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# A MACROECONOMETRIC ENERGY POLICY SIMULATION MODEL FOR THE PHILIPPINES: STRUCTURAL ANALYSIS

by

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## INTRODUCTION

Current planning and policy-making have not been very successful in terms of target-setting and policy prescriptions because of the seemingly implicit treatment of the energy factor in the formulation of models for policy and planning. Inflation and GNP growth targets, for example, were recently revised significantly because of unrealistic assumptions and the deficient framework used in the formulation of the NEDA Five-Year Development Plan.

What is necessary, therefore, is a model that will explicitly include energy disturbance variables (price and availability of energy), capture cost-push phenomena in price determination and analyze trade-offs among different target variables implied by alternative policy regimes.

This paper reports the results of an econometric modeling project aimed at studying energy-economy interactions in the Philippine economy. Specifically, it seeks to quantify the impact of the energy crisis on macro-economic variables of policy importance and, relatedly, may be used to evaluate the effectiveness of government policy reactions (fiscal, monetary and balance of payments policies) to the energy crisis of the 1970's. Furthermore, the model can serve as a planning and policy tool when utilized to make ex ante forecasts of the economy through alternative policy simulation experiments. The model will then be useful in answering the following questions:

1. What is the direction and magnitude of the effects of the energy crisis on the level and growth rate of gross domestic product and its components: consumption, investment, exports and imports?

2. By how much are domestic prices affected by increases in crude oil prices and at what speed of adjustments do these occur?

3. What will be the impact on employment if the relative price of energy increases and/or an energy supply shortage occurs? How do wages respond to resulting price increases and with how long a lag?

4. How will increases in relative prices of energy products affect the demand for these products? Accordingly, what would happen to the GDP-energy ratio (or efficiency of energy use)?

5. What is the effect of the energy crisis on the balance of payments, government budget deficit, and the monetary system in general?

6. To what extent have past economic policies counteracted or perhaps even excerbated the inflatioanry effect of the energy crisis? In general, what mix of economic policies is most effective in minimizing the impact of energy disturbances on the economy? Impacts of fiscal, monetary, and balance of payments policies have to be analyzed as to their differential effectiveness in combatting the

present and future energy-related economic crises.

We shall later attempt to answer these questions through simulation experiments with the model under alternative policy asssumptions, both historically (ex post simulation) and in forecasts (ex ante simulation).

However, we shall not attempt to do simulation exercises in this papaer for that will be the topic of another paper. Instead, we present the estimated model in its structural form and the underlying theoretical underpinnings for the specifications. The estimated parameters, taken as they are, already convey a lot of useful information for analyzing recent structural changes in the economy as compared, perhaps, with estimates of earlier models.[1/] We then, enumerate the possible uses of the model for policy simulation and conclude the paper with a summary of findings and possible areas for improvement.

## THE MODEL IN STRUCTURAL FORM

The model consists of 80 structural equations of which 18 are statistically estimated using ordinary least squares with auto-correlation applied on most equations. These are 110 variables ---

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[1/] These include the macromodel by Encarnacion, et al. [2], Narasimhan and Sabater [5] and Bautista [1], all of which used annual data up to 1969 only. A more recent macromodel by Villanueva [7] utilized semestral data from 1967-76 and focused on the Monetary sector.

80 endogenous and 30 exogenous. The data used consist of semestral observations from the first semester of 1970 to the second semester of 1979 (20 observations). The period of estimation, therefore, covers a relatively unstable decade for the Philippine economy characterized by devaluation of the peso, high inflation rates, externally generated economic disturbances led by spiralling imported crude oil prices, and a changed political environment under a martial law administration.

For discussion purposes, we have divided the model into two parts: an energy sub-model (42 equations) and a macroeconomic sub-model (38 equations). The division is not a rigid one as there exists a high degree of simultaneity between the two submodels becuse of the presence of strong linkage equations in both submodels accounting for two-way interactions. (In the following discussions, please refer to the list of symbols and the arrow diagrams found in subsequent pages.)

Energy Sub-Model

The energy sub-model contains the determinants of energy flows and prices within a consistent energy accounting framework designed for this purpose.[2] Consumption, production, trade and inventory

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[2] The accounting framework, data base, and methodology for deriving energy flows in the Philippine economy as well as theoretical discussions on energy prices and actual data computations are contained in separate papers available from the author upon request.

# A MACROECONOMETRIC ENERGY POLICY SIMULATION MODEL FOR THE PHILIPPINES: STRUCTURAL EQUATIONS

(Estimation Methods: OLS and OLS with Autocorrelation Correction)

## Part I. Energy Sub-Model

### Crude Petroleum and Refined Petroleum Products

(1) $ME_{cp} = CE_{cp} - PE_{cp} + \Delta Inv_{cp}$

(2) $CE_{cp} = 281.91584 + \underset{(22.24327)}{1.01140}\, PE_{rp}$

$\bar{R}^2 = 0.96483$ S.E.E. = 58.85175
D.W. = 1.80725 $\rho$ = 0.66397

(3) $PE_{rp} = CE_{rp} - GE_{rp}$

(4) $GE_{rp} = ME_{rp} - XE_{rp} - BE_{rp} - \Delta Inv_{rp}$

(5) $CE_{rp} = 774.25944 - \underset{(-1.77527)}{231.37450}\left(\frac{Pe_{rp}}{P}\right) + \underset{(9.67260)}{0.12351}\, Y + \underset{(2.03061)}{83.22202}\, Ds$

$\bar{R}^2 = 0.92540$ S.E.E. = 121.40701
D.W. = 2.01513 $\rho$ = 0.330745

### Coal and Hydro-geothermal Power

(6) $ME_{co} = CE_{co} - PE_{co}$

(7) $CE_{co} = -189.02496 + \underset{(2.25612)}{33.40527}\left(\frac{P}{Pe_{co}}\right) + \underset{(7.69469)}{0.00603}\, Y$

$\bar{R}^2 = 0.82767$ S.E.E. = 12.7074
D.W. = 1.50569

(8) $CE_{hg} = PE_{hg}$

Total System Energy Consumption

(9) $CPE = CE_{cp} + CE_{co} + CE_{hg}$

(10) $CE' = CPE + GE_{rp}$

(11) $CE = CE' - LE_{rp}$

(12) $CE^* = pe_{rp} \cdot CE_{rp} + pe_{co} \cdot CE_{co} + pe_{el} \cdot CE_{hg}$

Energy Consumption in Consuming Sector

(13) $$CE_C = 1385.8334 - 354.11914 \left(\frac{Pe_C}{P}\right) + 0.09303\ Y$$
$$(-3.23654) \qquad (9.10279)$$

$\bar{R}^2 = 0.86973$ S.E.E. = 106.59091
D.W. = 2.07567 $\rho$ = 0.37417

(14) $$CE_{Cnel} = 1206.7609 - 315.95435 \left(\frac{Pe_{nel}}{P}\right) + 0.08825\ Y$$
$$(-3.63138) \qquad (9.77277)$$

$\bar{R}^2 = 0.91060$ S.E.E. = 99.88461
D.W. = 2.05846 $\rho$ = 0.158945

(15) $CE_{Cel} = CE_C - CE_{Cnel}$

Energy Losses in Transformation Sector

(16) $LE_T = CE' - CE_C$

(17) $LE_{rp} = CE_{cp} - PE_{rp}$

Total System Energy Production and Imports

(18) $PE = PE_{rp} + PE_{co} + PE_{hg}$

(19) $PPE = PE_{cp} + PE_{co} + PE_{hg}$

(20) $ME = ME_{cp} + ME_{rp} + ME_{co}$

(21) $ME^* = (\$pme \cdot er) \cdot ME$

Energy Prices

(22) $pe_{rp} = pp_{rp} + t_s + t_{sf} + ed$

(23) $pp_{rp} = 0.07711 + 0.71426\ (\$pd_{cp}\ .\ er) + 0.28563\ pp_{rp\ -1}$

$(17.24408) \qquad (6.27231)$

$\bar{R}^2 = 0.99678 \qquad S.E.E. = 0.01954$

$D.W. = 2.04613$

(24) $\$pd_{cp} = \$pc_{cp}\ (1 + tm_{cp})$

(25) $pe = (CE^*/CE)$

(26) $pe_C = (pe_{nel}\ .\ CE_{cnel} + pe_{el}\ .\ CE_{cel})/CE_C$

(27) $pe_{nel} = -0.01413 + 1.09956\ pe_{rp}$

$(174.49739)$

$\bar{R}^2 = 0.99941 \qquad S.E.E. = 0.1116$

$D.W. = 1.98380 \qquad \rho = 0.072895$

(28) $pe_{el} = -0.46436 + 6.58941\ pe_{rp} - 6.00206\ (De\ .\ pe_{rp}) + 3.87504\ De$

$(2.10690) \qquad (-1.91251) \qquad (4.45855)$

$\bar{R}^2 = 0.97779 \qquad S.E.E. = 0.21202$

$D.W. = 1.53376$

(29) $\$pme = (\$pc_{cp}\ .\ ME_{cp} + \$pc_{rp}\ .\ ME_{rp} + \$pc_{co}\ .\ ME_{co})/ME$

(30) $pe_{co} = (\$pc_{co}\ .\ er\ .\ ME_{co} + pd_{co}\ .\ PE_{co})/CE_{co}$

(31) $Pe_{rp} = (pe_{rp}/0.25926)\ .\ 100$

(32) $Pe_{co} = (pe_{co}/0.08728)\ .\ 100$

(33) $Pe_{el} = (pe_{el}/1.43299)\ .\ 100$

(34) $Pe = (pe/0.29558)\ .\ 100$

(35) $Pe_C = (pe_C/0.34930)\ .\ 100$

(36) $Pe_{nel} = (pe_{nel}/0.26434)\ .\ 100$

(37) $\$Pme = (\$pme/0.01695)\ .\ 100$

(38) $Pme = (\$Pme\ .\ ER)/100$

Energy Efficiency

(39) $EE = Y/CE$

(40) $EE_{rp} = PE_{rp}/CE_{cp}$

Energy Self-Sufficiency

(41) $ES = PPE/CE'$

(42) $ES_{cp} = PE_{cp}/CE_{cp}$

## Part II. Macroeconomic Sub-Model

Aggregate Production

(43) $$\left(\frac{Y'}{N}\right) = 7.43677 + \underset{(2.28992)}{0.05339} \left(\frac{K}{N}\right) + \underset{(3.07811)}{3.31591} \left(\frac{CE}{N}\right) + \underset{(3.82845)}{1.65733}\, t$$

$\bar{R}^2 = 0.88048$ S.E.E. = 7.22310

D.W. = 1.95568 $\rho = 0.059715$

(44) $Y = Y' - Ce$

(45) $Ce = (CE^*/Pe) \,.\, 100$

(46) $K = K_{-1} + I_{-1}$

(47) $Y^* = (P \,.\, Y)/100$

Aggregate Expenditures

(48) $$C_p = 8559.829 + \underset{(3.88119)}{0.30835} (Y-T) + \underset{(3.30728)}{34.20700} \left(\frac{Z'}{P_{Cp}}\right)$$

$\bar{R}^2 = 0.91462$ S.E.E. = 414.23524

D.W. = 1.86851 $\rho = 0.58359$

(49) $C_g = (C_g^*/P_{Cg}) \,.\, 100$

(50) $C = C_p + C_g$

(51) $C^* = (C_p \cdot P_{Cp})/100 + C_g^*$

(52) $I = Y - C - X + M$

(53) $I_g = (I_g^*/P_I) \cdot 100$

(54) $I_p = I - I_g$

Employment and Wages

(55) $N = 98.686886 + 0.00204\ Y - 0.88565\ W + 0.32205\ P$
(2.93331) (-2.40759) (3.86443)

$\bar{R}^2 = 0.93755$ S.E.E. = 3.07703
D.W. = 1.31929 $\rho = 0.12115$

(56) $W = 25.20401 + 0.13295\ P + 0.62206\ W_{-1}$
(3.27490) (5.40166)

$\bar{R}^2 = 0.98639$ S.E.E. = 2.25219
D.W. = 2.62790

Prices

(57) $P = -313.69409 + 0.11832\ Pe_C + 84.51352 \log W + 0.00134\ Z'$
(2.80687) (1.78468) (2.91641)

$\bar{R}^2 = 0.97930$ S.E.E. = 7.88799
D.W. = 1.16420

(58) $\dot{P} = \left(\frac{P - P_{-1}}{P_{-1}}\right) \cdot 100$

(59) $P_{Cp} = -8.36077 + 0.11255\ Pe_C + 0.83226\ W + 0.00121\ CPS$
(3.54224) (1.78716) (3.56623)

$\bar{R}^2 = 0.98882$ S.E.E. = 4.93647
D.W. = 1.93866 $\rho = 0.173775$

(60) $P_{Cg} = -49.77615 + 0.07409\ Pe_C + 1.02817\ W + 0.41690\ P_{Cg-1}$
(2.41376) (2.32565) (2.73154)

$\bar{R}^2$ = 0.98813  S.E.E. = 5.74524
D.W. = 2.82276

(61) $F_I = (\frac{Y^* - C^* - X^* + M^*}{I}) \cdot 100$

Money and Interest

(62) $\frac{Z'}{P} = 11.63232 - 4.61409\,R + 0.00567\,Y + 22.99557\,De - 4.96257\,Ds$
(-2.96679) (8.65170) (2.66970) (-1.54060)

$\bar{R}^2$ = 0.97370  S.E.E. = 6.89085
D.W. = 2.12518  $\rho$ = 0.0542

(63) $Z = Z_{-1} + (CPS - CPS_{-1}) + (CGS - CGS_{-1}) + (NFA - NFA_{-1}) - (NOL - NOL_{-1})$

(64) $Z' = (Z + Z_{-1})/2$

Government Revenues and Expenditures

(65) $CGS - CGS_{-1} = Cg^* + Ig^* - T^* - F^*$

(66) $T^* = Te^* + Tne^*$

(67) $Te^* = (t_s + t_{sf}) \cdot CE_{rp} + t_{mcp}\,(\$pc_{cp} \cdot er \cdot ME_{cp})$

(68) $Tne^* = TD^* + TIne^*$

(69) $TIne^* = -56.042906 + 0.04548\,Y^* + 0.49099\,TIne^*_{-1}$
(2.51586) (2.09170)

$\bar{R}^2$ = 0.93991  S.E.E. = 473.56201
D.W. = 1.87082  $\rho$ = 0.210605

(70) $T = (T^*/P) \cdot 100$

Balance of Payments

(71) $NFA - NFA_{-1} = X^* - M^* + K_f^*$

(72) $M^* = ME^* + Mne^*$

(73) $ME^* = (\$pme \; . \; er) \; . \; ME$

(74) $Mne^* = (Pmne \; . \; Mne)/100$

(75) $M = Me + Mne$

(76) $Me = (ME^*/Pme) \; . \; 100$

(77) $$Mne = 2352.5435 + 0.09610\, Y - 1664.18237 \left(\frac{Pmne}{P}\right) + 11.37831\, Px$$
$$\qquad\qquad (4.11101) \qquad (2.32911) \qquad (4.86780)$$

$\bar{R}^2 = 0.92149$     S.E.E. = 279.57129

D.W. = 2.17761     $\rho = 0.19946$

(78) $ER = (er/6.67105) \; . \; 100$

(79) $Px = (\$Px \; . \; ER)/100$

(80) $Pmne = (\$Pmne \; . \; ER)/100$

## DEFINITION OF VARIABLES

Endogenous Variables (80):

C : total consumption expenditures at 1972 prices; in million pesos

C* : total consumption expenditures at current prices; in million pesos

Ce : value of total system energy consumption at 1972 prices; in million pesos

CE : total system energy consumption net of refinery fuel and loss; in $10^{10}$ kilocalories

CE' : total system energy consumption; in $10^{10}$ kilocalories

CE* : value of total system energy consumption net of refinery fuel and loss at current prices; in million pesos

