural commodities unprocessed, PUCDAG is total public agricultural consumption in current won/year from

KASM (not in the present version), and CPFI is the consumer price index for food from KASM.

$$(104)\quad AGIVPU(t) = PUIVAG(t)$$

where PUIVAG is public investment in agriculture in constant won/year from KASM (not in the present version).

The consumption component needs per capita consumption at current market prices of unprocessed and processed agricultural commodities, $PCDM_1$ and $PCDM_9$ (Equation (14)); total expenditure on non-food commodites, APCD (Equation (15)); total farm and non-farm population, $TPOP_1$ and $TPOP_2$ (Equation (24)); and agricultural imports, AM (Equation (25)).

$$(105)\quad PCDM_{1,1}(t) = \sum_{i=1}^{19} PFU_{1i}CPU_i(t)RDEM_i(t)$$

$$PCDM_{1,2}(t) = \sum_{i=1}^{19} PFU_{2i}CPU_i(t)Q_i(t)$$

where

RDEM = farm consumption,from KASM -- MT/year

Q = non-farm consumption, from KASM -- MT/year

CPU = consumer price of food -- won/MT

PFU = proportion of food consumed unprocessed.

$$(106)\quad PCDM_{9,1}(t) = \sum_{i=1}^{19} (1-PFU_{1i})CPU_i(t)RDEM_i(t)$$

$$PCDM_{9,2}(t) = \sum_{i=1}^{19} (1-PFU_{2i})CPU_i(t)Q_i(t).$$

(107) $APCD_1(t) = TAGDIP(t)/TPOP_1(t)$

$APCD_2(t) = TEXNF(t)/TPOP_2(t)$

where TAGDIP is farm disposable income for non-food consumption and TEXNF is non-farm non-food expenditures, both from KASM and both in current won/year.

(108) $TPOP_k(t) = POP_k(t)$

where POP_k is farm (k=1) and non-farm (k=2) population from KASM.

(109) $AM(t) = VALDF2(t)$

where VALDF2 is value of agricultural imports from KASM in current won/year.

The investment component needs private net investment in agriculture, AGIVPR (Equation (28)).

(110) $AGIVPR(t) = TEXCAP(t)/PIG_1(t)$

where TEXCAP is agricultural capital expenditures, from KASM, in current won/year, and PIG_1 is the capital goods price index for agriculture (Equation (33)). This use of TEXCAP may require its redefinition in KASM.

The production component requires of KASM the value of agriculture input demands at constant producer prices, AGINP (Equation (44)); agricultural output at current producer prices, AGOUT (Equation (44)); and agricultural production import coefficients PMC (Equation (46))

$$\text{(111)}\quad AGINP_i(t) = \begin{cases} \dfrac{\dfrac{AGINT_i(t)-AGINM_i(t)}{MP_i(t)} + \dfrac{AGINM_i(t)}{PWLD_i(t)}}{1+TDMGAI_i+TPMGAI_i} & \text{for } i\neq 12,13 \\ \sum\limits_{\substack{j=1 \\ j\neq 12}}^{16} AGINP_j(t)\,TDMGAI_j & \text{for } i=12 \\ \dfrac{AGINT_{13}(t)}{MP_{13}(t)} + \sum\limits_{\substack{j=1 \\ j\neq 13}}^{16} AGINP_j(t)\,TPMGAI_j & \text{for } i=13 \end{cases}$$

where

AGINT, AGINM = total and imported agricultural inputs, respectively, at market prices -- current won/year

MP, PWLD = domestic and world market price indices (Equations (5) and (58)), respectively

TDMGAI, TPMGAI = trade and transportation margins, respectively, for agricultural inputs.

AGINT and AGINM would come from KASM, although the latter don't exist in the current version. AGINT would include, for example, TEXFRT (expenditure on fertilizer) for i=4, TEXPST (expenditure on pesticide) for i=5, FUELNM+OILNM (fuel and oil expenditures) for i=7. Other inputs can be derived from TEXOTH (expenditures on other inputs) and from variable machinery costs, livestock equipment costs, veterinary expenses, etc. For some sectors i (e.g., mining, transportation) we may want to keep the 1970 input-output coefficients as constants.

$$(112)\quad AGOUT(t) = \sum_{i=1}^{19} TPAVG_i(t)TOUTPT_i(t)$$

where TPAVG is average yearly producer price, from KASM, in won/MT; and TOUTPT is total output, from KASM, in MT.

$$(113)\quad PMC_{i1}(t) = \frac{AGINM_i(t)/PWLD_i(t)}{AGOUT(t)/P_1(t)}$$

where AGINM is, again, imports of agricultural inputs at current world prices, from KASM.

The labor component needs from KASM agricultural labor requirements, DLA (Equation (50)); wage labor demand in agriculture, DWLA (Equation (51)); and agricultural wages, WA (Equation (53)).

$$(114)\quad DLA(t) = \sum_{r=1}^{NREGN} \sum_{i=1}^{19} EMP_{ri}(t)$$

$$(115)\quad DWLA(t) = \sum_{r=1}^{NREGN} \sum_{i=1}^{19} PCTHL_{ri}EMP_{ri}(t)$$

$$(116)\quad WA(t) = TEXLAB(t)$$

where

EMP_{ri} = agricultural employment in region r and commodity i, from KASM -- man equivalents

PCTHL = proportion of labor hired, from KASM

TEXLAB = total labor expenditures, from KASM -- won/year

NREGN = number of regions considered in KASM.

The price component requires from KASM producer and market price indices for unprocessed and processed agricultural commodities, P_1, P_9, MP_1, MP_9 (Equations (57) and (58))

$$(117)\quad MP_i(t) = CPFI(t) \quad \text{for } i=1,9$$

$$(118)\quad P_i(t) = MP_i(t)(1+TDMGC_i+TPMGC_i) - P_{12}(t)TDMGC_i - P_{13}(t)TPMGC_i \quad \text{for } i=1,9$$

where CPFI is the consumer food price index, from KASM, and TDMGC and TPMGC are consumer goods trade and transportation margins, respectively. (118) is an inversion of (58).

KASM provides NECON's accounting component with agriculture's indirect tax rate (Equation (62)) and customs duties (Equation (80)).

$$(119)\quad INTXR_1(t) = TPTAX(t)/AGOUT(t)$$

$$AGTXMR(t) = ACDREV(t)$$

where TPTAX is total producer tax revenues from agriculture in current won/year, AGOUT is computed in (112) and ACDREV is revenues from agricultural customs duties.

Feedback links from NECON to KASM are related to 1) consumption and the maintenance of consistency between the two consumption components, 2) price indices of the major agricultural inputs, and 3) nonagricultural labor requirements.

The conditions for consistency between the consumption components of KASM and NECON are given above in (20) - (22). (22) was used to determine the income constraint coefficient SN in (16); here, (20) and (21) will give us the price index and own-price elasticity of the aggregate nonagricultural commodity of KASM -- CPU_{20} and $ELASP_{20,20}$, where the non-agricultural commodity is the twentieth commodity in KASM.

From (20),

$$(20) \quad \vec{MPCR}(t)AO_k(t) = AMPCR_k(t)AOF_k(t),$$

we can write (referring to the variable definitions following (18) and (19))

$$(120) \quad AMPCR_k(t+DT) \equiv AMPC_k(t+DT)/AMPC_k(t)$$

$$= \frac{\vec{MPCR}(t+DT)AO_k(t+DT)}{AOF_k(t+DT)}$$

$$= \frac{1}{APCD_k(t)} \sum_{\substack{i=2 \\ i\neq 9}}^{16} \frac{MPC_i(t+DT)}{MPC_i(t)} PCDM_{ik}(t)$$

from which we get (defining $AMPC_2(0) = 1$)

$$(121) \quad CPU_{20}(t+DT) = AMPC_2(t+DT) = AMPCR_2(t+DT)AMPC_2(t)$$

where $AMPC_2$ is the price index for the aggregate nonagricultural commodity for non-farm consumers (the current version of KASM does not compute on-farm consumption of nonagricultural commodites); MPC_i is the i^{th} commodity's consumers' market price index (Equation (59)); $PCDM_{ik}$ is per capita consumption of the i^{th} commodity by the k^{th} consumer class (farm or non-farm); and APCD, from KASM, (Equation (107)) is related to PCDM by (18).

From (21),

$$(21)\quad MPC\vec{R}(t)A1_k(t)MPC(t) = AMPCR_k(t)A1N_k(t)AMPC_k(t),$$

we can write (referring to the variable definitions following (18) and (19))

$$(122)\quad A1N_k(t+DT) \equiv AEP_k(t+DT)APCD_k(t)/AMPC_k(t)$$

$$= \frac{1}{AMPCR_k(t+DT)AMPC_k(t+DT)} \sum_{\substack{i=2\\ i\neq 9}}^{16} \frac{MPC_i(t+DT)}{MPC_i(t)} \cdot \sum_{\substack{j=2\\ j\neq 9}}^{16} PCDM_{ik}(t)EP_{ijk} \frac{MPC_j(t+DT)}{MPC_j(t)}$$

from which we get

$$(123)\quad ELASP_{20,20}(t+DT) = AEP_2(t+DT)$$

$$= \frac{1}{(AMPCR_2(t+DT))^2 APCD_2(t)} \sum_{\substack{i=2\\ i\neq 9}}^{16} PCDM_{i2}(t) \cdot \frac{MPC_i(t+DT)}{MPC_i(t)} \sum_{\substack{j=2\\ j\neq 9}}^{16} EP_{ij2} \frac{MPC_j(t+DT)}{MPC_j(t)}$$

where AEP is the own-price elasticity of the aggregate nonagricultural commodity, and EP is the price elasticity matrix.

