

Yap, Josef T.

**Working Paper**

## PIDS Annual Macroeconometric Model 2000

PIDS Discussion Paper Series, No. 2000-13

**Provided in Cooperation with:**

Philippine Institute for Development Studies (PIDS), Philippines

*Suggested Citation:* Yap, Josef T. (2000) : PIDS Annual Macroeconometric Model 2000, PIDS Discussion Paper Series, No. 2000-13, Philippine Institute for Development Studies (PIDS), Makati City

This Version is available at:

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## PIDS Annual Macroeconometric Model 2000

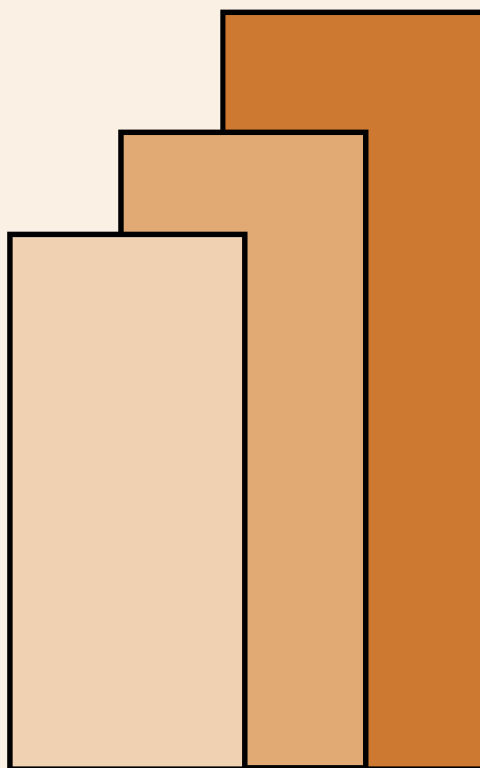
*Josef T. Yap*

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April 2000

For comments, suggestions or further inquiries please contact:

**The Research Information Staff**, Philippine Institute for Development Studies  
3rd Floor, NEDA sa Makati Building, 106 Amorsolo Street, Legaspi Village, Makati City, Philippines  
Tel Nos: 8924059 and 8935705; Fax No: 8939589; E-mail: [publications@pidsnet.pids.gov.ph](mailto:publications@pidsnet.pids.gov.ph)  
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## PIDS ANNUAL MACROECONOMETRIC MODEL 2000

*Josef T. Yap*<sup>1</sup>

(Revised: 12 April 2000)

The basic framework of the PIDS Annual Macroeconometric Model is presented in this paper. After outlining the general philosophy of the model, the discussion focuses on the production sector of the model in order to trace the manner by which macroeconomic policies affect relative prices and sectoral allocation of resources. The theoretical framework is largely derived from Constantino, Yap, Butiong and dela Paz (1990a, 1990b). The details of the PIDS-NEDA model are reported in these references while the most recent re-estimation is presented in Reyes and Yap (1993). A section in the main text lists the major changes that are introduced in the 2000 version of the model.

### *Some Basic Concepts*

The PIDS Annual Macroeconometric model is essentially structuralist in nature although the expenditure sector is specified along the lines of a Keynesian income-expenditure model. It is structuralist in the sense that it takes into account supply bottlenecks as affecting certain sectors of the economy and allows for less than full employment equilibrium.

Such a mixture of concepts stems from a desire to reflect current developing country realities, in particular, Philippine realities in the structure of the model. In developing economies, especially those that are agriculture-based, it is more appropriate to highlight the role of aggregate supply in the determination of output. This would capture the effects of supply bottlenecks. While supply constraints are important, other institutional constraints must be reflected in the model. Foremost is the persistent unemployment and underemployment in the labor force that reflects a non-market clearing wage. Chronic budget deficits and other macroeconomic imbalances are corrected with appropriate fiscal and monetary policies. Added to this is the effect of policy on economic activity via the influence on aggregate demand. Therefore, Keynesian demand elements are allowed to influence the present level of output.

As noted earlier, interaction of aggregate supply and expenditure may not necessarily result in full employment equilibrium. In the context of developing economies, it is not imperative that macroeconomic balance be achieved by automatic price adjustments (the Walrasian solution). This immediately rules out the market clearing process inherent in the classical system, a fact noted in the model via the specification of "fixprice" and "flexprice" sectors in the sense of Taylor (1983). The flexprice sector is assumed to have an adjusting price while the fixprice sector is assumed

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<sup>1</sup> Senior Research Fellow, Philippine Institute for Development Studies (PIDS). The author would like to acknowledge the able assistance of Ms. Ma. Teresa Dueñas-Caparas in the preparation of this paper. The usual disclaimer applies.

to have an adjusting output level. The former usually pertains to agriculture while the latter to industry.