$CE_C$ : energy consumption of consuming sector (industries and household); in $10^{10}$ kilocalories

$CE_{Cel}$ : electrical energy consumption of consuming sector; in $10^{10}$ kilocalories

$CE_{Cnel}$ : non-electrical energy consumption of consuming sector; in $10^{10}$ kilocalories

$CE_{co}$ : consumption of coal; in $10^{10}$ kilocalories

$CE_{cp}$ : consumption of crude petroleum; in $10^{10}$ kilocalories

$CE_{hg}$ : consumption of hydro-geothermal energy; in $10^{10}$ kilocalories

$C_g$ : government consumption expenditures at 1972 prices; in million pesos

$CE_{rp}$ : consumption of refined petroleum products; in $10^{10}$ kilocalories

CGS : claims on the government sector of the monetary system; in million pesos

$C_p$ : private consumption expenditures at 1972 prices; in million pesos

CPE : total consumption of primary energy; in $10^{10}$ kilocalories

$EE$ : macroeconomic energy efficiency ratio; in million pesos of real GDP per $10^{10}$ kilocalories

$EE_{rp}$ : petroleum refining efficiency ratio; in $10^{10}$ kilocalories of refined petroleum products per $10^{10}$ kilocalories of crude petroleum

$ER$ : peso to dollar exchange rate index; 1972 = 100

$ES$ : energy self-sufficiency ratio; in $10^{10}$ kilocalories of primary energy production per $10^{10}$ kilocalories of system energy consumption

$ES_{cp}$ : crude petroleum self-sufficiency ratio; in $10^{10}$ kilocalories of crude petroleum production per $10^{10}$ kilocalories of crude petroleum consumption

$GE_{rp}$ : consumption-production gap in refined petroleum products; in $10^{10}$ kilocalories

$I$ : total investment expenditures at 1972 prices; in million pesos

$I_g$ : government investment expenditures at 1972 prices; in million pesos

$I_p$ : private investment expenditures at 1972 prices; in million pesos

$K$ : capital stock at 1972 prices; in million pesos

$LE_{rp}$ : refinery fuel and loss including production of non-energy petroleum by-products; in $10^{10}$ kilocalories

$LE_T$ : total system energy losses in transformation sector; in $10^{10}$ kilocalories

$M$ : total imports of goods and services at 1972 prices; in million pesos

$M^*$ : total imports of goods and services at current prices; in million pesos

$Me$ : energy imports at 1972 prices; in million pesos

$ME$ : energy imports; in $10^{10}$ kilocalories

$ME^*$ : energy imports at current prices; in million pesos

$ME_{co}$ : imports of coal; in $10^{10}$ kilocalories

$ME_{cp}$ : imports of crude petroleum; in $10^{10}$ kilocalories

Mne : non-energy imports at 1972 prices; in million pesos

Mne* : non-energy imports at current prices; in million pesos

N : total employment index; 1972 = 100

NFA : net foreign assets of the monetary system; in million pesos

P : price index for gross domestic product; 1972 = 100

p : semestral inflation rate; in per cent

$P_{Cg}$ : price index for government consumption expenditures; 1972 = 100

$P_{Cp}$ : price index for private consumption expenditures; 1972 = 100

$P_I$ : price index for investment expenditures; 1972 = 100

Pe : price index for total system energy consumption net of refinery fuel and loss; 1972 = 100

$Pe_C$ : price index for energy consumption of consuming sector; 1972 = 100

$Pe_{co}$ : price index for coal consumption; 1972 = 100

$Pe_{el}$ : price index for electrical energy consumption; 1972 = 100

$Pe_{nel}$ : price index for non-electrical energy consumption; 1972 = 100

$Pe_{rp}$ : price index for refined petroleum products consumption; 1972 = 100

Pme : peso price index for energy imports; 1972 = 100

$Pme : dollar price index for energy imports; 1972 = 100

Pmne : peso price index for non-energy imports; 1972 = 100

Px : peso price index for exports; 1972 = 100

PE : total system energy production; in $10^{10}$ kilocalories

pe : weighted price of total system energy consumption net of refinery fuel and loss; in million pesos per $10^{10}$ kilocalories

$pe_C$ : weighted price of energy consumption of consuming sector; in million pesos per $10^{10}$ kilocalories

$pe_{co}$ : weighted price of coal; in million pesos per $10^{10}$ kilocalories

$pe_{el}$ : marginal price of electricity; in million pesos per $10^{10}$ kilocalories

$pe_{nel}$ : weighted price of non-electrical energy; in million pesos per $10^{10}$ kilocalories

$PE_{rp}$ : production of refined energy petroleum products; in $10^{10}$ kilocalories

$pe_{rp}$ : weighted price of refined energy petroleum products; in million pesos per $10^{10}$ kilocalories

PPE : total production of primary energy; in $10^{10}$ kilocalories

$PP_{rp}$ : weighted posted price (pre-tax) of refined energy petroleum products; in pesos per $10^{10}$ kilocalories

$\$pd_{cp}$ : duty paid landed cost of crude petroleum imports; in million dollars per $10^{10}$ kilocalories

\$pme : weighted price of refined energy petroleum products imports; in million dollars per $10^{10}$ kilocalories

R : weighted average interest rate on deposit substitutes; in per cent per annum

T : total tax revenues at 1972 prices; in million pesos

T* : total tax revenues at current prices; in million pesos

Te* : energy tax revenues at current prices; in million pesos

Tne* : non-energy tax revenues at current prices; in million pesos

TIne* : non-energy indirect tax revenues at current prices; in million pesos

W : money wage index for unskilled labor; 1972 = 100

X : total exports of goods and services at 1972 prices; in million pesos

Y : gross domestic product at 1972 prices; in million pesos

Y* : gross domestic product at current prices; in million pesos

Y' : gross output defined as gross domestic product plus the real value of intermediate energy input; in million pesos

Z : total liquidity at the end of the semester; in million pesos

Z' : average of beginning and end of the semester total liquidity; in million pesos

Exogenous Variables (30):

$Be_{rp}$ : refined energy petroleum products used for bunkering purposes; in $10^{10}$ kilocalories

Cg* : government consumption expenditures at current prices; in million pesos

CPS : claims on the private sector of the monetary system; in million pesos

Ds : semestral dummy variable; Ds = 1 for first semester
0 for second semester

De : dummy variable for energy crisis period; De = 1 after 1973
= 0 1973 and before

ed : equalization difference for refined energy petroleum products; in million pesos per $10^{10}$ kilocalories

er : peso to dollar exchange rate; in pesos per dollar

F* : net other sources of financing the fiscal deficit including errors and omissions; in million pesos

$I_g$* : government investment expenditures at current prices; in million pesos

$\Delta Inv_{cp}$ : increase in crude petroleum inventory; in $10^{10}$ kilocalories

$\Delta Inv_{rp}$ : increased in refined energy petroleum products inventory; in $10^{10}$ kilocalories

$K_f$* : net foreign capital inflows including errors and omissions; in million pesos

$ME_{rp}$ : imports of refined energy petroleum products; in $10^{10}$ kilocalories

NOL : net other liabilities of the monetary system; in million pesos

$\$Pm_{ne}$ : dollar price index of non-energy imports; 1972 = 100

$Px : dollar price index of exports; 1972 = 100

$PE_{co}$ : production of coal; in $10^{10}$ kilocalories

$PE_{cp}$ : production of crude petroleum; in $10^{10}$ kilocalories

$PE_{hg}$ : production of hydro-geothermal energy; in $10^{10}$ kilocalories

$\$pc_{co}$ : C.I.F. dollar price of coal imports; in million pesos per $10^{10}$ kilocalories

$pd_{co}$ : price of domestically produced coal; in million pesos per $10^{10}$ kilocalories

$\$pc_{cp}$ : C.I.F. dollar price of crude petroleum imports; in million dollars per $10^{10}$ kilocalories

$\$pc_{rp}$ : C.I.F. dollar price of refined energy petroleum products imports; in million dollars per $10^{10}$ kilocalories

TD* : total direct tax revenues at current prices; in million pesos

t : time; 1970 first semester = 1

$tm_{cp}$ : import duty on crude petroleum; in per cent

ts : weighted specific tax on refined energy petroleum products in million pesos per $10^{10}$ kilocalories

$t_{sf}$ : weighted special fund tax on refined energy petroleum products; in million pesos per $10^{10}$ kilocalories

X* : total exports of goods and services at current prices; in million pesos

$XE_{rp}$ : exports of refined energy petroleum products; in $10^{10}$ kilocalories