The non-farm consumption component of KASM also requires exponentially averaged per capita income for the consumption function,

(124) INCOM(t+DT) = YNFDPL(t+DT),

and an estimated projection of per capita income for the income constraint,

(125) EINCOM(t+DT) = EYNFD(t+DT),

where YNFDPL and EYNFD are computed in (86) and (88), respectively. Likewise, the farm consumption component needs

(126) FRMY(t+DT) = YFDPL(t+DT)

and

(127) EFRMY(t+DT) = EYFD(t+DT),

where FRMY would replace GIPCA in the current version of KASM, and EFRMY would be needed if a future version considers a farm income constraint on consumption.

Agricultural input price indices, AGINPI, can be determined by

$$(128)\quad AGINPI_i(t+DT) = WD_i(t)MP_i(t+DT) + WM_i(t)PWLD_i(t+DT)$$

where the weights $WD_i + WM_i = 1$ and

$$WD_i(t) = K_1/(K_1+K_2)$$

$$WM_i(t) = 1-WD_i(t)$$

$$K_1 = \frac{AGINT_i(t)-AGINM_i(t)}{MP_i(t)}$$

$$K_2 = \frac{AGINM_i(t)}{PWLD_i(t)}$$

and where MP is the domestic market price index (Equation (58)), PWLD is the world price index (Equation (5)), and AGINT and AGINM are total and imported agricultural inputs, respectively, from KASM (see the discussion above following Equation (111)).

(128) may be used to compute indices TPPEST (pesticides), FERPI (fertilizer), TPOI (other inputs), FUPI (fuels), and other inputs corresponding to NECON sectors which later versions of KASM may define. In the case of capital inputs, we have TPCAP = PIG_1, where PIG is computed in (33). AGINPI is an aggregate of domestic and world market price indices; government price subsidy policies for farmers may be accounted as such in KASM.

Finally, the population component of KASM needs nonagricultural labor requirements to project off-farm migration:

(129) DLABNA(t) = DLN(t)

where DLN is computed in (54).

DATA NEEDS OF THE NATIONAL ECONOMY MODEL

The data needs of any model fall into three categories initial conditions, constant coefficients and policy parameters. The categories are not distinct in that policy parameters are a subset of both other categories, i.e., some are initial conditions and others are constant coefficients. Data needs of the national economy model (NECON) will be discussed by component, in the same order as in the last section, and data gathered to date will be presented.

Foreign Trade and Public Demand

Table 2 lists the data requirements of the foreign trade and public demand component of NECON.

Most of them are designated as policy parameters; however, many of these are not actually policy instruments, particularly exports and world price indices, and will more properly be projected by analysis (e.g., by EPB or KDI) than by policy assumption. Nevertheless, alternative projections may also be made and tested as policy-specified targets, e.g., the import substitution parameters, and are thus also considered "policy parameters."

Table 2

Foreign Trade and Public Demand Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. ISCF(16)	PPCP	1	proportion	proportion of 1970 level of competitive consumption imports not ultimately substituted for
2. ISCR(16)	PPCP	1	proportion/yr	decay rate of the proportion of competitive consumption imports not substituted for
3. ISIF(16)	PPCP	1	proportion	same as ISCF but for investment goods imports
4. ISIR(16)	PPCP	1	proportion/yr	same as ISCR but for investment goods imports
5. ISPF(16)	PPCP	1	proportion	same as ISCF but for intermediate imports
6. ISPR(16)	PPCP	1	proportion	same as ISCR but for intermediate imports
7. PMCT(16,16)	CP	2	won input/ won output	total intermediate import coefficients for 1970
8. PMCN(16,16)	CP	2	won input/ won output	non-competitive intermediate import coefficients for 1970
9. IMCT(16)	CP	3	proportion	total investment goods imports coefficients for 1970
10. IMCN(16)	CP	3	proportion	non-competitive investment goods imports for 1970
11. CMCT(16)	CP	4	proportion	total consumption import coefficients for 1970
12. CMCN(16)	CP	4	proportion	non-competitive consumption import coefficients for 1970

(continued)

Table 2 (con't)

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
13. VPWLD(4,14)	PPCP	5	index	world price index in 1970, 1975, 1980, 1985 — or any other specified points in time
14. VXD(4,14)	PPCP	6	constant won/ yr	exports in 1970, 1975, 1980, 1985 — or any other specified points in time
15. VCDP(4,13)	PPCP	7	constant won/ yr	public consumption in 1970, 1975, 1980, 1985 — or any other specified points in time
16. VIVPU(4,15)	PPCP	8	constant won/ yr	public investment in 1970, 1975, 1980, 1985 — or any other specified points in time

* Numbers in parentheses are vector or matrix dimensions. There are 16 sectors defined in the sector model.

** PPCP = policy parameter constant parameter
CP = constant parameter

The 1970 total and non-competitive import coefficients for intermediate inputs, investment goods and consumer goods are derived from the 1970 input-output tables of the Bank of Korea[2] (see Appendix, Tables K1-K3). If Table K1 is called TIT (table of interindustry transactions), Table K2 is TTI (table of total imports) and Table K3 is TNI (table of non-competitive imports), then for row i and column j = 1, 2, ..., 16,

$$PMCT_{ij} = TTI_{ij}/TIT_{i,27}$$

$$PMCN_{ij} = TNI_{ij}/TIT_{i,27}$$

$$IMCT_{i} = (TTI_{i,20}+TTI_{i,21})/(TIT_{i,20}+TIT_{i,21})$$

$$IMCN_{i} = (TNI_{i,20}+TNI_{i,21})/(TIT_{i,20}+TIT_{i,21})$$

$$CMCT_{i} = (TTI_{i,18}+TTI_{i,19})/(TIT_{i,18}+TIT_{i,19})$$

$$CMCN_{i} = (TNI_{i,18}+TNI_{i,19})/(TIT_{i,18}+TIT_{i,19}).$$

<u>Consumption</u>

Data needs of the consumption component are listed in Table 3.

Of the 16 sectors in NECON, private consumption of two (1 and 9) are determined in KASM (Equations (105) and (106)), and private consumption of three others (4, 12 and 14) are assumed zero for all time. Time series for the remaining eleven are being compiled from urban household

Table 3

Consumption Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. EP(11,11,2)	CP	14,123	elasticity	own-and cross-price elasticities for farm and non-farm consumers
2. EX(11,2)	CP	14,16	elasticity	expenditure elasticities for farm and non-farm consumers
3. PCDM(11,2)	IC	14,16,120, 123	current won/ person-year	per capita non-food consumption expenditures for farm and non-farm consumers
4. APCD(2)	IC	14,16,120, 123	current won/ person-year	aggregate per capita non-food consumption expenditures for farm and non-farm consumers
5. SN(2)	IC	14,16	-	income constraint coefficient
6. TDMGC(16)	CP	26,58,118	proportion	consumer goods trade margin
7. TPMGC(16)	CP	26,58,118	proportion	consumer goods transportion margin

* Numbers in parentheses are vector or matrix dimensions. There are 16 sectors defined in the sector model, 11 of which are nonagricultural sectors whose consumption is determined in this component.

** CP = constant parameter
IC = initial condition

surveys[13] and price surveys[14], from which EP and EX will be estimated and PCDM will be taken directly. Estimation for farm households is difficult since farm household surveys[15], until just recently, have not collected consumption data at a disaggregated-enough level to permit reaggregation to NECON's sectors. For the time being, therefore, we intend to use non-farm elasticities for both consumer groups.

By definition, $APCD = \sum_{\substack{i=2 \\ i \neq 9}}^{16} PCDM$; and SN will be defined to be its nominal value, 1.0, in 1970.

Trade and transportation margins for consumer goods are derived from BOK input-output data, as indicated in Table K4.

Investment

The investment component requires data listed in Table 4.