The model consists of four major blocks: (1) the real sector consisting of the production, expenditure and employment, wages and prices, (2) the fiscal sector, (3) the financial sector, and (4) the external sector. In the present version of the model, employment equations have not been estimated. This does not affect the simulation results since in the past there has been no feedback from the level of employment to other sectors of the model.

The linkage between the production sector and expenditure sector comes mainly in the form of aggregate expenditure categories appearing as arguments in the demand functions in the production sector. Output, as determined, then enters into the employment equation (in past versions of the model).

The financial and the real sectors interact through the interest rate and through the price variables as some monetary aggregates affect prices.

The fiscal sector is essentially exogenous in the basic model, specifically with respect to government expenditures. However, tax revenues are linked to the level of economic activity or output. To the extent that it is monetized, the government budget deficit serves as the link with the financial sector. The deficit as a ratio to GNP appears as an explanatory variable in the interest rate equation.

The external sector links up with the rest of the economy through financial variables, specifically, net foreign assets (NFA). This is in addition to the link between the expenditure/production side, i.e. exports and imports, with the current account components. In the present version of the model, the BOP sector is not specified. Hence, NFA is exogenous.

### *Production Sector*

The production sector is classified into three sectors: the fixprice sector, the flexprice sector and the flexprice/flexquantity sector. The fixprice sector is assumed to have an adjusting output level and fixed prices. This is most applicable to the industrial sector, which is often characterized by an oligopolistic structure; therefore, adjustments to increases in demand take place on the quantity side.

Industrial prices are likely to be fixed in the short-run by relatively stable mark-ups over variable cost. In general, industrial sector prices are characterized as functions of prices of inputs, particularly labor and imported inputs, a capital stock index and a measure of excess demand which is average money supply divided by GNP (TL/GNP), an indicator of excess liquidity. In equation form we have

$$P_i = (1 + \tau)(a_L W + a_M PM)$$

where  $\tau$  is the mark-up rate,  $W$  is the wage rate,  $PM$  is the import price index, and  $a_L$  and  $a_M$  are per-unit inputs of labor and imported items, respectively. The mark up rate is assumed to be a function of the capital stock and the indicator of excess liquidity yielding a reduced form equation which in linear form appears as:

$$P_i = \beta_0 + \beta_1 W + \beta_2 PM + \beta_3 TL/GNP + \beta_4 K.$$

The presence of the capital stock index provides the link from increased investment expenditure to increased production. As the stock of capital increases, returns to capital decrease, labor productivity and efficiency increase, thereby bringing down industrial prices. Excess demand, on the other hand, is expected to drive up mark-up rates and hence prices.

Sector demand for the fixprice sectors are assumed to negatively depend on sector prices and positively on indicators of aggregate domestic and international demand. This specification is consistent with the assumption that output adjusts to quantity demanded due to excess capacity. In equation form we have:

$$Q_i^D = f(P_i, Y_j, \dots)$$

In the model  $Q_i^D$  is the sectoral value added,  $P_i$  is the relevant price index,  $Y_j$  is an expenditure category (consumption, investment, government spending); the ellipsis indicates shift variables.

The flexprice/flexquantity sector, on the other hand, supports the usual assumption of market clearing in the goods market. This structure is assumed the agriculture sector. While one can argue that the sector is resource limited and supply does not respond to price and other incentives in the short-run, the possibility of quantity adjustments have been made possible for some crops by multi-cropping within a given year.

The specification of the supply equations essentially follows standard lines. Own price determine supply positively while prices of inputs (labor, fertilizers and feeds) affect supply negatively. Input prices, however, do not appear in the most recent version of the agriculture sector equation. The demand equations, on the other hand, essentially include own prices and domestic scale variables. The demand and supply relations are then equated to derive the price functions, thus assuring market clearing.

The flexprice sector, on the other hand, applies to some crops wherein production is limited by certain capital constraints, i.e., resource constraints. This was used to specify the coconut sector in the previous version of the model.

Contractionary monetary and fiscal policy would manifest itself primarily in a drop in  $Q_i^D$  while a devaluation would directly impinge on  $P_i$ . The effect on factor

markets would arise from the varying sectoral responses to changes in the policy parameters. For example, an adjustment policy that would favor the industry sector would expectedly lead to higher profits since industry has generally been relatively capital intensive because of the protection alluded to it. The exact magnitude and direction of distributional effects is largely an empirical issue.

The estimated equations are listed in the last section.