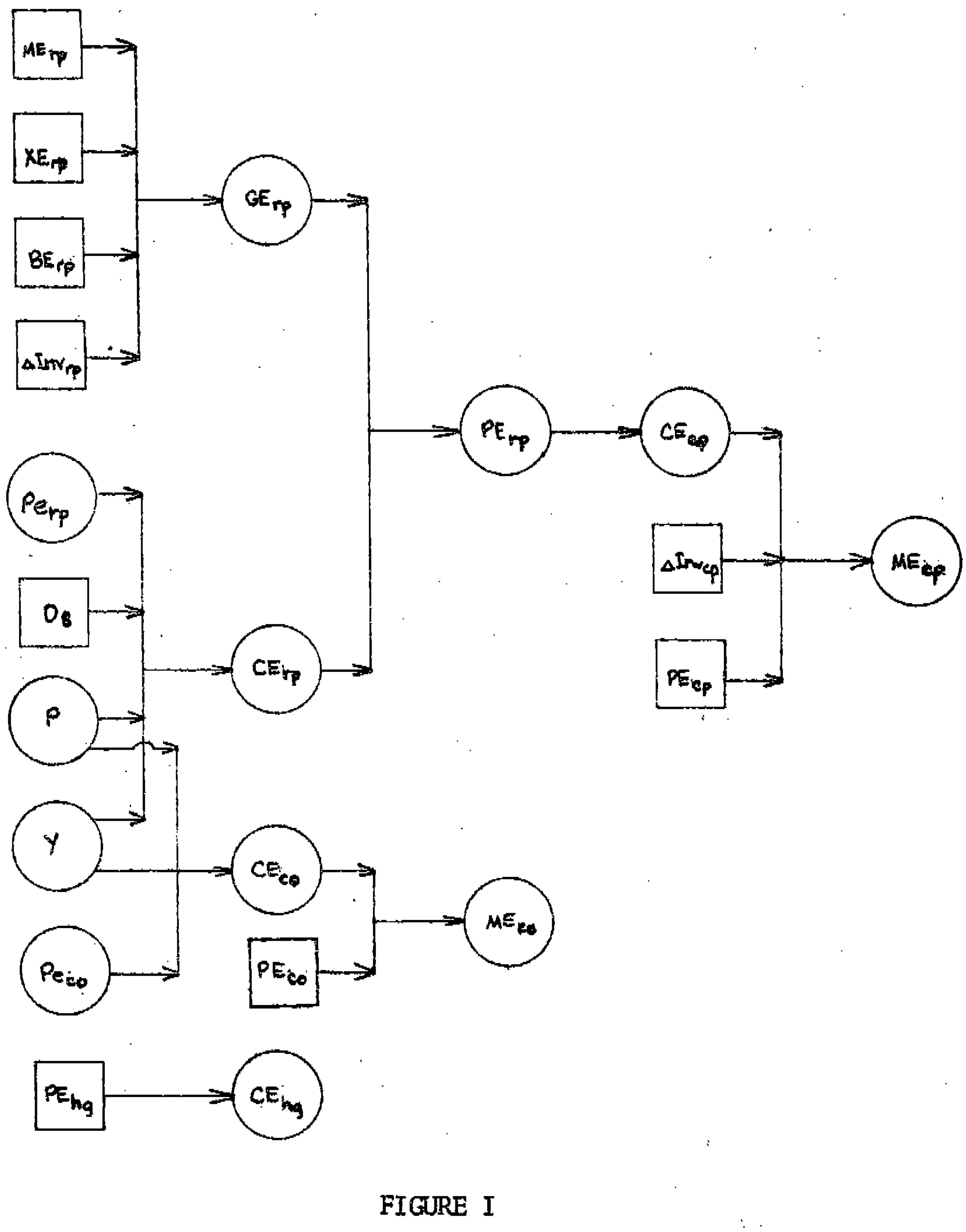


FIGURE I

CRUDE PETROLEUM, REFINED PETROLEUM PRODUCTS,
COAL AND HYDROGEOTHERMAL POWER

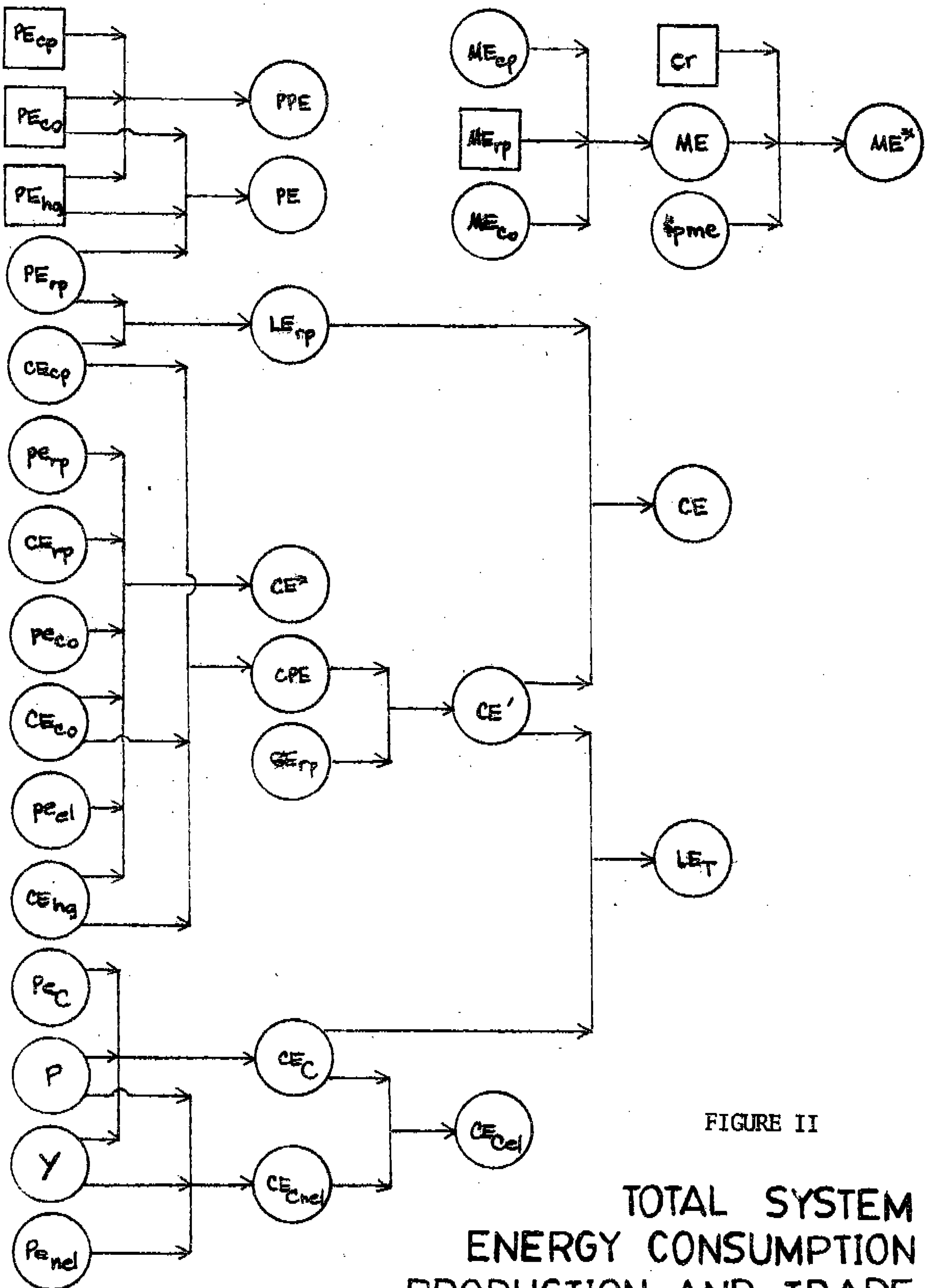


FIGURE II

TOTAL SYSTEM ENERGY CONSUMPTION PRODUCTION AND TRADE

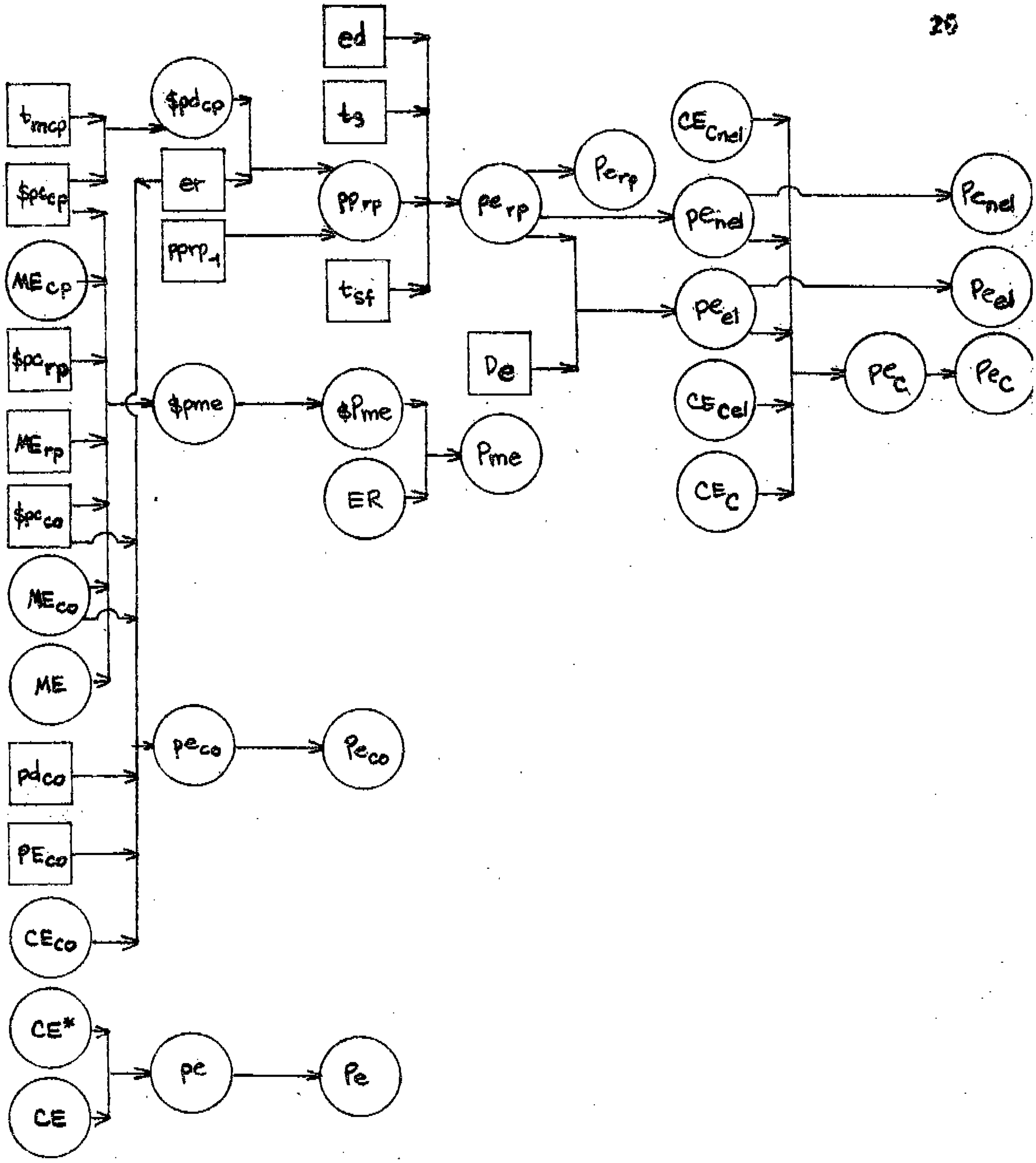


FIGURE III

ENERGY PRICES

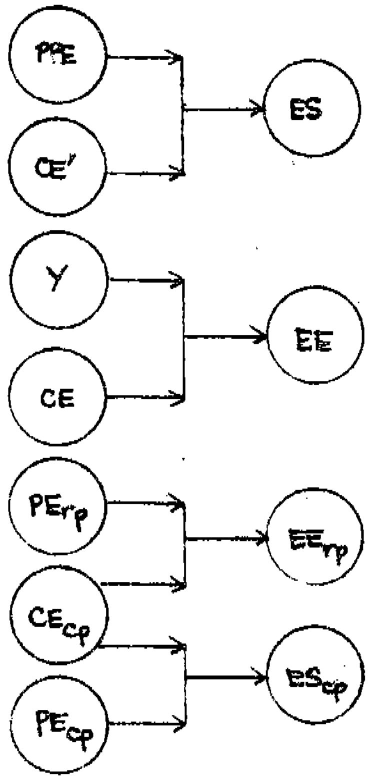


FIGURE IV

ENERGY EFFICIENCY AND SELF-SUFFICIENCY

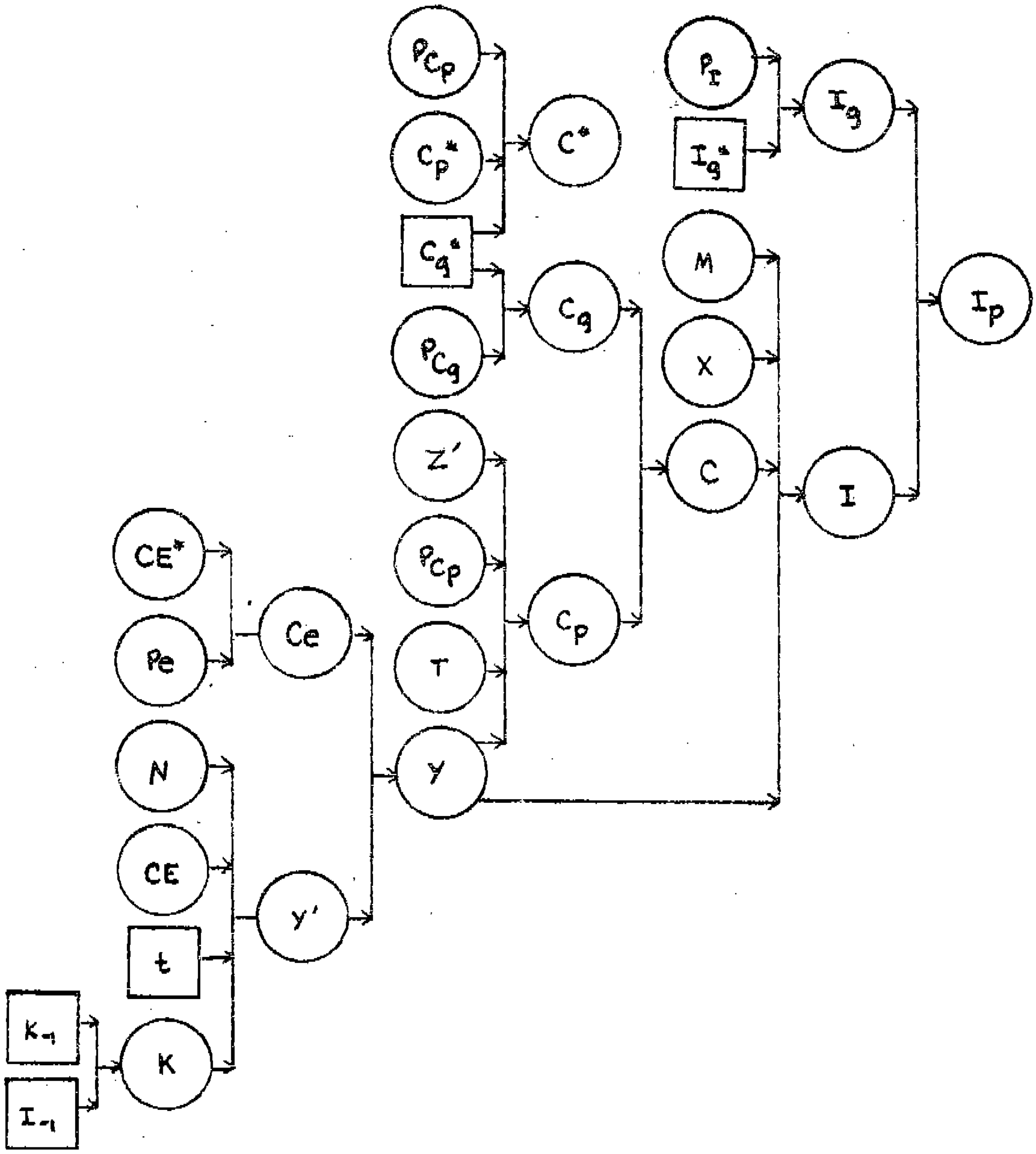


FIGURE V

AGGREGATE PRODUCTION & EXPENDITURES

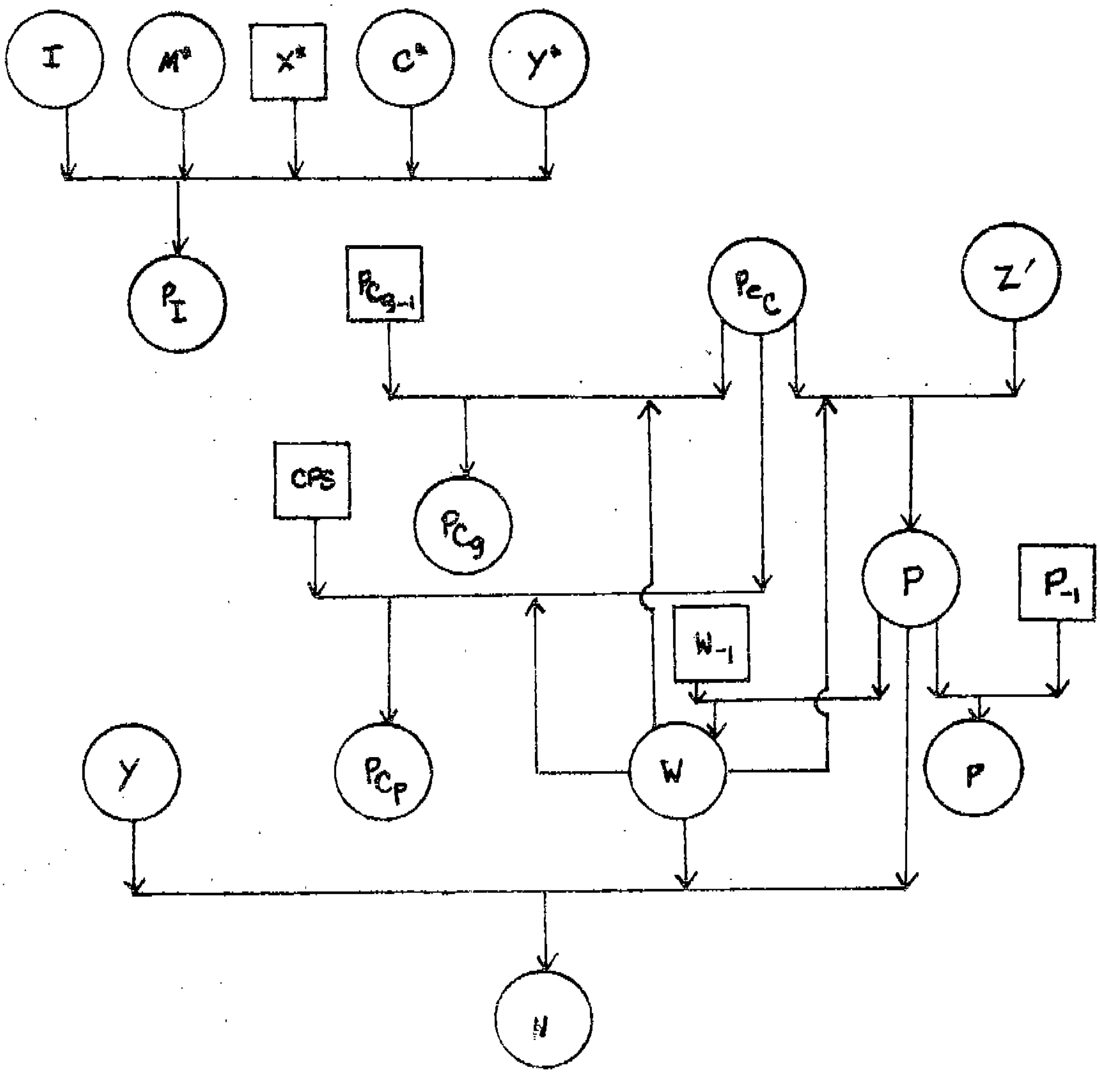


FIGURE VI

EMPLOYMENT, WAGES AND PRICES

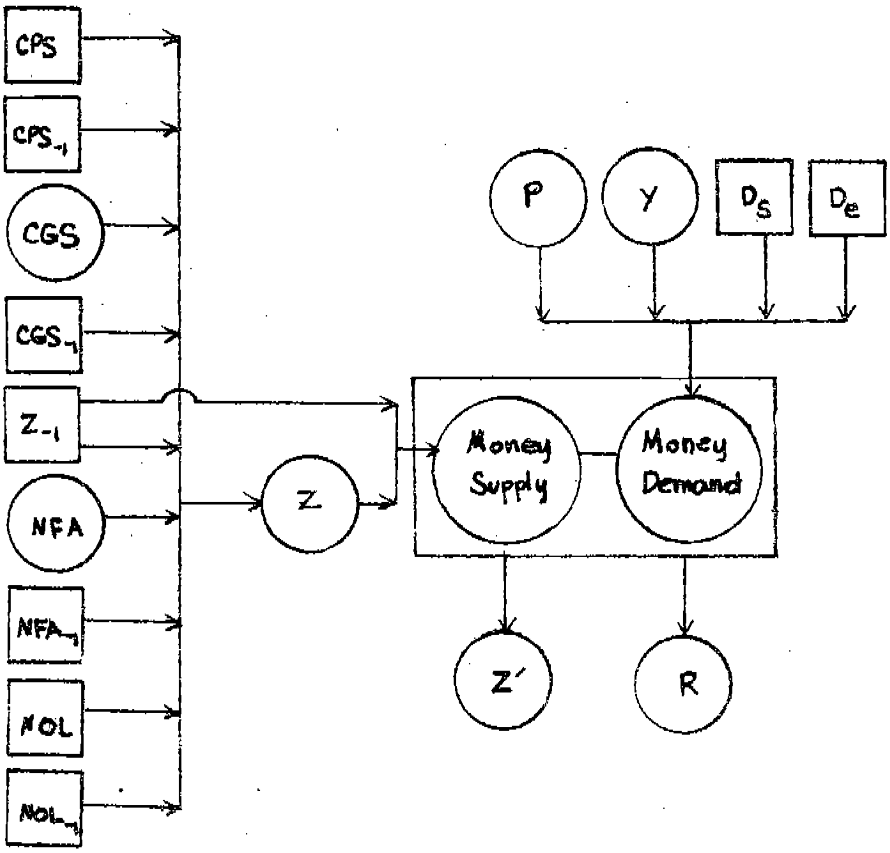


FIGURE VII

MONEY AND INTEREST

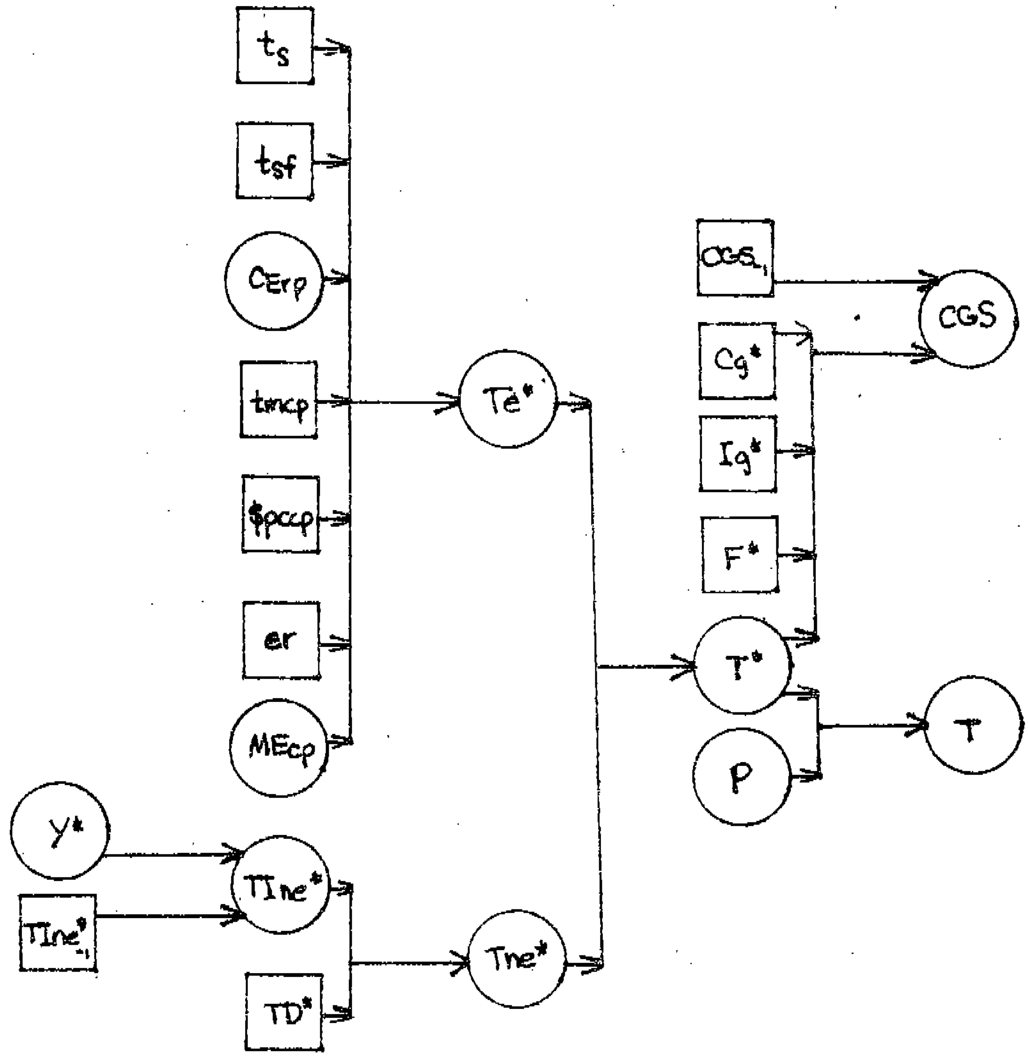


FIGURE VIII

GOVERNMENT REVENUES AND EXPENDITURES

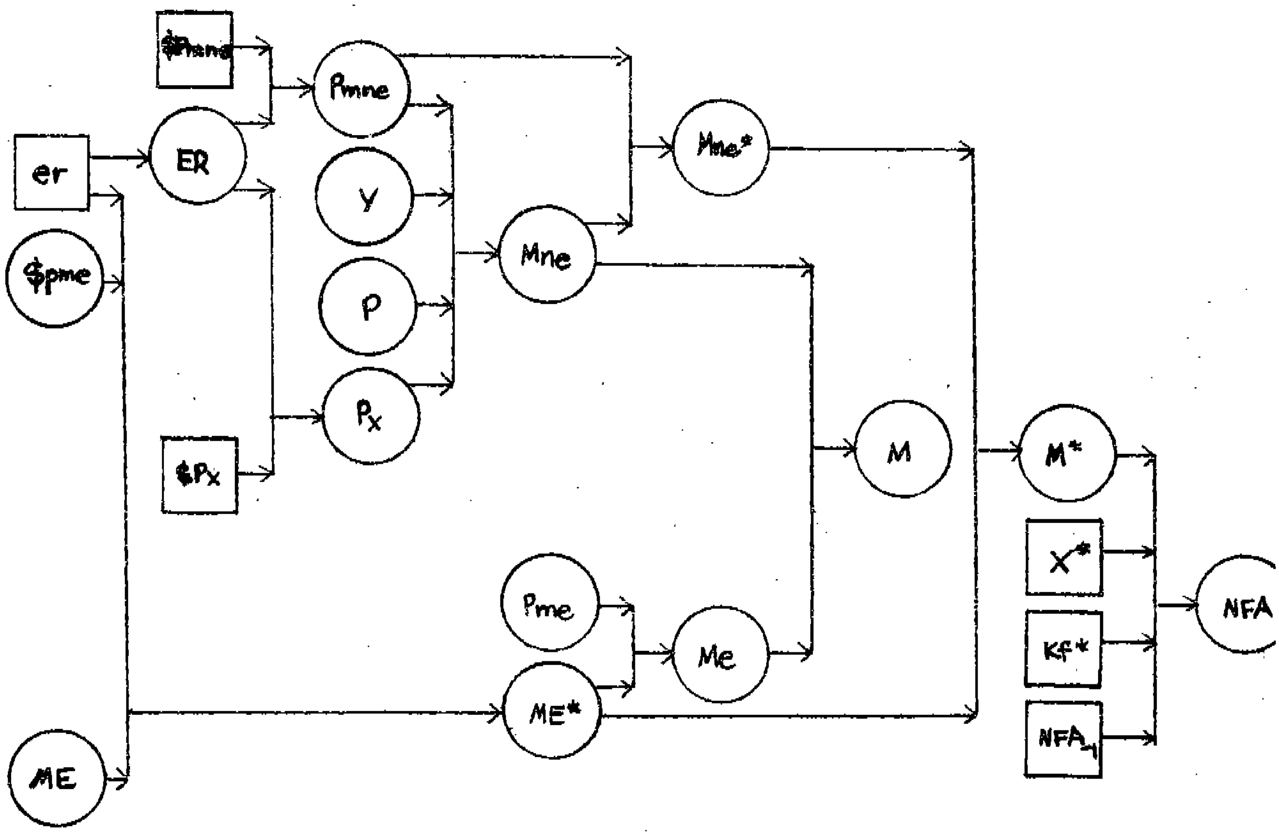


FIGURE IX

BALANCE OF PAYMENTS

change for broad energy products are linked within the sub-model. Demand equations are specified for crude petroleum, refined petroleum products, coal and hydrogeothermal electricity. Furthermore, total system energy consumption is decomposed into demand by the consuming sector and losses in the transformation sector. Demand by the consuming sector is in turn decomposed into electricity and non-electricity demand. Energy prices, on the other hand, are consumption- and time-weighted averages of individual energy products and includes energy tariffs and taxes.

Crude Petroleum and Refined Petroleum Products. Equation (1) is an accounting identity defining crude petroleum imports in terms of the domestic crude petroleum consumption-production gap and demand for accumulation. Domestic petroleum production and change in inventory are treated as exogenously determined variables subject to influence by energy policy as exemplified by a vigorous oil exploration program or a contingency plan of stockpiling crude petroleum. Total imports of crude petroleum can, therefore, be divided into consumption demand by oil refineries and a policy-determined demand for inventory accumulation net of domestic production.

The domestic demand for crude petroleum ($CE_{cp}$) is actually a derived demand from oil refineries' crude oil input requirements needed to satisfy a given output of refined petroleum products. An estimate of this raw material-intensive technical input-output relation is given in equation (2) (all units in $10^{10}$ kilocalories). The marginal crude input requirement of petroleum refineries is $\frac{\partial CE_{cp}}{\partial PE_{rp}} = 1.0114$ while the computed elaticity for 1979 (second semester) is $\varepsilon\ (CE_{cp}, PE_{rp}) = \frac{\partial CE_{cp}}{\partial PE_{rp}} \cdot \frac{PE_{rp}}{CE_{cp}} = 0.938$.

Production of refined petroleum products is less than the consumption of crude petroleum (eqn. 17) because of transformation losses, energy consumed by refineries, and production of non-energy by-products (eqn. (17)). The energy conversion efficiency of petroleum refineries (as defined in eqn. (40)) may also be derived from eqn. (2) as follows:

$$EE_{rp} = \frac{PE_{rp}}{CE_{cp}} = 0.98873 - \frac{278.73822}{CE_{cp}}$$

From this we can infer that, over time, $EE_{rp}$ improves as $CE_{cp}$ increases: $\frac{\partial EE_{rp}}{\partial CE_{cp}} = \frac{278.73822}{CE_{cp}^2} > 0$

Production of refined petroleum products ($PE_{rp}$) is determined in eqn. (3) as the difference between total consumption of refined petroleum products ($CE_{rp}$) and net supply from other sources of refined petroleum products ($GE_{rp}$). $GE_{rp}$ is defined in eqn. (4) as equal to net imports less bunker sales and inventory change. Again, inventory accumulation of refined petroleum products can be considered a policy instrument.

Eqn. (5) gives the demand for refined petroleum products ($CE_{rp}$) as a function of its real price ($PE_{rp}/P$), an activity variable (Y) and a seasonal dummy (Ds). Price elasticity estimates show that demand for refined petroleum products has become more elastic over time although in absolute terms it is still very price inelastic. Its price elasticity in the first semester of 1973 (pre-energy crisis) was -0.048 as compared to -0.100 in the first semester of 1979 indicating the increasing importance of prices as an energy conservation tool.

Income (GDP) elasticity of demand for refined petroleum products, on the other hand, is almost unitary (0.973 in second semester 1979). This estimate is substantially lower than the Ministry of Energy's official estimate of about 1.5 (for petroleum consumption) as well as an earlier estimate by Gonzalo.[3/] The disparity could be attributed to the difference in the time period used in the estimation. While the Ministry of Energy and Gonzalo used annual data which extends even to the 1960's (an era of cheap energy), we utilized semestral data for the more recent period of high cost energy and conservation that could have significantly changed this parameter.

A semestral intercept dummy(Ds) is also found to shift first semester consumption of refined petroleum products by a hefty $83.22 \times 10^{10}$ kilocalories.

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[3/] See Ministry of Energy /4/ and Gonzalo /3/.

Coal and Hydrogeothermal Power. Coal imports (eqn. (6)) fill the domestic coal consumption-production gap. For lack of coal inventory data or actual consumption figures, our coal consumption data are really apparent consumption derived implicitly from production and trade figures.[4/]

Domestic demand for coal was found to be significantly related to the reciprocal of its real price and gross domestic product (eqn. (7)). In this particular specification, demand for coal becomes more price inelastic over time. Its price elasticity estimate for second semester of 1979 is -0.248 compared to its elasticity at mean values of -0.663, implying the growing importance of coal as an alternative energy cource.