Time series are being collected from the Mining and Manufacturing Surveys[16] for estimation of PEI and CEI for the mining and manufacturing sectors of NECON (sectors 3-11). IVPR will come directly from the time series. Such detailed data does not exist for the forestry and service sectors, and agriculture is not a problem (for NECON, anyway) since agricultural private investment is determined in KASM. Parameters for these sectors will

Table 4

Investment Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. IVPR(15)	IC	28	constant won/yr	private net investment
2. PEI(15)	CP	28	elasticity	profitability elasticity of private investment
3. CEI(15)	CP	28	elasticity	capacity utilization elasticity of private investment
4. RESCON	IC	29	constant won/yr	investment in residential construction
5. RCI	CP	29	constant won/yr	residential construction intercept
6. EPRC	CP	29	elasticity	population elasticity of residential construction
7. EYRC	CP	29	elasticity	income elasticity of residential construction
8. ICOR(16,16)	CP	31	won investment/ won output change	incremental capital-output ratios
9. TDMGI(16)	CP	36	proportion	investment goods trade margin
10. TPMGI(16)	CP	36	proportion	investment goods transportation margin

* Numbers in parentheses are vector or matrix dimensions. There are 16 sectors defined in the sector model, private investment for one of which (agriculture) is determined in KASM.

** IC = initial condition
CP = constant parameter

have to be estimated from surrogate data that do exist (data series on contributions to GDP and investment do exist for the service sectors in the national income accounts[17]) and/or from guesstimates. A case could also be made for a different functional form than (28) for the service sectors. For example, for these sectors capacity output is probably not very closely tied to non-human capital investments, and so utilization of that capacity would have much less effect on investment (NECON does not model human capital investment) than in the manufacturing sectors.

Table K21 presents the time series used to estimate the residential construction function (29) and the regression results. The time series were obtained from the Economic Statistics Yearbook[18]. Although (28) calls for an exponential average of real disposable income, a one-year discrete lag of real disposable income was used in the regression.

Three estimates of incremental capital-output ratios (ICORs) by sector of origin and destination were derived from 1) K. C. Han's study[10] of capital coefficients based on the 1968 National Wealth Survey, 2) distributing B. N. Song's totals for sectors of destination[19] according to the distributions derived from 1), and 3) from an aggregation of KDI's 52-sector model[8].

From Han's study, incremental capital stocks in the mining and manufacturing sectors in 1968 by asset type (Table K11) were distributed by sector of origin (Table K13) using sector-of-origin distributions of 1968 gross capital stocks (Table K12). The ICORs for mining and manufacturing sectors were then derived (Table K14) by dividing by marginal actual output. (Han discounted his own ICOR estimates based on capacity output as unreliable. The use of actual output is alright if it can be assumed the capacity utilization rate was fairly constant during 1968.)

For the forestry sector (Table K15), I assumed assets "plants" came from forestry; "animals" from agriculture; "buildings" and "structures" from construction; "machineries," "ships" and "other transport machineries" from machinery; and "tools, instruments and fixtures" from other heavy and other light manufacturing, with an arbitrary split between the two.

For the agriculture, SOC and service sectors -- as for the forestry sector -- lacking information in Han's study on incremental capital-output ratios, I had to use average gross capital-output ratios. Redistributing capital stocks by asset type (Table K16) to capital stocks by industry of origin in a similar manner as for forestry (Table K17), average capital-output ratios were derived (Table K18). Notice that "ownership of dwellings" was excluded from ICOR estimates for the other services sector in order to be consistent with our special treatment of residential construction -- see the discussion in the previous section regarding Equations (30) and (34).

Tables K14, K15 and K18, then, are the first estimate of the ICORs. The second estimate (Table K19) uses B. N. Song's sector-of-destination totals with the sector-of-origin distribution of the first estimate. (Song's data also included textiles as a sector of origin.) The difficulty of disaggregating and reaggregating his 16 sectors to correspond with NECON's 16 sectors precluded using his sector-of-origin distributions as well. Nevertheless, I felt it important to include at least his totals to reflect his analysis beyond Han's initial study, including updating the estimates in light of industrial developments since 1968 and international comparisons.

I later had access to a report describing KDI's 52-sector model[8], from which Song derived his 16 sectors and for which Song estimated the ICORs. Aggregation to NECON's 16 sectors resulted in the third estimate (Table K20). The "total" columns of the two tables (K19 and K20) are similar, as they should be. The biggest discrepancy is the trade sector, due to difficulties of disaggregating and reaggregating -- "trade" and "other services" were a single sector in both Song's 16- and KDI's 52-sector models.

The sector-of-origin distributions, however, are quite different between the two estimates, particularly (for our purposes) for agriculture. Han's distribution (Table K19) has capital goods from agriculture and machinery evenly sharing about 75% of total agricultural investment, with construction getting about 18% of the business. KDI's estimates, on the other hand, give construction about 60%, while machinery gets about 25% and agriculture only about 12%.

It will be a simple matter to test the three estimates in the model to see how much difference there is in the results Actually, the second estimate, having the same sector-of-origin distribution as the first, is superfluous since it is only the proportional distribution rather than the total (Equation (31)) which interests us. As for agriculture, a future version of KASM treating agricultural investment in more detail -- including land and water development, mechanization and an improved livestock component -- will provide time-varying ICORs endogenously (see discussion in the previous section relating to Equation (32)), thus doing away with the need for estimates of agriculture's ICORs.

Finally, trade and transportation margins for investment goods are derived from BOK input-output data (Table K5).

Production

The production component requires data listed in Table 5.

Export trade and transportation margins are derived from BOK input-output data (Table K6).

The input-output coefficients A are derived from the 1970 interindustry transactions table TIT (Table K1) by

$$A_{ij} = TIT_{ij}/TIT_{i,27}$$

for row i and column j = 1, 2, ..., 16. The first column A_{i1} (inputs to agriculture) is an initial condition since it is recomputed from KASM outputs (Equation (44)). The input coefficients for other sectors are assumed constant (except for changes in relative prices).

Labor

Data requirements of the labor component are listed in Table 6.

Initial estimates of unit labor requirements, wage labor proportions and wage rates were derived from 1970 input-output data (Table K9). We are currently collecting time series data for the mining and manufacturing sectors[16] to verify the 1970 point estimates and to get an idea of the trend of productivity changes RL.

Table 5

**Production Component:
Data Requirements**

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. TDMGX(16)	CP	39,41,42	proportion	export trade margins
2. TPMGX(16)	CP	39,41,42	proportion	export transportation margins
3. A(16,16)	col.1:IC rest :CP	46	won input/ won output	interindustry input-output matrix

* Numbers in parentheses are vector or matrix dimensions. There are 16 sectors defined in the sector model.

** CP = constant parameter
IC = initial condition

Table 6

Labor Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. RL(15)	CP	49,52	persons/won	rate of change of unit labor requirements
2. L(15)	IC	49	person-years/won	unit labor requirements
3. PWL(15)	CP	51	proportion	wage labor proportion
4. WR(15)	IC	52	won/person-year	wage rate

* Numbers in parentheses are vector dimensions. There are 16 sectors defined in the sector model, employment data for one of which (agriculture) comes from KASM.

** CP = constant parameter
IC = initial condition

Table 7

Price Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. P(16)	IC	57	index	producer price index
2. UEP(15)	CP	57	elasticity	capacity utilization elasticity of price
3. CEP(15)	CP	57	elasticity	variable cost elasticity of price

* Numbers in parentheses are vector dimensions. There are 16 sectors defined in the sector model, price data for one of which (agriculture) comes from KASM.

** IC = initial condition
CP = constant parameter

Price

Table 7 lists data needs of NECON's price component.

The initial conditions of the price indices are, of course, $P_i(1970) = 1$. Time series data is currently being collected for estimation of the elasticities for the mining and manufacturing sectors[16]. Softer data may have to be used for the social overhead capital and service sectors.

Accounting

Data requirements of the accounting component are shown in Table 8.

Unit capital consumption allowances, net indirect tax rates and import tariff rates are derived from the 1970 interindustry transactions table TIT (Table K1) for sector $i = 1, 2, \ldots, 16$, by

$$CCAU_i = TIT_{20,i}/TIT_{23,i}$$

$$INTXR_i = TIT_{21,i} \cdot TIT_{23,i}$$

$$TXMR_i = TIT_{i,26}/(TIT_{i,25}+TIT_{i,26})$$

where the results for CCAU are given in Table K10.

The above gives 1970 indirect and import tax rates. These and the income tax rate may be changed by policy assumption, either as constants or projecting changes over time.

Table 8

Accounting Component:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. INTXR(15)	PPCP	62,66	proportion	net indirect tax rate
2. CCAU(16)	CP	63	proportion	unit capital consumption allowance
3. PDEL	CP	67	years	profitability lag time
4. CDEL	CP	68	years	cost lag time
5. VPFN(4)	PPCP	not shown	proportion	proportion of farm income from nonagricultural sources in 1970, 1975, 1980 and 1985 — or any other specified points in time
6. YTXR	PPCP	74,75,82	proportion	income tax rate
7. TXMR(15)	PPCP	80,81	proportion	import tariff rate
8. RGDPP(10)	IC	84	won/person-yr	real gross domestic product per capita, 1960–1969
9. YDEL	CP	85,86	years	income lag time
10. YFDL(2)	IC	88	won/year	farm disposable income in 1968 and 1969
11. YNFDL(2)	IC	88	won/year	non-farm disposable income in 1968 and 1969

(Continued)

Table 8 (con't)

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
12. CAPSTK(15)	IC	99	won	capital stock
13. GDEL(15)	CP	not shown	years	investment gestation delay
14. PPUL(15)	IC	67	won profits/ won output	unit profits in 1969
15. COSTL(15)	IC	68	won costs/ won output	unit variable costs in 1969

* Numbers in parentheses are vector dimensions. There are 16 sectors defined in the sector model, some of the data for one of which (agriculture) comes from KASM.