### *Recent Changes in the Model*

1. The production sector was modified in one important area: real prices are being used both in supply and demand equations.
2. The agriculture sector was compressed into one equation. The reasons for this are: a) it would make the model more tractable; and b) it was difficult getting the correct signs for the price variable in the disaggregated equations.
3. Generally the price variables used in the production sector are a real price:  $P_{\text{sector}}/P_{\text{GNP}}$ . In some cases a relative price was used:  $P_{\text{imports}}/P_{\text{sector}}$ . This is particularly relevant in the manufacturing sector where the Armington effect has to be incorporated. In other cases (e.g. DCONS) the choice was made based on what variable showed the correct sign in the specification.
4. The monetary sector and fiscal sectors were simplified. The monetary sector consists of money demand functions. There is a link to the supply side through the NFA variable that appears in the TBILL equation.
5. The fiscal sector consists of endogenous tax equations and exogenous expenditure items. The budget and national income accounts data are reconciled via bridge equations. The government deficit is measured based on national income accounts variables:  $CGN + CGOVN - TOT TAX$ .
6. The fiscal sector is linked to the real sector via two channels: a) Government expenditures appearing as explanatory variables. There was an effort to link sectoral expenditures to corresponding production sectors. This was successful only in terms of the agriculture sector (and government services, of course). The other possibility was through the Electricity, Gas and Water subsector but the expenditure variable did not turn out significant; b) Through the government deficit via the TBILL rate. The latter influences real liquidity, which then impacts on consumption and investment.
7. The monetary sector affects the real sector mainly through the price variables.
8. The average nominal tariff is incorporated through the model via the variable IMPCOST, which is significant in the wholesale price index (WPI) equation.

$IMPCOST = PMDOL * ER * (1 + TARFF/100)$ .  $PMDOL$  is the implicit dollar price of imports and is exogenous in the model. The variable  $TARFF$  also appears in the relative price variables.

9. Data from 1967-1998 was used in the estimation. In some cases the sample period was limited only up to 1996.
10. What is lacking at present is the BOP sector, which can link up to the model via NFA. While the BOP sector—the capital accounts in particular—was explicitly specified in previous versions of the model, it was still exogenous in nature.
11. The residuals of the behavioral equations were tested for stationarity and most equations had stationary residuals. This is an indication that the OLS specifications are viable. The empirical results are discussed in more detail in the next section.

### *Testing for Stationarity of Residuals*

Stationarity of the residuals implies that the variables in the equation are cointegrated and hence the estimated equation is valid. Two tests were applied to check the stationarity of residuals: the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron (PP) test. In both cases the test was carried out with an intercept and time trend included. Without the intercept or time trend, the absolute value of the critical value decreases significantly.

The PP test is generally more powerful than the ADF test. Using PP as a criterion, five equations<sup>2</sup> show nonstationary residuals. If either the intercept or time trend is excluded from the test, however, then all equations would show stationary residuals. Since the intercept and time trend are not significant in the regression that tests for stationarity, then it would be safe to conclude that the residuals in all equations are stationary.

### *Validation Exercises*

A dynamic simulation is performed over the period 1976-1996 to test the performance of the entire model. The mean absolute percentage errors for selected variables are computed and presented in Table 1. The errors are relatively large but acceptable. Previous versions of the model, however, did not have an endogenous Treasury bill rate. If the  $TBILL$  variable is exogenized, the MAPEs improve considerably (see Table 1).

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<sup>2</sup>  $DVAR$ ,  $DMFG$ ,  $PSER$ ,  $PCGOV$ , and  $MGDS$ . Four of these equations, however, show stationary residuals based on the ADF test statistic.

Graphs of selected variables (using the original dynamic simulation with an endogenous TBILL variable) show that the errors are large in the period between 1979 and 1984. The errors are quite small towards the end of the simulation period implying that the forecasting ability of the model is still good despite the large MAPEs of several variables.

To further test the model, the impact of the liberalization of regulations governing foreign exchange transactions was simulated. The major impact of this reform measure implemented in late 1992 was an increase in foreign exchange flows including foreign direct investment. The surge in capital flows brought about an appreciation of the peso both in nominal and real terms. Money demand also increased substantially particularly in 1994 and 1995.

To simulate the impact of eliminating foreign exchange liberalization a counterfactual simulation was run. A higher exchange rate (a peso depreciation) and tighter money supply reflected in a reduction in Net Foreign Assets of the BSP were assumed. Note that both ER and NFA are exogenous in the model. Since there was a depreciation of the peso between 1990 and 1991 because of the Gulf War, the idea was not to allow a peso appreciation after this period. In effect the impact of higher capital flows on ER and NFA was removed.