Income elasticity for coal, on the other hand, is very high (3.495 in the second semester of 1979 and 5.506 at the means). Although coal is becoming less income elastic, its current income elasticity is still substantially high indicating its potential as another energy source.

An alternative commercial energy source is hydro-geothermal electricity whose consumption ($CE_{hg}$) we just equate to an exogenously determined production level ($PE_{hg}$). For obvious reasons there is no inventory change nor trade in hydro-geothermal power. Production of

[4/] A similar concept of apparent consumption applied to energy data is used by the U.N. See /6/.

hydro-geothermal electricity can be treated as partly policy-influenced considering the government's hydro-geothermal power development program.

Total System Energy Consumption. Eqns. (9 - (11) define three alternative concepts of the economy's total energy consumption. The most common way is to define it in terms of consumption of primary energy inputs (CPE of crude petroleum, coal and hydro-geothermal electricity as given in eqn. (9). However, a better alternative would be to adjust this for consumption from net energy trade and inventory change of refined petroleum products ($GE_{rp}$ in eqn. (4)). In eqn. (10), CE' provides a more comprehensive definition incorporating these refinements. CE' in effect defines energy consumption by all consuming sectors including all losses in energy transformation in both petroleum refining and electricity generation and transmission. Still, a third definition (CE) which is variant of CE' is given in eqn. (11) and is really a post-petroleum refinery definition of total energy consumption since it excludes refinery losses and production of energy by-products ($LE_{rp}$ in eqn. (17)). As can be seen later, among these three definitions, CE proved to be the most significant variable in the economy's aggregate production function. CE* in eqn. (12) values CE in terms of individual energy products consumption and their respective prices.

Energy Consumption in Consuming Sector. The consuming sector consists of households and the non-energy producing industries. It, therefore, excludes petroleum refineries and electrical utilities which are classified under the energy transformation sector. We have broadly divided energy consumption by the consuming sector into two forms: electrical and non-electrical energy. Non-electrical energy consumption consists mainly of refined petroleum products and a relatively small share of coal.

Total energy demand function for the consuming sector is given in eqn. (13). The implied price elasticity in 1973 (second semester) is -0.084 becoming more elastic in 1979 (second semester) with an estimate of -0.176. Income elasticity, on the other hand, is close to unity with a value of 0.912 in 1979 (second semester).

Consumption of non-electrical energy by the consuming sector as given in eqn. (14) implies a mean price elasticity of -0.157 and mean income elasticity of 0.824. These compare with 1979 (second semester) values of -0.204 and 0.958 respectively.

Consumption of electrical energy by the consuming sector is the difference between its consumption of total energy and non-electrical energy as given by eqn. (15). It can be shown from eqns. (13), (14), (15), (26), (33), and (35) that the price elasticity of demand for electrical energy by the consuming sector can be expressed as

$$e\ (CE_{Cel},\ (\frac{Pe_{el}}{P}) = -1452.76034\ (\frac{Pe_{el}/P}{CE_C})$$

while the income elasticity is given by

$$e\ (CE_{Cel}\ ,\ Y) = 0.00483\ (\frac{Y}{CE_{Cel}})$$

The computed price and income elasticity for electricity consumption for second semester of 1979 is -0.356 and 0.487, respectively, compared with their respective second semester 1973 estimates of -0.358 and 0.538. Demand for electrical energy is, therefore, more price responsive compared to non-electrical energy (mainly refined petroleum products). This could be explained by the fact that the absolute price of electricity is several times higher than other secondary products and, therefore, solicits very strong substitution and conservation responses. Consumption of electrical energy is, however, seen to be quite income inelastic as compared to the almost unitary elasticity for non-electrical energy.

Energy Losses in Transformation Sector. Total system energy losses in conversion, transmission and production of non-energy by-products ($LE_T$) is derived in eqn. (16) as the difference between total system energy consumption (CE') and productive energy consumption of the consuming (non-energy producing) sector ($CE_C$). $LE_T$ would thus consist of energy losses in both petroleum refineries and electrical utilities. Eqn. (17), on the other hand, focuses on oil refinery losses in transforming crude petroleum into refined petroleum products ($LE_{rp}$).

Total System Energy Production and Imports. Eqn. (18) defines total post-refinery energy production as the sum of the production of refined petroleum products, coal and hydro-geothermal power. This definition, however, would include a substantial input of imported crude oil used in producing $PE_{rp}$. Thus we can redefine total system energy production to include only primary indigenous energy sources (PPE) as given in eqn. (19). Total energy imports (ME) is simply the sum of crude petroleum, refined petroleum products and coal imports (eqn. 20). This can also be expreseed in peso terms as in eqn. (21).