** PPCP = constant policy parameter
CP = constant parameter
IC = initial condition

The proportion of farm income deriving from non-agricultural sources may be projected by policy assumption (as a target, not a policy instrument) or as a constant or trend reflected in the farm household surveys[15].

Lag times will come more from guesstimates or model tuning than from hard data, with the possible exception of gestation delays.

Initial conditions of real per capita gross domestic product are available in national income accounts[17], while those for unit profits and variable costs may be obtained from the mining and manufacturing surveys and input-output data. Farm and non-farm disposable income will come from time series being collected for estimating demand elasticities. Initial capital stocks are available for 1968 from Han's data[10]

KASM-NECON Interface

Data requirements for the interface component may be found in Table 9.

Unprocessed agricultural exports are available from detailed export statistics[20]. Public consumption of unprocessed agricultural commodities will be assumed to be equal to the aggregate proportion for non-farm consumers, where the latter is derived for each commodity from urban household surveys[13] (Table K7). Farm household surveys[15] have not been as detailed in their commodity breakdowns, as have the urban surveys, until 1973. When that data is

Table 9

KASM-NECON Interface:
Data Requirements

Symbolic Name*	Type**	Equation Numbers	Unit	Definition
1. PAXU	CP	102	proportion	proportion of agricultural exports unprocessed
2. PACDPU	CP	103	proportion	proportion of public food consumption unprocessed
3. PFU(2,19)	CP	105,106	proportion	proportion of food consumed unprocessed by farm and non-farm populations
4. TDMGAI(16)	CP	111	proportion	agricultural inputs trade margins
5. TPMGAI(16)	CP	111	proportion	agricultural inputs transportation margins
6. AMPC(2)	IC	121	index	aggregate non-food consumers' price index for farm and non-farm consumers

* Numbers in parentheses are vector and matrix dimensions. There are 16 sectors defined in the sector model and 19 agricultural commodities defined in KASM.

** CP = constant parameter
IC = initial condition

available, they will be used to estimate farm unprocessed food consumption (Table K8 -- not yet available). Until then, non-farm proportions will be used.

Trade and transportation margins for agricultural inputs (Table K22) were derived from the 1970 input-output data; and, of course, the initial price indices must be 1.

SUMMARY AND CONCLUSION

We have looked at the broad outlines of a national economy sector model (NECON) designed to link Korean agriculture and nonagriculture for agricultural sector analysis. Specifically, it will operate as a component of the Korean agricultural sector model (KASM). Seven model components project exports, public demand, investment, consumption, output, employment and prices for 16 economic sectors. One of the sectors, agriculture, is treated in greater detail in KASM, and aggregate results are fed into NECON where interactions with nonagricultural sectors -- particularly food processing, agricultural inputs, non-farm food demand and nonagricultural labor requirements -- are considered.

We have also examined in depth how NECON operates -- how the seven components are linked; the equations, underlying assumptions, strengths and weaknesses of each component; and the specific links with KASM variables.

In addition, I have indicated areas where NECON can benefit from results of research outside the scope of the KASS project but within the purview of other research institutions in Korea, particularly projections of world prices and export demands for the 15 nonagricultural sectors; projections, reflected in the input-output coefficients, of changing technological interrelationships among the non-agricultural sectors; and, of course, improvement in the model's data base.

Which brings us to the final area covered: NECON's data requirements. These were presented in eight tables categorizing data needs into initial conditions, constant parameters and policy parameters. I discussed in detail the data sources used and being used, and included 22 tables of data collected to date (Appendix).

It remains to computerize the model, test it independently, link it with KASM, and test the overall linked model. Included in this is completion of the data collection effort, i.e., estimation of the consumption, investment and price functions.

When operational, the agricultural sector model linked to the national economy model will be a valuable tool in the hands of Korean agricultural researchers, planners and decision makers in the National Agricultural Economics Research Institute, in the Ministry of Agriculture and

Fishery and in the Economic Planning Board. Not only will it provide a laboratory for experimenting with alternative agricultural policies and programs at the sector level, but it will also help avoid some of the pitfalls of planning for agriculture in isolation from important interactions with the rest of the economy -- important considerations in national planning efforts.

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APPENDIX TABLES

TABLE K1

KOREAN INTERINDUSTRY TRANSACTIONS TABLE, 1970

INPUTS \ OUTPUTS		AG 1	FOR 2	MIN 3	CHF 4	OCH 5	MA 6	FU 7	OHM 8	FP 9	TX 10	OLM 11	TRD 12	TS 13	CON 14	UT 15	OS 16	Total intermed. output 17
1. Agriculture	AG	70.0723	0.0983	0.0034	0.0013	0.3575	0.0108	0.0079	0.3762	136.9518	33.1467	4.1617	0.1370	0.0103	4.5562	0.0002	22.3068	272.1984
2. Forestry	FOR	29.4272	4.2226	1.3297	0.0035	6.0720	0.0677	-	44.1148	0.4907	0.0042	0.3040	-	0.0001	4.0902	0.0060	2.9776	87.1103
3. Mining	MIN	0.2944	0.1707	0.1039	2.0474	1.6050	0.3813	60.6880	16.6012	0.8290	0.1064	0.1096	0.1646	0.0181	9.5876	2.3141	1.0868	96.1081
4. Chem. fert.	CHF	29.3552	0.3347	-	0.1295	0.0336	-	0.0003	0.4678	0.0448	0.0015	0.0050	-	-	0.0326	-	0.2048	30.6148
5. Other chem.	OCH	8.5451	0.5993	2.0966	1.9856	46.2474	4.6567	1.5591	13.0892	7.9229	44.5496	14.7924	1.1877	0.8451	8.4062	0.4073	18.3259	177.2201
6. Machinery	MA	2.8449	0.0766	1.1233	0.1509	0.5844	45.6281	0.9670	2.2786	1.6106	2.1453	0.5489	1.6880	22.4202	30.5439	2.3736	6.0859	121.3702
7. Fuels	FU	3.9937	0.8140	0.8235	5.1996	1.4443	1.9592	1.7467	7.5471	2.6603	2.6477	0.7555	3.7257	28.5588	6.8727	8.3811	10.6036	88.9935
8. Other heavy man.	OHM	5.0583	0.9185	1.5748	1.9463	6.3392	39.8295	0.9109	114.5911	14.8609	3.3766	17.7005	6.5875	7.4408	156.4453	0.6020	9.7024	367.8856
9. Food processing	FP	42.8932	0.0149	-	0.3144	4.0642	0.0183	0.0004	0.4147	55.6668	0.3602	2.3833	0.1835	-	0.0098	0.0064	43.2290	149.7563
10. Textiles	TX	5.8304	0.0447	0.1329	0.2020	0.5929	0.6157	0.1829	3.5047	1.5749	139.6899	2.6456	2.5227	1.0334	0.3449	0.2290	7.4564	166.6040
11. Other light man.	OLM	1.8535	0.5253	0.3152	0.0732	0.5484	0.6296	0.0974	0.9382	4.2734	1.7377	7.2346	2.5699	0.9816	0.4522	0.9199	10.2373	41.4164
12. Trade	TRD	14.2718	0.6535	1.3654	1.1602	10.7462	12.9870	6.9964	20.4206	29.9039	26.6721	8.1960	4.9296	12.1313	28.6986	2.4532	25.2836	207.1754
13. Transp. & strg.	TS	5.7201	0.2986	0.5793	0.6627	4.7260	2.5914	8.1505	12.7584	6.9532	2.6270	2.3463	9.3914	8.1272	18.8931	2.2331	11.3024	97.3257
14. Construction	CON	0.6926	0.0227	0.1706	0.0231	0.1121	0.1003	0.0952	0.1849	0.2210	0.1792	0.1259	1.8775	0.7840	0.4987	1.2243	24.7112	31.3225
15. Utilities	UT	0.4370	0.0047	2.3268	3.8054	3.2332	2.3007	0.8870	13.8303	6.1249	6.2596	1.7389	6.4756	1.9838	0.7594	1.8706	12.7950	64.8639
16. Other services	OS	27.4641	0.8029	3.4728	1.5658	10.5923	10.3329	3.8295	16.7201	13.8311	13.9724	8.9865	41.0750	19.7910	24.1218	4.5898	81.8044	278.9583
28. Total intermed. inputs		246.7730	8.7923	15.4452	19.5699	91.3037	122.1293	86.1202	270.0377	287.9223	277.3124	72.3047	82.5167	104.1267	294.3242	27.6050	296.1831	2298.6235
29. Wages		72.2325	25.2342	26.3302	3.2223	17.0975	24.4792	3.7217	42.3326	44.2600	52.2904	22.9261	73.7908	67.4269	127.0654	20.9482	348.4297	950.6032
30. Other value added		534.1159	20.9966	14.2381	6.3158	18.1082	18.4214	9.5795	35.2189	59.1572	33.0663	20.9592	297.1945	48.5296	53.6132	28.6259	208.2786	1426.4803
31. Capital consumption		10.2877	0.3579	5.2952	3.3027	6.4523	4.2757	4.4705	11.0751	4.9900	6.0599	1.5638	16.1430	32.9536	4.9765	9.8547	19.0640	141.4846
32. Indirect taxes less subs.		3.3577	0.0235	0.2989	-0.4641	5.5693	11.0772	22.8562	6.8069	64.2634	9.2147	1.1219	22.8968	18.1034	5.2379	8.6150	30.4082	209.6734
33. Total value added		620.1522	56.6272	46.1624	12.8637	47.2253	58.3243	42.6667	95.3443	164.6746	100.6319	46.8760	410.0231	167.5155	180.8930	68.0460	606.2405	2728.2435
34. Total inputs		866.9692	65.4191	61.4406	32.4358	138.5295	180.4258	128.7871	365.4228	452.5968	378.1434	119.1807	492.5398	271.6422	475.1972	95.6556	902.4236	5026.8670