The critical question is whether the reduction in capital flows would have reduced the impact of the Asian financial crisis on the Philippines in terms of a less depreciated currency. This would have to be balanced, however, against the need to maintain price competitiveness. Moreover, the experience in 1983 indicates that stricter capital regulations do not necessarily prevent speculative attacks on the peso. Hence the exchange rate was maintained at its baseline value for the period 1997-1999. The relevant variables and their values are as follows:

Exchange Rate (ER, pesos/dollar)

Year	Baseline	Shock
1993	27.12	28.50
1994	26.42	28.50
1995	25.71	28.50
1996	26.22	28.50
1997	29.47	29.47
1998	40.9	40.9
1999	38.9	38.9



Net Foreign Assets (million pesos)

Year	Baseline	Shock
1993	56769	45800
1994	91784	70000
1995	118356	105500
1996	232672	210000
1997	211896	190000
1998	232708	200000
1999	240000	200000

Net Foreign Assets (NFA) were adjusted to reflect the drop in net capital inflows. The basis for adjusting NFA was to bring down the levels to the trend that existed prior to 1993. Meanwhile, the growth rate in financial services was reduced to its trend value and this was carried over to the growth rate of value added for the entire services sector (which is the variable that appears in the model). The constant of the variable DSER (value added in services) was reduced based on the share of financial services to total value added in services.

Money supply adjusts endogenously via the impact of the reduction of NFA on interest rates. The 91-day Treasury bill rate (Tbill) is modeled as a function of inflation the budget deficit and the level of net foreign assets. On the other hand demand for money is a function of Tbill. Hence a fall in NFA leads to a decline in money demand (and money supply).

The results for this simulation exercise are shown in Table 2. If regulations governing foreign exchange transactions were not liberalized, GDP would have been at a lower level and the general price level (PGDP or the implicit GDP deflator) would have been higher. The increase in the price level stems from the higher exchange rate. Higher interest rates and higher prices dampen aggregate demand while the higher cost of production curtails aggregate supply. Being the most import-dependent, the industry sector suffers the highest decline in value added while the agriculture sector experiences the lowest contraction.

As expected, the trade balance improves following a currency depreciation. The table reports the trade balance in million pesos at constant prices. The numbers could be interpreted as a measure of volume of trade.

In order to measure the macroeconomic impact of foreign exchange liberalization, the results of the counterfactual simulation must be viewed in reverse. Thus, foreign exchange liberalization has led to a lower price level, higher output and a deterioration in the trade balance. The results of this policy simulation exercise are plausible and this lends support to the validity of the model.

## *Model Equations*

### **LIST OF BEHAVIORAL EQUATIONS<sup>3</sup>**

#### **Real Sector**

##### **A. Production**

###### **1. Supply of Agriculture**

$$\text{VAR} = -51974.64 + 38043.35 * \text{PVARR} + 5.731911 * \text{HCTRG} + 0.0006244 * \\ (-0.87) \quad (1.65) \quad (2.19) \quad (1.80)$$

$$\text{GOVAGRI}/(\text{PGNP}/100) + 7522.103 * \text{DUM80} + 0.560152 * \text{VAR}(-1) + \\ (2.51) \quad (4.25)$$

$$21.75977 * \text{TIME2} - 128.7842 * \text{PFEEDS} * \text{ER}/(\text{PGNP}/100) \\ (2.96) \quad (-1.60)$$

$$R^2 = 0.986 \quad \text{D.W.} = 2.58 \quad F = 136.43 \quad 1975-96$$

Phillips-Perron test statistic: -6.23      Augmented Dickey-Fuller test statistic: -3.22

Critical value: -3.64

###### **2. Demand for Agriculture**

$$\text{DVAR} = -61077.11 - 26704.05 * \text{PVARR} + 0.246382 * (\text{CP} + \text{XAGRRL}) - 158.2993 * \\ (-4.64) \quad (-2.44) \quad (5.60) \quad (-10.05)$$

$$\text{TIME} + 3315.045 * \text{POP} \\ (7.35)$$

$$R^2 = 0.987 \quad \text{D.W.} = 1.55 \quad F = 5547.08 \quad 1967-98$$

PP: -2.95      ADF: -4.23      CV: -3.57

###### **3. Demand for Manufacturing**

$$\text{DMFG} = -38952.9 + 18227.7 * \text{PMGDS} * (1 + \text{TARFF}/100) / \text{PMFG} + 0.691 * \text{VAR} \\ (2.24) \quad (3.59) \quad (3.92)$$

$$+ 0.053 * (\text{CP} + \text{GDCF} + \text{XGDS}) + 0.247 * \text{DMFG}(-1) \\ (3.89) \quad (2.23)$$