Energy Prices. The pricing mechanism in the petroleum industry is summarizad in eqns. (22) - (24). Because of data constraints, we decided to measure prices of refined petroleum products at the wholesale level (ex-Pandacan), instead of retail or pump prices. As such the price data used do not include the dealer's mark-up and freight charges. In eqn. (22) the price of refined petroleum products (in million pesos/$10^{10}$ kilocalories) is decomposed into $pp_{rp}$, the wholesale posted price (pre-tax), and the tax components consisting of specific taxes, ($t_s$), the special fund contribution ($t_{sf}$), and the equalization difference (ed). The pre-tax wholesale price, on the other hand, is postulated in eqn. (23) to be behaviorally related to the so-called duty-paid landed cost of crude petroleum ($\$pd_{cp}$) and the exchange rate (er). This is very important relation that captures the resultant price behavior (including lags) of both oil firms and government's institutional price-setting. Implied elasticity of $pp_{rp}$ with respect to ($\$pd_{cp}$ . er) in 1979 (second semester) is 0.728 in the short run and 1.019 in the long run, higher than pre-energy crisis (second semester 1973) values of 0.532 and 0.744, respectively, and implying an increasing response of domestic prices of petroleum products to the duty-paid landed cost. The equation also indicates a rapid domestic posted price adjustment with a mean lag of only 0.40 sesmesters or 2.4 months, with approximately 71.4 per cent of total response of $pp_{rp}$ felt during the current period. The duty-paid landed cost of crude petroleum, for our purpose, is defined as the dollar C.I.F. price ($\$pc_{cp}$) plus the ad valorem tariff on crude petroleum ($tm_{cp} \cdot \$pc_{cp}$) as seen in eqn. (24).

Eqn. (25) defines the average price of energy (net of oil refinery losses) consumed by the entire economy (pe) while eqn. (26) gives the effective energy price charged to the consuming sector ($pe_C$) as a weighted price of electrical and non-electrical energy. In first semester 1979, pe and $pe_C$ were about ₱1.68 million and ₱2.04 million (both per $10^{10}$ kilocalories), respectively, compared to only ₱0.24 million and ₱0.29 million, respectively, in first semester 1970.

Non-electricity price ($pe_{nel}$) is related to the price of refined petroleum products ($pe_{rp}$), its main component (eqn. (27)). Computed elasticity at the means of $pe_{nel}$ with respect to $pe_{rp}$ is 1.016.

Likewise, electricity price ($pe_{el}$) is determined by the price of refined petroleum products, these being the major input to electricity production (eqn. 28 ). A slope and intercept dummy variable for the energy crisis period (De = 1 after 1973, 0 otherwise) came out significant. The slope dummy variable drastically reduced the coefficient of $pe_{rp}$ from 6.589 to 0.587 while the intercept shifted by 3.875. The resulting elasticity estimates of $pe_{el}$ with respect to $pe_{rp}$ were 1.376 in second semester 1973 (pre-energy crisis) and 0.233 in second semester 1979 (during energy crisis). This drop in the elasticity values reflects perhaps the institutional price-setting behavior of government authorities in reluctantly granting rate increases in electricity despite spiralling oil prices because of the strong pressure from electricity consumers.

Eqn. (29) defines the effective dollar import price of energy imports while eqn. (30) gives the effective domestic price of coal as a weighted average of domestically produced and imported coal. Eqns. (31) - (38) transforms actual energy prices into indices (1972 = 100).

Energy Efficiency and Self- Sufficiency Ratios. Macroeconomic energy efficiency is defined as gross domestic production per unit of energy input (eqn. (39)). *A priori* we would expect this to be increasing from the onset of the energy crisis as conservation measures are adopted. Eqn. (40) focuses on the efficiency of energy conversion in the petroleum refineries. Here we define energy efficiency as refined petroleum products output per unit of crude petroleum input. Historically, this ratio has also been improving as was shown previously.

Energy self-sufficiency can be measured by the ratio between indigenous production of primary energy and total energy consumption (inclusive of losses) of the economy as in eqn. (41). Self-sufficiency in crude petroleum alone can also be measured as the ratio of domestic production of crude petroleum to total crude petroleum consumption (eqn. (42)).

Macroeconomic Sub-Model

The macroeconomic sub-model provides an integrating framework that links the energy variables with economic variables. It is general equilibrium in nature and contains equation blocks for aggregate production and expenditures, wage rates and prices, money supply and demand, government revenues and expenditures, and the balance of payments.

In view of the constraint imposed by energy inputs on the economy, the model is constructed with a basically supply-determined framework.

Aggregate Production. Eqn. (43) is a modified aggregate production function which is really a linearized version of a constant returns to scale production function with three inputs, namely, labor (N), capital (K) and energy (CE), and a shift parameter (t). The inclusion of an intermediate input, energy, necessitates a redefinition of output from a value added concept (returns to primary factors) such as GDP (Y) to gross output (Y') defined to include the real value of intermediate energy input (Ce) as given in eqn. (45). Aggregate supply, however, is not Y' but Y or GDP (eqn. (44) in conformity with national income accounting.

We could rewrite eqn. (43) in the following form:

$$Y' = (7.43677 + 1.65788\ t)\ N + 0.05339\ K + 3.31591\ CE$$

from which we could readily infer the marginal product of each factor input:

$$\frac{\partial Y'}{\partial N} = 7.43677 + 1.65788\ t$$

$$\frac{\partial Y'}{\partial K} = 0.05339$$

$$\frac{\partial Y'}{\partial CE} = 3.31591$$

The marginal productivity of labor is seen to be increasing over time. This seems plausible considering the more rapid growth of capital stock relative to labor as evidenced by an increase in the capital-ouput ratio from about 6.0 (semestral basis) in the 1950's to around 9.0 at present. In the absence of actual employment data by semester (call this $N'$, in thousands) we have used the Central Bank employment index for N. However, to compute for the marginal productivity per unit of employment (instead of per index point), it is necessary to have an auxillary equation linking $N'$ and N. After adjusting available NCSO employment data (mostly May and October figures) to approximate semestral average, we came out with rough transformation equations linking $N'$ and N.

OLS: $N' = -671.56150 + 124.97484\ N$
$\quad (9.31185)$
$\bar{R}^2 = 0.83449 \quad D.W. = 1.12114$

OLSAC: $N' = 1160.30240 + 109.58311\ N$
$\quad (5.64291)$
$\bar{R}^2 = 0.64467 \quad D.W. = 1.46381 \quad \rho = 0.43943$

Using the second equation (with autocorrelation correction) the marginal productivity per unit of labor can be computed as follows:

$$\frac{\partial Y'}{\partial N'} = \left(\frac{\partial Y'}{\partial N}\right)\left(\frac{\partial N}{\partial N'}\right) = \frac{7.43677 + 1.65788\ t}{109.58311}$$

The computed marginal productivity of labor for second semester 1979 is ₱741 per year at constant 1972 prices or about ₱1,918 in current prices. This is also increasing at the rate of ₱30 per year in real terms or ₱78 in current prices. The current marginal productivity of labor is substantially lower than the actual wage at present. This finding supports our contention in a later section that wages are set not by labor supply and demand considerations but by some institutional mechanism responding to price movements with some lag.

The computed marginal productivity of capital of 5.3 per cent per semester or about 11.0 per cent per annum (compounded) seems a reasonable estimate when compared to actually prevailing rates of return. However, the marginal productivity of energy input of about ₱3.31 million per $10^{10}$ kilocalories is almost twice the observed actual price of energy (₱1.68 million per $10^{10}$ kilocalories in second semester 1979), indicating that energy is still relatively underpriced when compared to its contribution to output.

Eqn. (46) is our definition of capital stock while eqn. (47) transforms real GDP into current terms.

Aggregate Expenditures. The consumption function in eqn. (48) is quite unique in that aside from disposable income (a flow variable) which is used as a proxy for total wealth. Consumption need not be determined by current disposable income but also from accumulated wealth and savings. The personal consumption deflator ($P_{Cp}$) was used as the deflator of total liquidity (Z'). In this equation, Z' provides one link between the real and the monetary sectors while $P_{Cp}$ links with the energy sub-model via the effect of increases of energy prices on $P_{Cp}$. The computed marginal propensity to consume of 0.31 is relatively small and can be attributtd, firstly, to our definition of disposable income (Y-T) which is an overestimate because, aside from personal income, it also includes corporate income. Secondly, the presence of the liquid wealth variable captures a very significant explanation of consumption.

Real government consumption ($C_g$) is determined in eqn. (49) from the exogenously given current value of government consumption ($C_g$*) and its price index ($P_{Cg}$). Fiscal planners estimate revenues and expenditures in nominal terms, hence $C_g$* instead of $C_g$ is treated as a policy variable. Total real and current consumption are defined in eqns. (50) and (51), respectively.

Total real investment is determined from the national income accounting identity in eqn. (52). As in government consumption, current government investment ($I_g$*) is taken as policy-determined and real government investment is found by deflating $I_g$* with its price index ($P_I$) (eqn. (53). Private investment ($I_p$) is then the difference between total investment and government investment (eqn. (54)).

Employment and Wages. In our empolyment equation (eqn. (55)), labor denand (N) is a function of an activity variable, GDP (or Y), wage rate index (W) and the GDP deflator (P). N is seen to have an inelastic response to Y, its elasticity being 0.650 in second semester 1979. Nominal wage is also seen to have a stronger impact than price their elasticity estimates for second semester 1979 being -0.938 for wage and 0.600 for price. Ceteris paribus, prices would have to grow by about one and one-half times the growth in wages if employment level is to be maintained.

For wage behavior, we postulate an institutionally set wage rate either through minimum wage legislation or collective bargaining agreements aimed at regaining labor's purchasing power. The net effect is seen to be an incomplete lagged indexation pattern of wages to prices. In eqn. (56), a simple Koyck lag is introduced in order to estimate wage reaction to price increases. In terms of elasticities (computed for second semester 1979), a short run (first period) elasticity of wages with respect to prices of 0.232 is estimated, or only 37.8 per cent of the long run elastivity of 0.615. The computed mean lag of 1.646 semesters implies that it takes about 10 months before even one-half of the full wage response is felt. Wages, therefore, are not only inelastically adjusted to prices but also lag significantly behind prices.

Prices. The price level equation (eqn. (57) is a mixed explanation for inflation. Cost push factors are embodied in the energy price index variable ($Pe_C$) and the wage rate (W). We also include a monetary variable, domestic liquidity (Z'), considering the rapid growth of money supply in recent years and its high correlation with prices. $Pe_C$, the effective energy price index for the consuming sector, came out more significantly in the price equation than Pe, the effective energy price index for the economy (inclusive of transformation losses), and was therefore used. $Pe_C$ represents not only price movements in imported crude oil prices but also changes in policy-controlled taxes in energy consumption and tariffs on energy imports as well as movements in the exchange rate.

Eqns. (56) and (57) jointly exhibit a feedback mechanism between wages and prices. Computed elasticities of prices with respect to energy price, wages and domestic liquidity for second semester 1979 are 0.267, 0.326, and 0.285, respectively. The relatively high elasticity of prices with respect to wages can probably be attributed to the relatively higher share of the wage bill compared, for example, to energy expense in the cost of production. However, the particular form of the wage variable (log.W) in eqn. (57) shows a declining importance of wage increases and an increasing significance for energy price and monetary expansion over time as primary determinants for inflation. The elasticity estimates for 1979 are higher than the mean elasticities with respect to energy price (0.214) and money supply (0.228) but elasticity with respect to wages exhibited a decline from its mean value of 0.542. Eqn. (58) computes for the semestral inflation rates (p) in terms of the GDP deflator (P).

Consumer prices, as represents by the deflator for personal consumption expenditures ($P_{Cp}$) is similarly linked to energy price in the consuming sector ($Pe_C$) and wages (W). However, we chose to include credits to the private sector (CPS) as our monetary variable because of its direct effect on consumer spending and hence, demand pressures on consumer prices. Elasticity estimates of $P_{Cp}$ with respect to $Pe_C$, W, and CPS in second semester 1979 are 0.247, 0.464 and 0.323, respectively.

A Koyck lag formation is done for the deflator for government consumption ($P_{Cg}$) in eqn. (60). We do not include a monetary variable in the specification. A slow reaction of $P_{Cg}$ to changes in energy prices and wages is seen with a mean lag of 0.71 semesters or 4.3 months. This can probably be explained by the fact that most of Cg are government purchases of labor services whose wages, in particular, have been shown to be slow in responding to price increases. Computed shortrun elasticity for first semester 1979 is 0.437 while longrun elasticity is 1.036.

In order not to overdetermine the system, the deflator for investment ($P_I$) is derived residually from the ratio between current investment expenditures and real investment expenditures (eqn. (61)).

<u>Money and Interest Rate.</u> In this model, we adopt the broad definition of money supply (commonly referred to as $M_3$) or domestic

liquidity (our Z). Eqn. (63) presents a simplified accounting of period to period changes in money supply and its components as found in the monetary survey of the Central Bank. Domestic credits to the private sector (CPS) is assumed to be policy-controlled through the traditional Central Bank monetary tools. Credits to the government sector (CGS),)and net foreign assets (NFA), however, are endogenous to the model and are determined in the fiscal and balance of payments equations, respectively.

In the demand for money equation (eqn. (62), on the other hand, we have redefined Z (beginning of period balance) to Z' (semestral average balance) as given in eqn. (64). Money demand (in real terms) is specified as a function of the effective interest rate (R), gross domestic product (Y), a seasonal dummy variable (Ds) and another dummy variable that captures a structural shift implied by the energy crisis period (De = 1 from first semester 1974 to second semester 1979). This particular specification constrains the elasticity of Z' with respect to P to unity. Money demand is seen to be inelastic with respect to the interest rate (-0.306 at the means, -0.234 in second semester 1979). However, it is elastic with respect to GDP with a value of 1.276 at the means and 1.239 in second semester 1979.

Eqns. (62) and (64) (together with (63)) jointly solve for domestic liquidity (Z' or Z) and the interest rate (R).

Government Revenues and Expenditures. Eqn. (65) defines the fiscal deficit as the difference between current government expenditures ($Cg^* + Ig^*$) and revenue from taxes ($T^*$) and other sources ($F^*$). Any fiscal deficit (surplus) will register as an increase (decrease) in money supply (eqn. (63)) through ($CGS - CGS_{-1}$), the change in claims to the government sector of the monetary system.

In order to analyze the impact of energy taxes, we have divided total taxes into total energy taxes ($Te^*$) and non-energy taxes ($Tne^*$) in eqn. (66). In eqn. (67), an institutional relation for total energy taxes is specified to include specific tax ($t_s$) and special fund ($t_{sf}$) applied on energy consumption of refined petroelum products ($CE_{rp}$) and an ad valorem tax ($t_{mcp}$) applied on the value of crude petroleum imports ($ME_{cp} \cdot \$pc_{cp} \cdot er$). The impact of energy taxes is double-edged. While it has a direct effect on increasing energy prices and thus, overall prices, it also has an anti-inflationary impact through reduction of the fiscal deficit, and hence, money supply. Its net effect, however, can only be known through simulation of the model.

Non-energy taxes is further decomposed in eqn. (68) into direct taxes ($TD^*$), a fiscal policy tool, and non-energy indirect taxes ($TIne^*$). A behavioral equation is formulated for non-energy indirect taxes to be a function of current GDP and lagged $TIne^*$ (eqn. (69)). Short and long-run elasticities of $TIne^*$ with respect to $Y^*$ of 0.543 and 1.067 for second semester 1979 are exhibited. A relatively slow response of $TIne^*$ to $Y^*$ is ssen from its mean lag value of 0.965 semesters or almost six months. This may well explain why persistent fiscal deficits have exhibited in the past. Government expenditures have been outstripping revenues because of a longer lag of revenue collections compared to expenditures in response to inflation or income growth.

Eqn. (70) transforms current tax revenues (T*) into real value (T).