INPUTS \ OUTPUTS		Consumption: Private 18	Consumption: Public 19	Investment: Private 20	Investment: Public 21	Change in inventory 22	Exports 23	Total final demand 24	Imports (-) 25	Custom duties (-) 26	Total output 27
1. Agriculture	AG	642.0863	1.0629	2.3571	0.0100	31.5568	24.6647	701.7578	103.9685	2.3965	866.9692
2. Forestry	FOR	12.1237	0.3842	17.8637	-	-7.1823	0.0775	23.2668	43.6263	1.3347	65.4191
3. Mining	MIN	2.3383	0.2315	-	-	-0.0387	12.1496	14.6807	47.0611	2.2171	61.4406
4. Chem. fert.	CHF	-	0.0972	-	-	1.4122	1.7309	3.2403	1.4194	0.0001	32.4358
5. Other chem.	OCH	43.5312	2.0946	-	-	6.2973	3.6162	55.5393	78.7434	15.4865	138.5295
6. Machinery	MA	16.1652	1.9732	190.0890	17.6540	11.2407	16.9321	254.0562	179.3110	15.6456	180.4258
7. Fuels	FU	29.2890	4.4545	-	-	1.1738	8.6328	43.5501	3.0080	0.7485	128.7871
8. Other heavy man.	OHM	15.0855	1.9979	2.4342	0.3751	10.8392	48.7284	79.1603	90.1459	11.4772	365.4228
9. Food processing	FP	308.9399	2.3337	-	-	6.5344	16.8395	334.6515	28.0340	3.7770	452.5968
10. Textiles	TX	134.9823	0.3362	0.6371	0.0236	5.3330	99.9404	241.2526	29.0373	0.6799	378.1434
11. Other light man.	OLM	45.3354	5.0884	1.8951	0.8282	0.3506	37.4906	90.9883	11.0747	2.1493	119.1807
12. Trade	TRD	232.9856	2.8323	23.9098	1.6503	4.9853	19.4524	285.8157	0.4513	-	492.5398
13. Transp. & strg.	TS	127.2116	6.2121	0.8430	0.1038	1.4238	41.0497	176.8440	2.5275	-	271.6422
14. Construction	CON	-	8.7370	269.4271	158.3079	-	7.7027	444.1747	-	-	475.1972
15. Utilities	UT	23.2778	4.1928	-	-	-	4.0272	31.4978	0.7061	-	95.6556
16. Other services	OS	359.9744	244.6685	-	-	-	32.9599	637.5928	11.9557	0.3718	902.4236
28. Total intermed. inputs		1993.3252	286.6970	509.1521	178.9529	73.9301	376.0046	3418.0629	613.0702	56.7452	5026.8670

Source: Derived from Bank of Korea, "1970 Input Output Tables," Table I-1.

Unit: Billion Won

TABLE K2

KOREAN INTERINDUSTRY TOTAL IMPORTS TABLE, 1970

INPUTS \ OUTPUTS		AG 1	FOR 2	MIN 3	CHF 4	OCH 5	MA 6	FU 7	OHM 8	FP 9	TX 10	OLM 11	TRD 12	TS 13	CON 14	UT 15	OS 16	Total 17	Private Consumption Expenditure 18	Government Consumption Expenditure 19	Private Fixed Cap Formation 20	Government Fixed Cap Formation 21	Change in Stocks 22	Total Final Demand 23	(Less) Import 24	(Less) Custom Duties 25
1. Agriculture	AG	.7704	-	-	-	.0437	-	-	.1660	30.0716	23.2835	.2015	-	-	-	-	.4351	54.9748	47.9957	.0491	.2200	-	3.7274	51.9922	103.9685	2.9985
2. Forestry	FOR	-	.0485	.2783	-	.0470	.0023	-	42.0494	.0280	.0014	.2607	-	-	1.3605	-	-	44.0761	.3646	.0378	.2513	-	.2282	.8819	43.6263	1.3317
3. Mining	MIN	.0149	.0070	.0111	1.8599	.5615	.1928	42.1511	4.5050	.0599	-	.0343	-	-	.1320	.0015	.1104	49.6724	.4486	.0004	-	-	-.8122	-.3632	47.0611	2.2471
4. Chem. fert.	CHF	1.0808	.0004	-	.0945	-	-	-	.0540	.0147	-	.0011	-	-	-	-	-	1.2535	-	-	-	-	.1660	.1660	1.4296	.0001
5. Other chem.	OCH	.4703	.0280	.2672	1.6983	36.9817	1.6462	1.2012	8.3184	2.9475	20.7951	10.1750	.2210	.1183	1.2249	.1825	4.4510	90.5866	1.0066	.2276	-	-	2.4091	3.5433	78.7434	15.3865
6. Machinery	MA	.7410	-	.2558	.0257	.0632	30.0032	.1028	.6801	.1718	.4084	.2094	.2669	6.8578	13.7929	.9357	1.6799	56.1056	2.3311	.6101	120.9844	9.5724	5.3930	138.8920	179.3110	15.6456
7. Fuels	FU	.0501	-	.0226	.0136	.1208	.1779	.0817	.8692	.0913	.0898	.0316	.0541	.7055	.3354	.0610	.1998	2.9034	.4052	.1529	-	-	.2950	.8531	3.0080	[illegible]
8. Other heavy man.	OHM	.5905	.0856	.2423	.0737	1.4140	10.2239	.3452	53.0406	2.2331	.7837	1.9298	.4140	.2728	26.2555	.0318	1.1981	99.0356	.9015	.1022	.1870	.0739	1.3229	2.5875	90.1459	11.4772
9. Food processing	FP	5.3472	-	-	-	3.1721	-	-	.0740	13.3946	-	1.1855	-	-	-	-	.5408	23.7142	5.8414	.0845	-	-	2.1709	8.0968	28.0340	3.7770
10. Textiles	TX	.0738	-	-	.0220	.0396	.0511	-	.4965	.0211	25.7728	.2816	.2400	.0343	.0020	-	.6006	27.6554	1.3676	.0006	.0162	.0062	.6673	2.0578	29.0373	.6759
11. Other light man.	OLM	.0005	-	-	.0084	.0692	.0835	-	.0524	.0334	.4919	2.9570	.1453	.0571	.0021	.0290	1.7827	5.7225	4.4054	.8164	1.3759	.6337	-.3351	7.5015	11.0747	2.1493
12. Trade	TRD	-	-	-	-	-	-	-	-	-	-	-	.4513	-	-	-	-	.4513	-	-	-	-	-	-	.4513	-
13. Transp. & strg.	TS	-	-	-	-	.0057	.0142	-	.0063	-	.0135	.0363	.6103	.1517	-	.2864	.2658	1.3902	.3102	.8271	-	-	-	1.1373	2.5275	-
14. Construction	CON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Utilities	UT	.0054	-	-	-	.0013	.0004	-	.0001	.0002	.0002	.0208	.0599	.0167	-	-	.0580	.1630	.2268	.3163	-	-	-	.5431	.7061	-
16. Other services	OS	1.2226	.0334	.1055	.0347	.0594	.2316	.0487	.3244	.3425	.2363	.1529	1.0849	2.1234	.5891	.0363	3.5003	10.1290	2.2065	1.7920	-	-	-	3.9985	13.9557	.1718
26. Total interm.l. input		10.3855	.2029	1.0128	3.8308	42.5792	42.6301	43.9317	110.4664	49.4327	71.8756	17.4775	3.5477	10.3176	43.6944	1.5642	24.8825	467.8326	67.8112	5.0670	123.0347	10.2912	15.8027	221.9868	633.0702	[illegible]

56.7

Source: Derived from Bank of Korea, "1970 Input Output Tables," Table I-3.