Balance of Payments. The balance of payments surplus is defined in eqn. (71) as the sum of the surplus on current account (X* - M*) and capital account ($K_f$*). This is reflected in a change in net foreign assets (NFA - $NFA_{-1}$) component of domestic liquidity. X* and $K_f$* are treated exogenously while current imports is decomposed into current energy imports (ME*) and current non-energy imports (Mne*) in eqn. (72). Current energy and non-energy imports are given in eqns. (73) and (74), respectively. In real value terms eqn. (75) also decomposes imports into energy and non-energy components. Eqn. (76) defines real energy imports. Real non-energy imports, on the other hand, is related to an activity variable Y, relative price of non-energy imports (Pmne/P) and a foreign exchange constraint variable proxied by the export price index (Px) as in eqn. (77). The mean elasticities of non-energy imports with respect to relative prices, GDP and export price index are -0.308, 0.554 and 0.347, respectively.

In eqn. (78) we transform the peso to dollar exchange rate (a policy variable) into its index form. Finally, eqns. (79) and (80) are definitional equations linking the dollar export and non-energy import price indices respectively with their peso equivalents through the exchange rate index.

USES OF THE MODEL FOR POLICY SIMULATION

The complete model can be described as a dynamic nonlinear simultaneous system of equations whose solution would require an iterative computer algorithm. Assuming that the model is dynamically stable, various simulation experiments can be performed with it.

For example, one may be interested to quantify the costs to the economy of the energy crisis in the past in terms of losses in gross domestic product, employment, investment and other target variables. Simple "with" and "without" simulations of the model can be performed and the two dynamic paths resulting for each endogenous variable can be compared. These marginal differences can then be attributed to the assumed change in the energy crisis variable (e.g., increases in dollar C.I.F. price of imported oil, $\$pc_{cp}$ in our model.).

An interesting question that can be analyzed by historical simulation of the model, however, is whether the economy could have performed better had an alternative policy mix been implemented. Thus, we would try to simulate the economy's performance given, for instance, lower energy tax rates ($t_s$, $t_{sf}$ and $t_{mcp}$ in the model), a balanced budget ($CGS - CGS_{-1} = 0$), a tightening of credits to the private sector (CPS) or money supply in general, a further devaluation of the peso (er) or any combination of policy instruments which could have been more appropriately implemented in the past.

Another interesting issue is to know the impact of the oil exploration program and the hydro-geothermal power development program had these been initiated much earlier. We could then assume domestic production of oil ($PE_{cp}$) and hydro-geothermal power ($PE_{hg}$) to have higher shares to total primary energy consumption in the past and simulate the impact on the economy.

However, the most useful application of the model would be in short-term and evaluation of alternative future policy regimes designed to counteract adverse changes in the non-controllable variables. Alternative future scenarios can be simulated (e.g., high cost of energy scenario versus a moderate price of enrgy scenario) and possible ways of minimizing the effect through monetary, fiscal and balance of payments policy.

Future assessments and revisions of the NEDA Five-Year Development Plan would find particular use for such simulation experiments especially when projecting internally consistent (in the accounting and behavioral sense) macroeconomic variables.

The simulation examples just outlined are but a few of the many possible applications of the model, depending on the purpose of the user.

CONCLUSIONS

In this paper, we have tried to show that it is possible to construct a macroeconometric model with an explicit energy sector and the advantage of such an approach to planning a policy evaluation. We have tried to incorporate in the model quite a number of fiscal, monetary, balance of payments and energy policy instruments that can be manipulated in practice.

The estimates of the structural equations confirm our hypothesis that significant changes in parameter values of the behavioral equations have occurred, therefore, justifying the construction of a new model.

We have shown that with the use of recent semestral data, significant lagged variables as well as seasonal, slope and intercept dummy variables are appropriately introduced. Hence short-run and long-run elasticities, seasonal and structural shifts may be estimated.

We have tried to show also that it is possible to construct consistent semestral energy data on consumption, production trade and prices from various sources and how these might link with the macro-economy.

The model can be extended by further disaggregating energy demand into demand for specific refined petroleum products. Sectoral demand by households and industries can also be done. Modeling each industrial sector, however, would require estimating sectoral production functions. Fortunately, it is well established that energy consumption is a highly correlated variable with capital stock and can, therefore, serve as a proxy variable for sectoral capital stock.

DATA USED IN THE MODEL

## DATA USED IN THE MODEL

## ENDOGENOUS VARIABLES

| Year and Semester | | C | C* | Ce | CE | CE' | CE* | $CE_C$ | $CE_{Cel}$ | $CE_{Cnel}$ | $CE_{co}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 20383.00 | 14929.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 13.99 |
| 1970 | I | 20575.00 | 15651.00 | 1064.17 | 3600.27 | 3970.59 | 866.46 | 3088.31 | 207.71 | 2880.60 | 15.59 |
| | II | 20741.00 | 17415.00 | 1047.07 | 3542.41 | 3909.54 | 929.44 | 3233.41 | 225.95 | 3007.96 | 8.08 |
| 1971 | I | 21421.00 | 18945.00 | 1142.50 | 3865.28 | 4141.55 | 1086.14 | 3284.68 | 231.88 | 3052.80 | 7.56 |
| | II | 21632.00 | 20893.00 | 1182.20 | 3999.61 | 4388.71 | 1129.72 | 3462.93 | 252.10 | 3210.83 | 15.03 |
| 1972 | I | 22210.00 | 22210.00 | 1222.41 | 4135.65 | 4534.42 | 1179.72 | 3593.59 | 235.04 | 3358.55 | 6.56 |
| | II | 22972.00 | 22972.00 | 1210.74 | 4096.14 | 4490.32 | 1202.69 | 3592.38 | 282.98 | 3309.40 | 15.25 |
| 1973 | I | 23873.00 | 24706.00 | 1387.65 | 4694.67 | 5111.60 | 1385.52 | 3993.64 | 279.10 | 3714.54 | 14.01 |
| | II | 24279.00 | 29766.00 | 1304.63 | 4413.81 | 4873.64 | 1473.03 | 3799.75 | 291.53 | 3508.22 | 8.56 |
| 1974 | I | 24662.00 | 34581.00 | 1345.18 | 4550.99 | 4901.16 | 3370.27 | 3640.40 | 281.01 | 3355.68 | 14.17 |
| | II | 25419.00 | 40044.00 | 1274.54 | 4311.98 | 4543.91 | 3974.07 | 3552.03 | 298.00 | 3254.03 | 17.55 |
| 1975 | I | 25935.00 | 42176.00 | 1385.90 | 4688.74 | 4915.98 | 4327.92 | 3842.17 | 319.24 | 3522.93 | 17.04 |
| | I | 26267.00 | 43374.00 | 1472.10 | 4980.37 | 5204.69 | 4844.89 | 3976.40 | 308.07 | 3668.33 | 41.76 |
| 1976 | I | 27461.00 | 49959.00 | 1472.08 | 4980.31 | 5202.84 | 5594.54 | 4036.40 | 327.06 | 3709.34 | 37.25 |
| | II | 28010.00 | 50886.00 | 1498.34 | 5069.15 | 5328.68 | 5785.52 | 4174.82 | 359.72 | 3815.10 | 33.37 |
| 1977 | I | 28479.00 | 56836.00 | 1602.45 | 5421.36 | 5727.12 | 6161.08 | 4243.84 | 345.95 | 3897.89 | 80.57 |
| | II | 29610.00 | 60279.00 | 1641.43 | 5553.24 | 5810.00 | 6641.75 | 4477.10 | 371.68 | 4105.42 | 94.24 |
| 1978 | I | 30518.00 | 64182.00 | 1671.10 | 5653.62 | 6021.57 | 6877.57 | 4385.67 | 386.62 | 3999.05 | 88.13 |
| | II | 31188.00 | 68872.00 | 1658.72 | 5611.73 | 5982.19 | 6849.15 | 4585.12 | 403.09 | 4182.03 | 74.37 |
| 1979 | I | 3190.00 | 76670.00 | 1695.57 | 5736.42 | 6093.85 | 7698.64 | 5129.25 | 427.20 | 4305.73 | 69.69 |
| | II | 32506.00 | 85351.00 | 1729.37 | 5850.76 | 6253.90 | 9803.22 | 1.00 | 441.70 | 4102.47 | 76.81 |

DATA USED IN THE MODEL

ENDOGENOUS VARIABLES

| Year and Semester | | $CE_{cp}$ | $CE_{hg}$ | $C_g$ | $CE_{rp}$ | CGS | $C_p$ | CPE | EE | $EE_{rp}$ | ER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | I | 1.00 | 71.96 | 2038.00 | 3435.18 | 3939.00 | 18345.00 | 1.00 | 1.00 | 1.00000 | 58.75 |
| 1970 | I | 4760.20 | 88.64 | 2161.00 | 3496.04 | 3618.00 | 18414.00 | 4864.43 | 6.94 | 0.92220 | 85.24 |
| | II | 4712.35 | 88.78 | 2067.00 | 3445.55 | 3880.00 | 18674.00 | 4809.71 | 7.31 | 0.92210 | 95.37 |
| 1971 | I | 4712.84 | 106.23 | 2307.00 | 3751.49 | 3501.00 | 19114.00 | 4826.63 | 6.91 | 0.94138 | 96.46 |
| | II | 4981.78 | 106.41 | 2247.00 | 3878.17 | 3703.00 | 19385.00 | 5103.22 | 6.63 | 0.92190 | 96.36 |
| 1972 | I | 4673.24 | 109.94 | 2393.00 | 4019.15 | 3227.00 | 19817.00 | 4789.74 | 6.50 | 0.91467 | 98.37 |
| | II | 4612.00 | 108.14 | 2867.00 | 3972.75 | 3163.00 | 20105.00 | 4735.39 | 6.92 | 0.91453 | 101.63 |
| 1973 | I | 5225.42 | 79.97 | 2867.00 | 4600.69 | 1477.00 | 21006.00 | 5319.40 | 6.62 | 0.92021 | 101.48 |
| | II | 4307.99 | 81.72 | 2968.00 | 4323.53 | 1147.00 | 21311.00 | 4398.27 | 6.62 | 0.89326 | 103.58 |
| 1974 | I | 4276.13 | 102.38 | 3144.00 | 4434.44 | 61.00 | 21518.00 | 4392.68 | 7.07 | 0.91811 | 100.76 |
| | II | 3989.80 | 102.23 | 3589.00 | 4192.20 | -91.00 | 21830.00 | 4109.58 | 7.11 | 0.94187 | 102.75 |
| 1975 | I | 4559.09 | 92.49 | 3490.00 | 4579.21 | 705.00 | 22445.00 | 4668.62 | 7.07 | 0.95016 | 105.42 |
| | II | 4757.86 | 102.23 | 3497.00 | 4836.38 | 4253.00 | 22770.00 | 4901.85 | 6.92 | 0.95285 | 111.88 |
| 1976 | I | 4613.60 | 115.78 | 3630.00 | 4827.28 | 5273.00 | 23831.00 | 4766.63 | 7.35 | 0.95177 | 111.70 |
| | II | 4876.40 | 125.17 | 3835.00 | 4910.61 | 5986.00 | 24175.00 | 5034.94 | 7.37 | 0.94678 | 111.36 |
| 1977 | I | 4909.72 | 90.45 | 3674.00 | 5250.34 | 5649.00 | 24805.00 | 5080.74 | 7.12 | 0.93772 | 111.16 |
| | II | 5051.78 | 96.15 | 3782.00 | 5362.85 | 7241.00 | 25828.00 | 5242.17 | 7.27 | 0.94917 | 110.77 |
| 1978 | I | 5232.58 | 118.63 | 3891.00 | 5446.86 | 8202.00 | 26627.00 | 5439.34 | 7.18 | 0.92968 | 110.45 |
| | II | 5267.37 | 121.98 | 4034.00 | 5415.38 | 2206.00 | 27154.00 | 5463.72 | 7.44 | 0.92967 | 110.37 |
| 1979 | I | 5237.99 | 120.45 | 4050.00 | 5546.28 | 7529.00 | 27870.00 | 5428.13 | 7.28 | 0.93176 | 110.58 |
| | II | 5515.93 | 124.28 | 4175.00 | 5649.67 | 8637.00 | 2831.00 | 5717.02 | 7.61 | 0.92691 | 110.60 |

## DATA USED IN THE MODEL

## ENDOGENOUS VARIABLES

| Year | Semester | ES | $ES_{cp}$ | $GE_{rp}$ | I | $I_g$ | $I_p$ | K | $LE_{rp}$ | $LE_T$ | M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 1.00000 | 1.00000 | -616.07 | 5933.00 | 1609.00 | 4320.00 | 1.00 | 1.00 | 1.00 | 5335.00 |
| 1970 | I | 0.02624 | 0.00000 | -893.84 | 5595.00 | 789.35 | 4805.65 | 236794.00 | 370.32 | 882.28 | 5081.00 |
| | II | 0.02475 | 0.00000 | -900.17 | 5240.00 | 503.47 | 4736.53 | 242389.00 | 367.13 | 675.63 | 4909.00 |
| 1971 | I | 0.02748 | 0.00000 | -685.08 | 5942.00 | 915.80 | 5026.20 | 247629.00 | 276.27 | 856.87 | 4983.00 |
| | II | 0.02759 | 0.00000 | -714.51 | 5284.00 | 663.82 | 4620.18 | 253571.00 | 389.10 | 925.78 | 5032.00 |
| 1972 | I | 0.02566 | 0.00000 | -255.32 | 5188.00 | 661.00 | 4527.00 | 258855.00 | 398.77 | 940.83 | 5060.00 |
| | II | 0.02747 | 0.00000 | -245.07 | 5302.00 | 455.00 | 4657.00 | 264043.00 | 394.18 | 897.94 | 5274.00 |
| 1973 | I | 0.01831 | 0.00000 | -207.80 | 5764.00 | 632.45 | 5131.55 | 269345.00 | 416.93 | 1117.96 | 4892.00 |
| | II | 0.01842 | 0.00000 | 475.37 | 5849.00 | 656.94 | 5192.06 | 275109.00 | 459.83 | 1073.89 | 5908.00 |
| 1974 | I | 0.02372 | 0.00000 | 508.48 | 8350.00 | 1117.60 | 7232.40 | 280958.00 | 350.17 | 1264.47 | 6081.00 |
| | II | 0.02565 | 0.00000 | 434.33 | 7301.00 | 2047.04 | 5253.96 | 289308.00 | 231.93 | 991.88 | 6302.00 |
| 1975 | I | 0.02222 | 0.00000 | 247.36 | 9042.00 | 2160.23 | 6881.77 | 296174.00 | 227.24 | 1073.31 | 6597.00 |
| | II | 0.02765 | 0.00000 | 302.84 | 9942.00 | 3409.85 | 6532.15 | 304835.00 | 224.32 | 1228.29 | 6908.00 |
| 1976 | I | 0.02884 | 0.00000 | 436.21 | 10145.00 | 2132.74 | 8012.26 | 314492.00 | 222.53 | 1166.44 | 6357.00 |
| | II | 0.02965 | 0.00000 | 293.74 | 10030.00 | 2216.69 | 7363.30 | 324324.00 | 259.53 | 1153.86 | 6822.00 |
| 1977 | I | 0.02935 | 0.00000 | 646.38 | 9783.00 | 2358.70 | 7424.30 | 334404.00 | 305.76 | 1483.28 | 6916.00 |
| | II | 0.03039 | 0.00000 | 567.83 | 11045.00 | 3003.07 | 8041.93 | 344187.00 | 256.76 | 1332.90 | 7133.00 |
| 1978 | I | 0.03089 | 0.00000 | 582.23 | 10868.00 | 2853.07 | 8014.92 | 355323.00 | 367.95 | 1635.90 | 7502.00 |
| | II | 0.03281 | 0.00000 | 518.47 | 11340.00 | 3032.49 | 8307.51 | 366290.00 | 370.46 | 1397.07 | 8056.00 |
| 1979 | I | 0.07219 | 0.04769 | 665.72 | 10995.00 | 2324.45 | 8670.55 | 377785.00 | 357.43 | 1360.92 | 8499.00 |
| | II | 0.17239 | 0.15900 | 536.88 | 12853.00 | 2598.46 | 10254.54 | 389289.00 | 403.14 | 1709.73 | 8827.00 |