Unit: Billion Won

TABLE K3

INTERINDUSTRY COMPLEMENTARY IMPORT TRANSACTIONS TABLE FOR 1970
(CIF + Custom Duties)

INPUTS \ OUTPUTS		AG 1	FOR 2	MIN 3	CHF 4	OCH 5	MA 6	FM 7	OHM 8	FP 9	TX 10	OLM 11	TRD 12	TS 13	CON 14	UT 15	OS 16	Total Intermediate Demand 17	Private Consumption Expenditure 18	Government Consumption Expenditure 19	Private Fixed Capital Formation 20	Government Fixed Capital Formation 21	Increase in Stocks 22	Total Final Demand 23	Total Demand 24	(Less) Imports 25	(Less) Custom Duties 26	Total Supply 27
1. Agriculture	AG					.0349			.0090	.9715	22.9161	.0005					.1715	24.1035	.3062				2.2283	2.5345	26.6380	24.9624	1.6756	26.6380
2. Forestry	FOR					.0706	.0023		39.1932		.0014	.2103						39.4078					.2282	.2282	39.6360	38.7105	.9255	39.6360
3. Mining	MIN			.0011	1.0584	.2120	.0168	42.1506	.1580	.0016		.0084				.0015		44.4376					-.8312	-.8312	43.6064	41.7352	1.8712	43.6064
4. Chem. fert.	CHF	.7798			.0945							.0011						.8754					.1590	.1590	1.0344	1.0343	.0001	1.0344
5. Other chem.	OCH	.2003		.1640	1.6436	29.3741	.6839	1.1657	5.5325	1.6366	2.5301	1.1885		.0003	.1551	.1057	3.2100	46.6214	.3356	.1360			2.1184	2.5900	49.2114	39.4509	9.7605	49.4114
6. Machinery	MA						25.1887	.0257	.0601	.0013		.0166	.0214	4.9077	3.3221	.4472	.3179	24.3387	.0206	.1238	21.9815	1.3694	.9089	24.4072	48.7459	44.9553	3.7906	48.7459
7. Fuels	FU					.0509	.0274	.0424	.0028	.0831		.0023				.0001		.2090							.2090	.1554	.0536	.2090
8. Other heavy man.	OHM					.5656	.1624		12.1412			.0434			.0012		.0569	12.9707		.0082		.0029	.5223	.5334	13.5041	12.0612	1.4429	13.5041
9. Food processing	FP					2.9770			.0077	7.9318		.0002						10.9167					2.0752	2.0762	12.9929	10.7468	2.2461	12.9929
10. Textiles	TX										.1201							.1201		.0006	.0053	.0062	.0134	.0255	.1456	.1424	.0032	.1456
11. Other light man.	OLM						.0256					.2066		.0012			.1283	.3617		.0175	.5140	.1536		.6851	1.0468	.8131	.2337	1.0468
12. Trade	TRD																											
13. Transp. & strg.	TS																											
14. Construction	CON																											
15. Utilities	UT																											
16. Other services	OS																											
17. Total intermed. input		.9801		.1651	3.5965	32.2441	26.1071	43.3854	57.1045	10.6261	25.5677	1.7079	.0214	4.9092	3.4784	.5545	3.9146	204.3626	.6624	.2861	22.5038	1.5321	7.4235	32.4079	236.7705	214.7683	22.0022	236.7705

Table K4

Consumer Goods Trade and Transportation Margins (1970)

1 Sector	Consumer Goods Demand m ₩/yr CD(1970)	3 Trade Margin m ₩/yr	4 Transp. Margin m ₩/yr	5 Unit Trade Margin TDMGC	6 Unit Transp. Margin TPMGC
1. AF	643,149.2	71,358.4	9,908.8	.1111	.0154
2. FOR	12,507.9	294.6	81.4	.0236	.0065
3. MIN	2,569.8	215.6	224.2	.0839	.0872
4. CHF	97.2	11.8	7.2	.1214	.0741
5. OCH	45,625.8	14,992.0	603.2	.3286	.0132
6. MA	18,138.4	4,193.8	80.5	.2312	.0044
7. FU	33,743.5	7,142.4	2,415.0	.2117	.0716
8. OHM	17,083.4	5,792.4	880.9	.3391	.0516
9. FP	311,273.6	77,109.4	4,734.3	.2477	.0152
10. TX	135,318.5	41,958.9	675.5	.3101	.0050
11. OLM	50,423.8	12,699.8	878.7	.2519	.0174
12. TRD	235,817.9	–	–	0	0
13. TS	133,423.7	–	–	0	0
14. CON	8,737.0	0	0	0	0
15. UT	27,470.6	0	0	0	0
16. OS	604,642.9	48.8	4.7	.0001	.0000
Total	2,280,023.2	235,817.9	20,494.4	.1034	.0090

Source: Columns 2-4: derived from Bank of Korea, "1970 Input Output Tables"
Column 2 -- Table I-1 (col. 57 + col. 58)
Column 3*-- Table V-2 (col. 57 + col. 58)
Column 4*-- Table V-1 (col. 57 + col. 58)
Column 5*: Column 3/Column 2
Column 6*: Column 4/Column 2

* Except rows 12 and 13.

Table K5

Investment Goods Trade and Transportation Margins (1970)

1 Sector	2 Investment Goods Demand m ₩/yr ID(1970)	3 Trade Margin m ₩/yr	4 Transp. Margin m ₩/yr	5 Unit Trade Margin TDMGI	6 Unit Transp. Margin TPMGI
1. AG	2,367.1	14.8	8.2	.0063	.0035
2. FOR	17,863.7	43.9	21.8	.0025	.0012
3. MIN	0	0	0	0	0
4. CHF	0	0	0	0	0
5. OCH	0	0	0	0	0
6. MA	207,739.0	24,143.6	604.3	.1162	.0029
7. FU	0	0	0	0	0
8. OHM	2,509.3	647.1	275.3	.2579	.1097
9. FP	0	0	0	0	0
10. TX	660.7	145.7	2.1	.2205	.0032
11. OIM	2,723.3	565.0	35.1	.2075	.0129
12. TRD	25,560.1	-	-	0	0
13. TS	946.8	-	-	0	0
14. CON	427,735.0	0	0	0	0
15. UT	0	0	0	0	0
16. OS	0	0	0	0	0
Total	688,105.0	25,560.1	946.8	.0371	.0014

Source: Columns 2-4: derived from Bank of Korea, "1970 Input Output Tables"
Column 2 -- Table I-1 (col. 59 + col. 60)
Column 3*-- Table V-2 (col. 59 + col. 60)
Column 4*-- Table V-1 (col. 59 + col. 60)
Column 5*: Column 3/Column 2
Column 6*: Column 4/Column 2

* Except rows 12 and 13.

Table K6

Export Trade and Transportation Margin (1970)

1 Sector	2 Exports m ₩/yr XD(1970)	3 Trade Margin m ₩/yr	4 Transp. Margin m ₩/yr	5 Unit Trade Margin TDMGX	6 Unit Transp. Margin TPMGX
1. AG	24,684.7	1,028.6	224.0	.0417	.0091
2. FOR	77.5	20.2	.2	.2606	.0026
3. MIN	12,149.6	231.3	1,108.4	.0190	.0912
4. CHF	1,730.9	64.8	171.1	.0374	.0989
5. OCH	3,616.2	256.9	54.9	.0710	.0152
6. MA	16,932.1	970.2	55.4	.0573	.0033
7. FU	8,632.8	325.3	71.4	.0377	.0083
8. OHM	48,728.4	1,147.0	2,214.1	.0235	.0454
9. FP	16,839.5	1,403.9	227.3	.0834	.0135
10. TX	99,940.4	5,499.1	373.5	.0550	.0037
11. OIM	37,490.6	1,193.9	221.6	.0318	.0059
12. TRD	19,452.4	-	-	0	0
13. TS	41,049.7	-	-	0	0
14. CON	7,702.7	0	0	0	0
15. UT	4,027.2	0	0	0	0
16. OS	32,949.9	3,533.1	333.1	.1072	.0101
Total	376,004.6	15,674.3	5,055.0	.0417	.0134

Source: Columns 2-4: derived from Bank of Korea, "1970 Input Output Tables"
Column 2 -- Table I-1 (col. 62)
Column 3*-- Table V-2 (col. 62)
Column 4*--Table V-1 (col. 62)
Column 5*: Column 3/Column 2
Column 6*: Column 4/Column 2

* Except rows 12 and 13.