DATA USED IN THE MODEL

ENDOGENOUS VARIABLES

| Year and Semester | | M* | Me | ME | ME* | $ME_{co}$ | $ME_{cp}$ | Mne | Mne* | N | NFA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 2852.00 | 489.97 | 4333.19 | 222.39 | 0.00000 | 4304.34 | 4845.03 | 2629.61 | 1.00 | -377.00 |
| 1970 | I | 3843.00 | 547.88 | 4845.30 | 351.11 | 0.03000 | 4834.89 | 4533.12 | 3491.89 | 94.60 | -880.00 |
| | II | 4393.00 | 556.47 | 4921.30 | 407.60 | 0.08000 | 4912.35 | 4352.53 | 3985.40 | 94.60 | -697.00 |
| 1971 | I | 4524.00 | 412.55 | 3648.48 | 468.39 | 0.00000 | 3620.32 | 4570.45 | 4055.61 | 97.30 | -638.00 |
| | II | 5124.00 | 696.66 | 6161.06 | 541.14 | 0.35000 | 6132.77 | 4335.34 | 4582.86 | 98.00 | -617.00 |
| 1972 | I | 5060.00 | 614.88 | 5437.88 | 567.27 | 0.16000 | 5432.67 | 4445.45 | 4492.73 | 99.40 | -1168.00 |
| | II | 5274.00 | 462.58 | 4090.95 | 509.08 | 0.04000 | 4058.80 | 4811.42 | 4764.92 | 100.70 | -978.00 |
| 1973 | I | 5943.00 | 568.87 | 5030.98 | 629.61 | 0.41000 | 5021.97 | 4323.12 | 5313.39 | 104.60 | 1453.00 |
| | II | 7449.00 | 542.72 | 4799.67 | 815.36 | 0.49000 | 4785.19 | 5365.28 | 6633.64 | 112.30 | 2671.00 |
| 1974 | I | 11732.00 | 560.60 | 4957.77 | 2018.09 | 0.29000 | 4541.11 | 5520.40 | 9713.91 | 122.30 | 3869.00 |
| | II | 13668.00 | 528.93 | 4677.72 | 2470.75 | 3.24000 | 4485.58 | 6273.07 | 11197.25 | 114.20 | 3437.00 |
| 1975 | I | 14155.00 | 583.13 | 5157.09 | 2664.44 | 0.31000 | 4943.04 | 6013.87 | 11490.56 | 111.20 | 1226.00 |
| | II | 15602.00 | 543.25 | 4804.37 | 2990.84 | 0.08000 | 4779.36 | 6364.75 | 12611.16 | 110.70 | -639.00 |
| 1976 | I | 15631.00 | 613.97 | 5429.82 | 3138.34 | 2.97000 | 5016.12 | 6243.03 | 12492.66 | 119.70 | -1828.00 |
| | II | 16210.00 | 635.62 | 5621.29 | 3624.08 | 0.53000 | 5157.88 | 6186.38 | 12585.12 | 121.80 | -2113.00 |
| 1977 | I | 18024.00 | 612.38 | 5415.77 | 3143.97 | 2.92000 | 4744.27 | 6303.62 | 14880.03 | 124.70 | -409.00 |
| | II | 16651.00 | 670.25 | 5927.51 | 4194.91 | 13.80000 | 5396.13 | 6512.75 | 12456.09 | 127.70 | -1093.00 |
| 1978 | I | 19495.00 | 615.43 | 5442.68 | 3464.13 | 20.74000 | 5115.51 | 6886.57 | 16030.87 | 128.90 | -714.00 |
| | II | 21826.00 | 657.37 | 5813.64 | 4009.90 | 0.06000 | 5439.98 | 7398.63 | 17816.10 | 129.13 | -2090.00 |
| 1979 | I | 24950.00 | 657.62 | 5815.83 | 4535.31 | 0.03000 | 4905.60 | 7841.38 | 20414.69 | 136.20 | -5795.00 |
| | | 28170.00 | 638.41 | 5645.92 | 5755.60 | 0.02000 | 4700.64 | 8188.59 | 22414.40 | 139.80 | -7164.00 |

DATA USED IN THE MODEL

ENDOGENOUS VARIABLES

| Year and Semester | | P | p | $P_{Cg}$ | $P_{Cr}$ | $P_I$ | Pe | $Pe_C$ | $Pe_{co}$ | $Pe_{el}$ | $Pe_{nel}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 72.81 | 1.00 | 81.50 | 72.32 | 65.01 | 1.00 | 1.00 | 13.99 | 1.00 | 1.00 |
| 1970 | I | 79.14 | 8.68 | 78.25 | 75.81 | 79.05 | 81.42 | 83.53 | 15.56 | 68.98 | 91.37 |
| | II | 85.44 | 7.97 | 88.19 | 83.50 | 87.19 | 83.17 | 88.42 | 8.00 | 68.98 | 97.52 |
| 1971 | I | 90.87 | 6.36 | 88.51 | 88.43 | 88.99 | 95.07 | 96.67 | 7.56 | 78.62 | 105.07 |
| | II | 96.54 | 6.23 | 99.19 | 96.27 | 97.77 | 95.56 | 97.27 | 14.68 | 79.02 | 104.99 |
| 1972 | I | 100.00 | 3.58 | 100.00 | 100.00 | 100.00 | 96.53 | 97.56 | 6.40 | 86.60 | 105.08 |
| | II | 100.00 | 0.00 | 100.00 | 100.00 | 100.00 | 99.34 | 102.44 | 15.21 | 111.17 | 98.42 |
| 1973 | I | 105.96 | 5.96 | 104.71 | 103.32 | 111.15 | 99.85 | 108.50 | 13.60 | 104.31 | 111.65 |
| | II | 135.36 | 27.75 | 108.79 | 124.52 | 154.50 | 112.91 | 121.61 | 8.07 | 104.31 | 127.05 |
| 1974 | I | 144.64 | 6.85 | 118.57 | 143.38 | 153.01 | 250.54 | 267.57 | 13.88 | 224.14 | 281.43 |
| | II | 168.93 | 16.79 | 146.78 | 159.30 | 192.52 | 311.80 | 337.23 | 14.31 | 284.67 | 345.10 |
| 1975 | I | 167.25 | -0.99 | 154.38 | 163.90 | 181.51 | 312.28 | 340.99 | 16.73 | 285.59 | 351.12 |
| | II | 166.25 | -0.60 | 158.91 | 166.08 | 194.06 | 329.11 | 350.51 | 41.68 | 285.59 | 372.04 |
| 1976 | I | 179.32 | 7.86 | 181.74 | 181.96 | 200.49 | 380.04 | 395.28 | 34.28 | 288.36 | 451.76 |
| | II | 181.20 | 1.05 | 179.32 | 182.04 | 205.49 | 386.13 | 402.05 | 32.84 | 288.36 | 433.98 |
| 1977 | I | 193.77 | 6.93 | 192.65 | 200.60 | 215.97 | 384.51 | 410.44 | 77.65 | 288.36 | 451.76 |
| | II | 201.06 | 3.77 | 195.95 | 204.69 | 209.35 | 404.63 | 427.14 | 80.44 | 288.36 | 474.00 |
| 1978 | I | 206.50 | 2.70 | 206.24 | 210.90 | 221.94 | 411.56 | 439.48 | 67.39 | 288.36 | 485.75 |
| | II | 218.01 | 5.56 | 211.68 | 222.19 | 241.78 | 412.92 | 433.29 | 74.31 | 288.36 | 477.07 |
| 1979 | I | 240.24 | 10.20 | 231.14 | 241.51 | 264.97 | 454.04 | 471.14 | 69.66 | 288.36 | 529.24 |
| | | 258.93 | 7.78 | 241.39 | 265.69 | 281.40 | 566.87 | 583.36 | 76.79 | 288.36 | 685.55 |

DATA USED IN THE MODEL

ENDOGENOUS VARIABLES

| Year and Semester | | $Pe_{rp}$ | Pme | $Pme | Pmne | Px | PE | pe | $pe_c$ | $pe_{co}$ | $pe_{el}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 4051.25 | 45.39 | 77.25 | 54.27 | 56.80 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| 1970 | I | 4389.25 | 64.09 | 75.76 | 77.03 | 90.83 | 0.23926 | 0.24067 | 0.29177 | 0.04680 | 0.98855 |
| | II | 4345.72 | 73.25 | 76.80 | 91.56 | 93.99 | 0.26090 | 0.26233 | 0.30884 | 0.06005 | 1.12666 |
| 1971 | I | 4436.57 | 113.54 | 117.70 | 88.73 | 105.33 | 0.27960 | 0.28100 | 0.33768 | 0.06463 | 1.13233 |
| | II | 4592.68 | 77.68 | 80.61 | 105.71 | 100.67 | 0.28072 | 0.28246 | 0.33976 | 0.10438 | 1.24092 |
| 1972 | I | 4274.47 | 92.26 | 93.78 | 101.07 | 100.00 | 0.28339 | 0.28531 | 0.34077 | 0.10781 | 1.59302 |
| | II | 4217.82 | 110.05 | 108.29 | 99.03 | 100.00 | 0.29062 | 0.29362 | 0.35784 | 0.07874 | 1.49475 |
| 1973 | I | 4808.49 | 110.68 | 109.06 | 122.91 | 122.55 | 0.29404 | 0.29513 | 0.37898 | 0.11940 | 1.49475 |
| | II | 3848.16 | 150.24 | 145.05 | 123.64 | 164.10 | 0.33240 | 0.33373 | 0.42477 | 0.12544 | 3.21192 |
| 1974 | I | 3925.96 | 359.99 | 357.27 | 175.96 | 208.19 | 0.74212 | 0.74056 | 0.93463 | 0.31160 | 4.07937 |
| | II | 3757.87 | 467.12 | 454.63 | 178.50 | 239.57 | 0.92365 | 0.92163 | 1.17795 | 0.33649 | 4.09252 |
| 1975 | I | 4331.85 | 456.92 | 433.43 | 191.07 | 230.69 | 0.92576 | 0.92305 | 1.19107 | 0.25892 | 4.09245 |
| | II | 4533.54 | 550.54 | 492.10 | 198.14 | 198.12 | 0.97547 | 0.97280 | 1.22432 | 0.22976 | 4.13214 |
| 1976 | I | 4391.07 | 511.15 | 457.60 | 200.11 | 187.35 | 1.12631 | 1.12333 | 1.38072 | 0.32728 | 4.13214 |
| | II | 4616.87 | 570.29 | 512.11 | 203.43 | 202.09 | 1.14268 | 1.14132 | 1.40437 | 0.31067 | 4.13214 |
| 1977 | I | 4603.96 | 513.40 | 461.83 | 236.05 | 204.79 | 1.14001 | 1.13654 | 1.43368 | 0.30996 | 4.13214 |
| | II | 4795.02 | 625.87 | 564.05 | 191.26 | 208.99 | 1.15800 | 1.19601 | 1.49199 | 0.32603 | 4.13214 |
| 1978 | I | 4864.63 | 562.88 | 509.62 | 232.78 | 223.82 | 1.22681 | 1.21649 | 1.53512 | 0.35421 | 4.13214 |
| | II | 4896.91 | 609.99 | 552.65 | 240.80 | 227.49 | 1.22263 | 1.22051 | 1.151348 | 0.34246 | 4.13214 |
| 1979 | I | 4880.56 | 689.65 | 623.65 | 260.35 | 265.02 | 1.32935 | 1.34206 | 1.64570 | 0.39668 | 4.13214 |
| | II | 5112.79 | 901.55 | 815.17 | 273.73 | 274.50 | 1.00000 | 1.67555 | 2.03769 | 0.39620 | 4.13214 |

DATA USED IN THE MODEL

ENDOGENOUS VARIABLES

| Year and Semester | | $pe_{nel}$ | $PE_{rp}$ | $pe_{rp}$ | PPE | $PP_{rp}$ | $\$pd_{cp}$ | $\$pme$ | R | T | T* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 1.00000 | 76.21 | 0.19759 | 85.95 | 0.16755 | 0.01563 | 0.01309 | 10.20 | 2283.89 | 1663.00 |
| 1970 | I | 0.24153 | 85.84 | 0.22256 | 104.20 | 0.19276 | 0.01548 | 0.01274 | 11.92 | 2874.79 | 2275.00 |
| | II | 0.25770 | 94.17 | 0.24414 | 96.78 | 0.21401 | 0.01579 | 0.01302 | 11.94 | 2796.11 | 2389.00 |
| 1971 | I | 0.27775 | 99.32 | 0.25749 | 113.79 | 0.22851 | 0.02424 | 0.01995 | 10.40 | 3176.89 | 2887.00 |
| | II | 0.27753 | 100.22 | 0.25983 | 121.09 | 0.23161 | 0.01658 | 0.01366 | 12.24 | 3057.80 | 2952.00 |
| 1972 | I | 0.27778 | 100.08 | 0.25946 | 116.34 | 0.23180 | 0.01926 | 0.01590 | 12.23 | 3319.00 | 3319.00 |
| | II | 0.25222 | 99.93 | 0.25907 | 123.35 | 0.23200 | 0.02220 | 0.01835 | 13.76 | 3003.00 | 3003.00 |
| 1973 | I | 0.29514 | 106.00 | 0.27481 | 93.57 | 0.24781 | 0.02245 | 0.01849 | 11.90 | 5512.32 | 5841.00 |
| | II | 0.33586 | 120.42 | 0.31220 | 89.79 | 0.27655 | 0.02980 | 0.02459 | 12.05 | 3498.00 | 4735.00 |
| 1974 | I | 0.74393 | 264.16 | 0.68487 | 116.26 | 0.55584 | 0.07761 | 0.06056 | 15.06 | 4944.73 | 7152.00 |
| | II | 0.91224 | 326.73 | 0.84708 | 116.54 | 0.69867 | 0.08989 | 0.07706 | 16.40 | 4358.64 | 7363.00 |
| 1975 | I | 0.92815 | 332.29 | 0.86150 | 109.22 | 0.71919 | 0.09234 | 0.07347 | 14.54 | 5142.01 | 8600.00 |
| | II | 0.98345 | 352.26 | 0.91327 | 143.91 | 0.76895 | 0.09627 | 0.08341 | 15.03 | 4620.73 | 7682.00 |
| 1976 | I | 1.13812 | 407.82 | 1.05731 | 150.06 | 0.87225 | 0.10115 | 0.07756 | 12.37 | 4647.08 | 8333.00 |
| | II | 1.14717 | 412.99 | 1.07073 | 158.01 | 0.88193 | 0.10095 | 0.08341 | 13.16 | 4608.13 | 8350.00 |
| 1977 | I | 1.19418 | 423.37 | 1.09762 | 168.10 | 0.88928 | 0.10726 | 0.07828 | 13.60 | 4639.07 | 8989.00 |
| | II | 1.25297 | 446.91 | 1.15866 | 176.59 | 0.91480 | 0.10837 | 0.09577 | 11.58 | 5000.39 | 10054.00 |
| 1978 | I | 1.28405 | 450.10 | 1.16694 | 186.02 | 0.91826 | 0.10974 | 0.08638 | 9.97 | 5680.97 | 11731.00 |
| | II | 1.26108 | 450.12 | 1.16698 | 196.29 | 0.91980 | 0.11045 | 0.09367 | 11.48 | 5601.98 | 12213.00 |
| 1979 | I | 1.39900 | 498.86 | 1.29335 | 439.92 | 1.00058 | 0.12596 | 0.10571 | 12.73 | 6138.45 | 14747.00 |
| | II | 1.81219 | 632.14 | 1.63890 | 1078.09 | 1.24233 | 0.17162 | 0.13317 | 13.04 | 6293.24 | 16295.00 |