Table K7

Non-Farm Consumption of Unprocessed Food Commodities, 1972

1 Commodity	2 Total Consumption ₩/household-mo	3 Unprocessed Consumption ₩/household-mo	4 Proportion Unprocessed PFU(2)
1. Rice	6863	6767	0.986
2. Barley	660	608	0.921
3. Wheat	635	18	0.028
4. Other grains	45	45	1.000
5. Fruits	621	576	0.927
6. Pulses	265	77	0.290
7. Vegetables	1290	1242	.962
8. Potatoes	146	135	.924
9. Tobacco	-	-	0
10. Forage	-	-	0
11. Silk	-	-	0
12. Industrial crops	-	-	0
13. Beef	657	0	0
14. Milk	145	33	.227
15. Pork	340	0	0
16. Chicken	177	0	0
17. Eggs	336	336	1.000
18. Fish	1330	934	.702
19. Ag. residual	1792	760	.424
Total	15,302	11,531	.754

Source: Columns 2 and 3: Bureau of Statistics, Economic Planning Board, "Annual Report on the Family Income and Expenditure Survey 1972," Table 11.
Column 4: Column 3/Column 2

Table K9

Employment and Wages (1970)

1 Sector	2 Output ₩ billion/yr OUT(1970)	3 Wages ₩ billion/yr W(1970)	4 Employment Total persons DL(1970)	5 Wage persons DWL(1970)	6 Wage Labor Proportion PWL	7 Wage Rate ₩/person-yr WR(1970)	8 Unit Labor Requirement Person-yr/₩ L(1970)
1. AG	866.9892	72.4325	4,520,600	524,000	0.116	138,200	.00000521
2. FOR	65.4191	15.2391	283,400	102,300	0.361	149,000	.00000433
3. MIN	61.4806	26.3302	109,000	106,350	0.976	247,600	.00000177
4. CHF	32.4356	3.2113	5,800	5,800	1.000	553,700	.00000179
5. OCH	138.5295	17.0975	70,550	69,300	0.982	246,700	.00000051
6. MA	180.4238	24.4792	112,900	109,500	0.970	223,600	.00000063
7. FU	128.7871	5.7817	17,600	16,800	0.955	344,100	.00000014
8. OHM	365.4228	42.3340	230,800	214,800	0.931	197,100	.00000063
9. FP	452.5968	40.2640	235,200	211,250	0.898	190,600	.00000052
10. TX	378.1434	52.2904	371,600	354,100	0.953	147,700	.00000098
11. OLM	119.1807	22.9261	144,000	134,600	0.935	170,300	.00000121
12. TRD	492.5398	73.7908	1,151,700	238,500	0.207	309,400	.00000234
13. TS	271.6422	67.9269	308,750	272,550	0.883	249,200	.00000114
14. CON	475.1972	117.0654	355,000	339,000	0.955	345,300	.00000075
15. UT	95.6556	20.9464	52,900	52,900	1.000	396,000	.00000055
16. OS	902.4236	348.4897	1,242,700	877,000	0.706	397,300	.00000138
Total	5026.8670	950.6052	9,212,500	3,628,750	0.394	262,000	.00000183

Source:

Columns 2-3: Table K1.

Columns 4-5: derived from Bank of Korea, "Employment Requirement Coefficients for 1970," Table 1.

Column 6: Column 5/Column 4

Column 7: Column 3/Column 5

Column 8: Column 4/Column 2

Table K10

Capital Consumption Allowance (1970)

1 Sector	2 Output ¥ billion/yr OUT(1970)	3 Capital Consump. ¥ billion/yr CCA(1970)	4 Unit Capital Consumption CCAU
1. AG	866.9892	10.2877	.0119
2. FOR	65.4191	0.3679	.0056
3. MIN	61.4806	5.1952	.0845
4. CHF	32.4356	3.8027	.1172
5. OCH	138.5292	6.4503	.0466
6. MA	180.4238	4.2767	.0237
7. FU	128.7871	4.4705	.0347
8. OHM	365.4228	11.0251	.0302
9. FP	452.5968	4.9900	.0110
10. TX	378.1434	6.0599	.0160
11. OLM	119.1807	1.5688	.0132
12. TRD	492.5398	16.1410	.0328
13. TS	271.6422	32.9536	.1213
14. CON	475.1972	4.9765	.0105
15. UT	95.6556	9.8547	.1030
16. OS	902.4236	19.0640	.0211
Total	5026.8670	141.4846	.0281

Source:
Columns 2-3: Table K1
Column 4 : Column 3/Column 2

Table K11

Incremental Capital Stocks by Industry and Asset Type (1968): Mining and Manufacturing

Sector \ Asset	Buildings	Structures	Machinery	Ships	Other Transp. Equipment	Tools, Instruments, Fixtures	Total	Marginal Actual Output
3. MIN	72,298	161,668	121,227	31,884	52,102	12,208	451,387	907,399
4. CHF	208,354	47,818	210,574	-	13,542	23,608	503,896	520,870
5. OCH	1,090,916	138,713	1,059,671	-	208,842	193,400	2,691,542	5,818,153
6. MA	817,525	141,945	1,717,994	15,900	256,274	306,578	3,256,276	10,471,981
7. FU	88,251	50,894	182,370	10,716	117,454	6,494	456,179	1,212,858
8. OHM	1,793,664	675,363	4,816,135	4,719	605,467	448,062	8,343,410	16,726,070
9. FP	2,750,001	224,618	1,422,494	1,609	266,782	167,566	4,833,070	22,715,341
10. TX	2,301,949	167,220	3,621,314	-	184,717	136,957	6,412,157	13,394,595
11. OIM	521,204	38,921	686,930	-	158,610	112,842	1,518,507	4,836,716

Source: K.C. Han, Estimates of Korean Capital and Inventory Coefficients in 1968, 1970, Appendix G.
Units: Thousand Won

Table K12

Gross Capital Stocks by Industry of Origin and Destination (1968): Mining and Manufacturing

Destn. \ Origin	6 MA	8 OHM	11 OIM	14 CON	Total
3. MIN	2,139,234	103,298	3,443	1,694,882	3,940,857
4. CHF	6,410,125	258,175	9,497	2,272,963	8,950,760
5. OCH	8,717,078	948,846	309,091	4,744,521	14,719,536
6. MA	10,494,820	1,272,426	131,345	8,817,620	20,716,211
7. FU	902,151	42,191	963	493,394	1,438,699
8. OHM	61,635,215	3,446,493	255,053	24,009,649	89,346,410
9. FP	15,265,153	1,363,012	47,313	29,727,207	46,406,685
10. TX	37,917,726	814,613	158,828	16,635,341	55,526,508
11. OIM	6,189,899	1,575,174	112,538	4,030,656	11,908,267

Source: K.C. Han, Estimates of Korean Capital and Inventory Coefficients in 1968, 1970, Appendix F.

Units: Thousand Won

Table K13

Incremental Capital Stocks by Industry of Origin and Destination (1968): Mining and Manufacturing

Destn. \ Origin	6 MA	8 OHM	11 OIM	14 CON	Total	Marginal Actual Output
3. MIN	205,213	11,814	394	233,966	451,387	907,399
4. CHF	224,116	22,770	838	256,172	503,896	520,870
5. OCH	1,268,513	145,862	47,538	1,229,629	2,691,542	5,818,153
6. MA	1,990,168	277,882	28,696	959,530	3,256,276	10,471,981
7. FU	310,540	6,349	145	139,145	456,179	1,212,858
8. OHM	5,426,321	417,146	30,916	2,469,027	8,343,410	16,726,070
9. FP	1,690,885	161,936	5,630	2,974,619	4,833,070	22,715,341
10. TX	3,806,031	114,606	22,351	2,469,169	6,412,157	13,394,595
11. OIM	845,540	105,315	7,527	560,125	1,518,507	4,836,716

Source: Tables K11 and K12.
Unit: thousand won

Table K14

Incremental Capital-Output Ratios (1968):
Mining and Manufacturing

Destn. \ Origin	6 MA	8 OHM	11 OLM	14 CON	Total
3. MIN	.2262	.0130	.0004	.2578	.4975
4. CHF	.4303	.0437	.0016	.4918	.9674
5. OCH	.2180	.0251	.0082	.2113	.4626
6. MA	.1900	.0265	.0027	.0916	.3110
7. FU	.2560	.0052	.0001	.1147	.3761
8. OHM	.3244	.0249	.0018	.1476	.4988
9. FP	.0744	.0071	.0002	.1310	.2128
10. TX	.2841	.0086	.0017	.1843	.4787
11. OLM	.1748	.0218	.0016	.1158	.3140

Source: Table K13.

Table K15

Forestry Gross Average Capital Coefficients
by Asset Type and by Industry of Origin

Asset Type	
1. Building	.44434
2. Structures	.06207
3. Machineries	.01400
4. Ships	-
5. Other Transport Machineries	.03074
6. Tools, Instruments and Fixtures	.05085
7. Plants	.06594
8. Animals	.00045
Total	.66839
Industry of Origin	
1. Agriculture	.00045
2. Forestry	.06594
6. Machinery	.04474
8. Other Heavy Manufacturing	.05000
11. Other Light Manufacturing	.00085
14. Construction	.50641
Total	.66839

Source: Asset Type -- K.C. Han, Estimates of Korean Capital and Inventory Coefficients in 1968, 1970, Table 4.1; except plants and animals, from Table 3.7.

Tabke K16

Gross Capital Stocks by Industry and Asset Type (1968): Agriculture, SOC and Services

Asset / Sector	Buildings	Structures	Machinery	Ships	Other Transp. Equipment	Tools, Instruments, Fixtures	Plants and Animals	Total	Actual Output
1. AG	53,944.9	1,632.2	8,925.6	101,157.4	4,505.9	17,465.8	113,076.0	300,707.8	587,291.7
12. TRD	125,960.5	2,382.1	20,039.6	2,149.9	6,134.1	12,394.2	–	169,060.4	298,147.9
13. TS	18,482.4	501,856.4	16,729.5	32,008.1	109,138.7	4,636.5	–	682,851.6	144,157.0
14. CON	22,477.8	2,425.2	19,631.5	2,070.0	4,664.5	1,767.5	–	53,036.5	256,714.7
15. UT	23,471.3	87,435.2	79,047.9	5.0	1,374.5	2,208.0	–	193,541.9	61,027.9
16. OS*	470,401.7	68,458.1	32,751.9	1,913.6	9,140.7	58,795.5	–	641,461.5	295,640.0

Source: K.C. Han, Estimates of Korean Capital and Inventory Coefficients in 1968, 1970, Tables 3.2 and 3.5.
Unit: Million Won
* Except "ownership of dwellings."

Table K17

Gross Capital Stocks by Industry of Origin and Destination (1968): Agriculture, SOC and Services

Destn. \ Origin	1 AG	6 MA	8 OHM	11 OLM	14 CON	Total	Actual Output
1. AG	113,076.0	114,588.9	15,719.2	1,746.6	55,577.1	300,707.8	587,291.7
12. TRD	-	28,323.6	11,154.8	1,239.4	128,342.6	169,060.4	298,147.9
13. TS	-	157,876.3	4,172.8	463.7	520,338.8	682,851.6	144,157.0
14. CON	-	26,366.0	1,590.7	176.8	24,903.0	53,036.5	256,714.7
15. UT	-	80,427.4	1,987.2	220.8	110,906.5	193,541.9	61,027.9
16. OS*	-	43,806.2	52,915.9	5,879.6	538,859.8	641,461.5	295,640.0

Source: Table K16
Unit: Million Won
* Except "ownership of dwellings."

Table K18

Average Capital-Output Ratios (1968):
Agriculture, SOC and Services

Destn. \ Origin	1 AG	6 MA	8 OHM	11 OLM	14 CON	Total
1. AG	.1925	.1951	.0268	.0030	.0946	.5120
12. TRD	-	.0950	.0374	.0042	.4305	.5671
13. TS	-	1.0952	.0289	.0032	3.6095	4.7368
14. CON	-	.1027	.0062	.0007	.9070	.2066
15. UT	-	1.3179	.0326	.0036	1.8173	3.1714
16. OS*	-	.1482	.1790	.0199	1.8227	2.1698

Source: Table K17
* Except "onwership of dwellings."

Table K19

Incremental Capital-Output Ratios — Estimate 2

Origin / Destn.	1 AG	2 FOR	6 MA	8 OHM	10 TX	11 OLM	14 CON	Total
1. AG	.3442		.3489	.0479	.0030	.0023	.1692	.9155
2. FOR	.0008	.1179	.0800	.0894		.0015	.9055	1.1951
3. MIN			.6610	.0380		.0012	.7533	1.4535
4. CHF			.4837	.0491		.0018	.5529	1.0875
5. OCH			.2451	.0282		.0092	.2375	.5200
6. MA			.2798	.0390	.0001	.0039	.1349	.4577
7. FU			.4392	.0089		.0002	.1968	.6451
8. OHM			.4350	.0334		.0024	.1980	.6688
9. FP			.1102	.0105		.0003	.1941	.3151
10. TX			.3327	.0101		.0020	.2158	.5606
11. OLM			.2449	.0306		.0022	.1622	.4399
12. TRD			.0654	.0257		.0029	.2964	.3904
13. TS			1.0890	.0288	.0001	.0031	3.5890	4.7100
14. CON			.0985	.0060		.0006	.0931	.1982
15. UT			2.2374	.0553		.0061	3.0852	5.3840
16. OS*			.0999	.1207	.0002	.0132	1.2290	1.4630

* Except "ownership of dwellings."

Sources: "Total" column — B.N. Song, "Observations on Korean Capital Coefficients with International Comparisons," Working Paper 7405, Korean Development Institute, 1974, Tables 4 and 5.

Other columns -- ratioed from Tables K14, K15, and K18.

Table K20

Incremental Capital-Output Ratios — Estimate 3

Origin / Destn.	1 AG	2 FOR	6 MA	8 OHM	10 TX	11 OLM	14 CON	Total	Weight
1. AG	.113800		.235171	.000597	.005672		.573458	.928698	622,886.7
2. FOR	.000264	.038980	.308074	.000782			.751230	1.099330	810,389.9
3. MIN			.690714	.031051		.001632	.729105	1.452502	44,726.9
4. CHF			.579640	.022673		.000829	.559522	1.162664	12,276.0
5. OCH			.295467	.026027		.010496	.226763	.558753	69,139.6
6. MA			.258840	.032679	.000106	.003337	.162745	.457707	131,810.4
7. FU			.413376	.011461		.000224	.219997	.645058	69,224.6
8. OHM			.442668	.021723		.002474	.238864	.705729	210,763.1
9. FP			.150482	.008680		.000544	.125968	.285674	273,714.9
10. TX			.297733	.008184		.000997	.253644	.560558	237,994.3
11. OLM			.220906	.044630		.002921	.141740	.410197	68,114.0
12. TRD			.202724	.003186		.056456	.776853	1.039219	375,871.4
13. TS			2.248674	.008536		.143985	2.603509	5.004704	144,187.0
14. CON			.178580	.004533	.000023	.044834	.096699	.324669	156,714.7
15. UT			1.583858	.010557	.000245	.525555	2.348955	4.469170	61,027.9
16. OS*			.298124	.004685	.000158	.083024	1.142431	1.528422	552,752.1

* Except "ownership of dwellings."

Sources: Derived from M.J. Kim, et al., "A 52-Sector Interindustry Projection Model for Korea," Korea Development Institute, July 1973, Table A. 2-1.

Table K21

Estimation of Residential Construction

Equation:

$$RESCON(t) = RCI\ (TPOP_1(t) + TPOP_2(t))^{EPRC}\ (RTYDL(t))^{EYRC}$$

Data:

t	RESCON(t) bil. ₩	$TPOP_1 + TPOP_2(t)$ thous.	RTYD(t-1) bil. ₩
1957	13.04	22,677	791.78
1958	12.39	23,331	888.85
1959	15.84	24,003	922.99
1960	23.28	24,695	940.56
1961	18.45	25,498	929.20
1962	18.05	26,231	961.41
1963	21.00	26,987	982.50
1964	23.83	27,678	1,063.23
1965	26.54	28,327	1,150.79
1966	35.57	28,962	1,204.47
1967	42.06	29,541	1,350.17
1968	66.97	30,171	1,432.15
1969	71.46	30,738	1,574.98
1970	87,93	31,298	1,848.25
1971	96.07	31,847	1,972.27
1972	89.46	32,416	2,161.41
1973	119.74	32,905	2,360.13

Source: Bank of Korea, Economic Statistics Yearbook, 1974.

Regression Results:

	lnRCI	EPRC	EYRC	R^2
Value	-27.4150	1.9566	1.5348	.9638
t-statistic	-3.69	2.10	4.79	-

Table K22

Agricultural Inputs Trade and Transportation Margin (1970)

1 Sector	2 Inputs m₩/yr	3 Trade Margin m₩/yr	4 Transp. Margin m₩/yr	5 Unit Trade Margin TDMGAI	6 Unit Transp. Margin TPMGAI
1. AG	70,072.3	1,867.2	1,065.4	.0266	.0152
2. FOR	29,427.2	53.1	26.8	.0018	.0009
3. MIN	294.4	11.8	55.8	.0401	.1895
4. CHF	29,355.2	3,683.9	2,247.5	.1255	.0766
5. OCH	8,548.1	1,909.5	321.7	.2234	.0376
6. MA	2,844.9	222.9	12.0	.0784	.0042
7. FU	5,993.7	1,879.4	295.4	.3136	.0493
8. OHM	5,058.3	1,172.9	345.8	.2319	.0684
9. FP	42,890.4	2,659.8	983.1	.0620	.0229
10. TX	5,830.4	412.9	19.8	.0708	.0034
11. OLM	1,893.5	202.6	46.9	.1070	.0248
12. TRD	14,271.8	-	-	0	0
13. TS	5,720.1	-	-	0	0
14. CON	691.6	0	0	0	0
15. UT	437.0	0	0	0	0
16. OS	23,464.1	195.8	18.7	.0083	.0008
Total	246,793.0	14,271.8	5,438.9	.0578	.0220

Source: Columns 2-4: derived from Bank of Korea, "1970 Input-Output Tables"
Column 2 -- Table I-1 (cols. 1-4, 6)
Column 3*-- Table V-2 (cols. 1-4, 6)
Column 4*-- Table V-1 (cols. 1-4, 6)
Column 5*: Column 3/Column 2
Column 6*: Column 4/Column 2

* Except rows 12 and 13