## DATA USED IN THE MODEL

### ENDOGENOUS VARIABLES

| ear and Semester | | Te* | Tne* | TIne* | W | X | Y | Y* | Y' | Z | Z' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 150.74 | 1512.26 | 1074.26 | 80.20 | 4102.00 | 25083.00 | 18264.00 | 1.00 | 8619.00 | 8162.00 |
| 1970 | I | 180.91 | 2094.09 | 1339.09 | 82.50 | 3916.00 | 25005.00 | 19788.00 | 26069.17 | 8779.00 | 8699.00 |
| | II | 192.82 | 2196.18 | 1642.18 | 94.30 | 4828.00 | 25900.00 | 22129.00 | 26947.07 | 9388.00 | 9083.50 |
| 1971 | I | 210.56 | 2676.44 | 1724.44 | 94.60 | 4349.00 | 26729.00 | 24290.00 | 27871.50 | 9944.00 | 9666.00 |
| | II | 227.29 | 2724.71 | 1958.71 | 94.10 | 4648.00 | 26532.00 | 25614.00 | 27714.20 | 10494.00 | 10219.00 |
| 1972 | I | 234.98 | 3084.02 | 2078.02 | 100.30 | 4529.00 | 26867.00 | 26867.00 | 28089.41 | 10391.00 | 10442.50 |
| | II | 217.69 | 2785.31 | 1999.31 | 99.80 | 5348.00 | 28348.00 | 28348.00 | 29558.74 | 11871.00 | 11131.00 |
| 1973 | I | 261.86 | 5579.13 | 2915.14 | 100.70 | 6332.00 | 31077.00 | 32930.00 | 32464.65 | 15179.00 | 13525.00 |
| | II | 331.80 | 4403.19 | 3154.20 | 104.70 | 4980.00 | 29200.00 | 39526.00 | 30504.63 | 18063.00 | 16621.00 |
| 1974 | I | 999.40 | 6152.60 | 4268.60 | 108.30 | 5236.00 | 32167.00 | 46526.00 | 33512.18 | 21602.00 | 19832.50 |
| | II | 1120.55 | 6242.45 | 4626.45 | 113.30 | 4744.00 | 30662.00 | 51797.00 | 31936.53 | 24242.00 | 22922.00 |
| 1975 | I | 1230.53 | 7369.47 | 5486.47 | 118.80 | 4780.00 | 33160.00 | 55460.00 | 34545.90 | 25590.00 | 24916.00 |
| | II | 1317.24 | 6364.76 | 4815.76 | 121.40 | 5171.00 | 34472.00 | 57310.00 | 35944.10 | 28886.00 | 27238.00 |
| 1976 | I | 1575.15 | 6757.85 | 4634.85 | 124.40 | 5856.00 | 36605.00 | 65639.00 | 38077.08 | 32311.00 | 30598.50 |
| | II | 1624.68 | 6725.32 | 4892.32 | 128.10 | 6075.00 | 37343.00 | 67666.00 | 38841.34 | 35898.00 | 34104.50 |
| 1977 | I | 1774.37 | 7214.63 | 4769.63 | 131.10 | 7241.00 | 38587.00 | 74769.00 | 40189.45 | 39592.00 | 37745.00 |
| | II | 2087.06 | 7966.94 | 5767.94 | 134.60 | 6927.00 | 40399.00 | 81228.00 | 42040.43 | 43931.00 | 41761.50 |
| 1978 | I | 2100.44 | 9630.56 | 6444.56 | 137.73 | 6708.00 | 40592.00 | 83821.00 | 42263.10 | 46705.00 | 45318.00 |
| | II | 2136.39 | 10076.61 | 7458.61 | 139.05 | 7272.00 | 41744.00 | 91007.00 | 43402.71 | 51837.00 | 49271.00 |
| 1979 | I | 2316.54 | 12430.46 | 9012.46 | 143.42 | 7376.00 | 41792.00 | 100401.00 | 43487.57 | 52800.00 | 52318.50 |
| | II | 2861.36 | 13433.64 | 9649.64 | 148.10 | 7983.00 | 44515.00 | 115262.00 | 46244.37 | 57360.00 | 55080.00 |

DATA USED IN THE MODEL

EXOGENOUS VARIABLES

| and Semester | | $BE_{rp}$ | Cg* | CPS | Ds | De | ed | er | F* | $I_g$* | $\Delta Inv_{cp}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 1.00 | 1661.00 | 8228.00 | 0.00000 | 0.00000 | 0.00000 | 3.92 | 1.00 | 1046.00 | 1.00 |
| 1970 | I | 188.18 | 1691.00 | 8752.00 | 1.00000 | 0.00000 | 0.00000 | 5.68 | 361.00 | 624.00 | 74.69 |
| | II | 225.40 | 1823.00 | 9541.00 | 0.00000 | 0.00000 | 0.00000 | 6.36 | -389.00 | 439.00 | 199.50 |
| 1971 | I | 274.95 | 2042.00 | 10457.00 | 1.00000 | 0.00000 | 0.00000 | 6.43 | 349.00 | 815.00 | -1092.52 |
| | II | 260.43 | 2231.00 | 10872.00 | 0.00000 | 0.00000 | 0.00000 | 6.43 | -274.00 | 649.00 | 1150.99 |
| 1972 | I | 224.58 | 2393.00 | 11567.00 | 1.00000 | 0.00000 | 0.00000 | 6.56 | 211.00 | 661.00 | 759.43 |
| | II | 227.31 | 2867.00 | 13127.00 | 0.00000 | 0.00000 | 0.00000 | 6.78 | 573.00 | 645.00 | -553.20 |
| 1973 | I | 93.38 | 3002.00 | 14517.00 | 1.00000 | 0.00000 | 0.00000 | 6.77 | -450.00 | 703.00 | -203.45 |
| | II | 280.56 | 3229.00 | 17195.00 | 0.00000 | 0.00000 | 0.00000 | 6.91 | -161.00 | 1015.00 | 477.20 |
| 1974 | I | 87.59 | 3728.00 | 21389.00 | 1.00000 | 1.00000 | 0.00000 | 6.72 | -628.00 | 1710.00 | 264.98 |
| | II | 85.68 | 5268.00 | 26591.00 | 0.00000 | 1.00000 | 0.00000 | 6.85 | 1998.00 | 3941.00 | 495.78 |
| 1975 | I | 105.52 | 5388.00 | 27885.00 | 1.00000 | 1.00000 | 0.00000 | 7.03 | -87.00 | 3921.00 | 383.95 |
| | II | 141.76 | 5557.00 | 31005.00 | 0.00000 | 1.00000 | 0.00000 | 7.46 | 944.00 | 6617.00 | 21.50 |
| 1976 | I | 113.97 | 6597.00 | 34713.00 | 1.00000 | 1.00000 | 0.00000 | 7.45 | 1520.00 | 4276.00 | 402.52 |
| | II | 126.07 | 6877.00 | 37692.00 | 0.00000 | 1.00000 | 0.00000 | 7.43 | 2369.00 | 4555.00 | 281.48 |
| 1977 | I | 101.52 | 7078.00 | 39555.00 | 1.00000 | 1.00000 | 0.00000 | 7.42 | 3520.00 | 5094.00 | -165.45 |
| | II | 169.94 | 7411.00 | 44223.00 | 0.00000 | 1.00000 | 0.00000 | 7.39 | 2052.00 | 6287.00 | 344.35 |
| 1978 | I | 128.18 | 8025.00 | 47736.00 | 1.00000 | 1.00000 | 0.00000 | 7.37 | 1665.00 | 6332.00 | -117.07 |
| | II | 161.31 | 8539.00 | 54869.00 | 0.00000 | 1.00000 | 0.00000 | 7.36 | 3654.00 | 7332.00 | 172.61 |
| 1979 | I | 148.63 | 9361.00 | 63774.00 | 1.00000 | 1.00000 | 0.02330 | 7.38 | 1450.00 | 6159.00 | -82.58 |
| | II | 197.29 | 10078.00 | 70914.00 | 0.00000 | 1.00000 | 0.08008 | 7.38 | -13.00 | 7312.00 | 61.73 |

## DATA USED IN THE MODEL

### EXOGENOUS VARIABLES

| Year and Semester | | $\Delta Inv_{rp}$ | $K_f^*$ | $ME_{rp}$ | NOL | $\$Pm_{ne}$ | $\$Px$ | $PE_{co}$ | $PE_{cp}$ | $PE_{hg}$ | $\$pc_{co}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 1.00 | 1.00 | 28.85 | 2671.00 | 92.38 | 96.68 | 1.00 | 0.00000 | 71.96 | 0.00000 |
| 1970 | I | 243.91 | 283.00 | 10.38 | 2711.00 | 90.36 | 106.56 | 55.91 | 0.00000 | 88.64 | 0.15103 |
| | II | 463.23 | 38.00 | 8.87 | 3336.00 | 96.01 | 98.55 | 68.81 | 0.00000 | 88.78 | 0.17061 |
| 1971 | I | 81.67 | 2.00 | 28.16 | 3376.00 | 91.99 | 109.20 | 74.11 | 0.00000 | 106.23 | 0.00000 |
| | II | 180.46 | 466.00 | 27.94 | 3464.00 | 109.70 | 104.47 | 119.60 | 0.00000 | 106.41 | 0.20867 |
| 1972 | I | -204.03 | -20.00 | 5.05 | 3235.00 | 102.75 | 101.66 | 123.53 | 0.00000 | 109.94 | 0.20950 |
| | II | -83.35 | 116.00 | 32.11 | 3441.00 | 97.44 | 98.40 | 90.22 | 0.00000 | 108.14 | 0.19400 |
| 1973 | I | 90.24 | 614.00 | 8.60 | 2268.00 | 121.11 | 120.77 | 136.81 | 0.00000 | 79.97 | 0.15285 |
| | II | -950.89 | 405.00 | 13.99 | 2950.00 | 119.37 | 158.43 | 143.72 | 0.00000 | 81.72 | 0.16437 |
| 1974 | I | -239.64 | 2029.00 | 416.37 | 3717.00 | 174.63 | 206.62 | 357.01 | 0.00000 | 102.38 | 0.22164 |
| | II | -382.40 | 1871.00 | 188.90 | 5695.00 | 173.72 | 233.16 | 385.53 | 0.00000 | 102.23 | 0.10267 |
| 1975 | I | -149.24 | 917.00 | 213.74 | 4226.00 | 181.25 | 218.33 | 296.66 | 0.00000 | 92.49 | 0.29545 |
| | II | -635.71 | 3492.00 | 24.93 | 5733.00 | 177.11 | 177.09 | 263.24 | 0.00000 | 102.23 | 0.34325 |
| 1976 | I | -139.45 | 3471.00 | 410.73 | 5847.00 | 179.14 | 167.72 | 374.98 | 0.00000 | 115.78 | 0.10478 |
| | II | -86.27 | 3648.00 | 462.88 | 5667.00 | 182.68 | 181.47 | 355.95 | 0.00000 | 125.17 | 0.23102 |
| 1977 | I | -117.55 | 4899.00 | 668.58 | 5203.00 | 212.35 | 184.22 | 355.13 | 0.00000 | 90.45 | 0.12056 |
| | II | -299.25 | 1490.00 | 517.58 | 6440.00 | 172.65 | 188.67 | 373.54 | 0.00000 | 96.15 | 0.07412 |
| 1978 | I | -456.52 | 4860.00 | 306.43 | 8519.00 | 210.76 | 202.64 | 405.83 | 0.00000 | 118.63 | 0.07875 |
| | II | -319.11 | 3907.00 | 373.60 | 9148.00 | 218.17 | 206.10 | 392.37 | 0.00000 | 121.98 | 5.86745 |
| 1979 | I | 55.55 | 1697.00 | 910.20 | 12708.00 | 235.43 | 239.66 | 454.44 | 249.81000 | 120.45 | 0.35700 |
| | II | 194.45 | 4888.00 | 945.26 | 15027.00 | 247.50 | 248.19 | 453.94 | 877.02000 | 124.28 | 0.32485 |

DATA USED IN THE MODEL

EXOGENOUS VARIABLES

| Year and | Semester | $pd_{co}$ | $\$pc_{cp}$ | $\$pc_{rp}$ | TD* | t | $tm_{cp}$ | $t_s$ | $t_{sf}$ | X* | $XE_{rp}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | II | 1.00000 | 0.01281 | 0.05544 | 438.00 | 1.00 | 0.22000 | 0.03004 | 0.00000 | 2330.00 | 417.09 |
| 1970 | I | 0.04724 | 0.01268 | 0.03936 | 755.00 | 2.00 | 0.22000 | 0.02980 | 0.00000 | 3557.00 | 472.13 |
| | II | 0.04980 | 0.01294 | 0.05181 | 554.00 | 3.00 | 0.22000 | 0.03013 | 0.00000 | 4538.00 | 220.41 |
| 1971 | I | 0.06468 | 0.01987 | 0.03011 | 952.00 | 4.00 | 0.22000 | 0.02898 | 0.00000 | 4581.00 | 356.62 |
| | II | 0.07489 | 0.01359 | 0.02780 | 766.00 | 5.00 | 0.22000 | 0.02822 | 0.00000 | 4679.00 | 301.56 |
| 1972 | I | 0.07614 | 0.01579 | 0.12884 | 1006.00 | 6.00 | 0.22000 | 0.02766 | 0.00000 | 4529.00 | 239.82 |
| | II | 0.07549 | 0.01820 | 0.03829 | 786.00 | 7.00 | 0.22000 | 0.02707 | 0.00000 | 5348.00 | 133.22 |
| 1973 | I | 0.09181 | 0.01840 | 0.06057 | 2664.00 | 8.00 | 0.22000 | 0.02700 | 0.00000 | 7760.00 | 32.78 |
| | II | 0.06409 | 0.02443 | 0.07461 | 1249.00 | 9.00 | 0.22000 | 0.03565 | 0.00000 | 8172.00 | 208.95 |
| 1974 | I | 0.28698 | 0.06362 | 0.02706 | 1884.00 | 10.00 | 0.22000 | 0.09126 | 0.03777 | 10901.00 | 59.94 |
| | II | 0.25333 | 0.07368 | 0.15685 | 1616.00 | 11.00 | 0.22000 | 0.11663 | 0.03178 | 11365.00 | 51.29 |
| 1975 | I | 0.22522 | 0.07569 | 0.02168 | 1883.00 | 12.00 | 0.22000 | 0.11347 | 0.02884 | 11027.00 | 10.10 |
| | II | 0.22528 | 0.07891 | 0.94513 | 1549.00 | 13.00 | 0.22000 | 0.10777 | 0.03655 | 10245.00 | 216.04 |
| 1976 | I | 0.28799 | 0.08291 | 0.01204 | 2123.00 | 14.00 | 0.22000 | 0.14015 | 0.04491 | 10971.00 | 0.00 |
| | II | 0.28799 | 0.08275 | 0.13181 | 1833.00 | 15.00 | 0.22000 | 0.14321 | 0.04559 | 12277.00 | 129.34 |
| 1977 | | 0.28799 | 0.08792 | 0.00970 | 2445.00 | 16.00 | 0.22000 | 0.15967 | 0.04867 | 14829.00 | 38.23 |
| | [illegible] | 0.28799 | 0.08883 | 0.16869 | 2199.00 | 17.00 | 0.22000 | 0.18886 | 0.05500 | 14477.00 | 79.06 |
| 1978 | [illegible] | 0.28463 | 0.08995 | 0.02727 | 3186.00 | 18.00 | 0.22000 | 0.19318 | 0.05550 | 15014.00 | 52.54 |
| | II | 0.39785 | 0.09054 | 0.13845 | 2618.00 | 19.00 | 0.22000 | 0.19168 | 0.05550 | 16543.00 | 12.93 |
| 1979 | [illegible] | 0.39572 | 0.10324 | 0.11898 | 3418.00 | 20.00 | 0.22000 | 0.19180 | 0.07767 | 19548.00 | 40.30 |
| | II | 0.39568 | 0.14067 | 0.12574 | 3784.00 | 21.00 | 0.22000 | 0.19604 | 0.12045 | 21913.00 | 16.64 |

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