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<sup>3</sup> The equations were estimated using EViews 3.0.

$$R^2 = 0.985 \quad D.W. = 0.93 \quad F = 398.2 \quad 1970-98$$

$$PP: -2.86 \quad ADF: -3.74 \quad CV: -3.59$$

#### 4. Implicit Price Index for Manufacturing

$$PMFG = 0.628616 + 0.133334 * WPI + 0.526904 * PMFG(-1) \\ (0.65) \quad (8.73) \quad (8.54)$$

$$R^2 = 0.998 \quad D.W. = 1.39 \quad F = 8606.81 \quad 1968-98$$

$$PP: -3.68 \quad ADF: -2.75 \quad CV: -3.58$$

#### 5. Demand for Mining and Quarrying

$$DMQ = 7128.157 - 6416.004 * PMQ/PGNP + 343.5951 * PGOLD*ER/PGNP + \\ (3.51) \quad (-3.26) \quad (5.18)$$

$$154.3842 * PCOPPER*ER/PGNP + 0.025496 * IDER + 3514.378 * DUM85 \\ (1.51) \quad (1.64) \quad (2.43)$$

$$R^2 = 0.800 \quad D.W. = 1.32 \quad F = 20.05 \quad 1968-98$$

$$PP: -4.07 \quad ADF: -3.56 \quad CV: -3.58$$

#### 6. Implicit Price Index for Mining and Quarrying

$$PMQ = 27.18440 + 0.171218 * WPI + 0.793313 * AR(1) \\ (2.18) \quad (8.52) \quad (6.50)$$

$$R^2 = 0.985 \quad D.W. = 1.83 \quad F = 900.97 \quad 1968-98$$

$$PP: -4.76 \quad ADF: -4.71 \quad CV: -3.58$$

#### 7. Demand for Construction

$$DCONS = -9579.5 + 6356.6 * PMGDS*(1+TARFF/100)/PCONS + 0.363243*(CONSPR \\ (2.93) \quad (3.34) \quad (4.78)$$

$$+ CONSGO) + 0.527 * DCONS(-1) - 11803.9 * D8485 \\ (4.56) \quad (-3.25)$$

$$R^2 = 0.968 \quad D.W. = 1.54 \quad F = 180.56 \quad 1970-98$$

$$PP: -5.09 \quad ADF: -2.62 \quad CV: -3.58$$

#### 8. Implicit Price Index for Construction

$$\text{PCONS} = 0.551055 + 0.078010 * \text{WPI} + 0.792022 * \text{PCONS}(-1) \\ (0.43) \quad (4.39) \quad (12.12)$$

$$R^2 = 0.998 \quad \text{D.W.} = 1.75 \quad F = 6252.43 \quad 1968-98$$

$$\text{PP: } -4.36 \quad \text{ADF: } -3.21 \quad \text{CV: } -3.58$$

#### 9. Supply of Electricity, Gas and Water

$$\text{SEGW} = -4042.2 + 19343.3 * \text{PEGW/PGNP} + 0.0632 * \text{TLR} \\ (-0.76) \quad (4.10) \quad (11.39)$$

$$- 6252.04 * \text{PMGDS} * (1 + \text{TARFF}/100) / \text{PGNP} \\ (-3.44)$$

$$R^2 = 0.940 \quad \text{D.W.} = 1.75 \quad F = 131.62 \quad 1970-98$$

$$\text{PP: } -3.73 \quad \text{ADF: } -3.25 \quad \text{CV: } -3.58$$

#### 10. Implicit Price Deflator for Electricity, Gas and Water

$$\text{PEGW} = -4.988417 + 0.249596 * \text{WPI} + 0.757377 * \text{AR}(1) \\ (-0.55) \quad (15.23) \quad (5.07)$$

$$R^2 = 0.991 \quad \text{D.W.} = 1.67 \quad F = 1508.45 \quad 1968-98$$

$$\text{PP: } -4.34 \quad \text{ADF: } -3.16 \quad \text{CV: } -3.57$$

#### 11. Demand for Government Services

$$\text{GSER} = 2636.9 + 0.205 * \text{CG} + 894.30 * \text{TIME} + 0.867 * \text{AR}(1) \\ (.49) \quad (3.32) \quad (4.36) \quad (8.07)$$

$$R^2 = 0.996 \quad \text{D.W.} = 2.10 \quad F = 2500.06 \quad 1968-98$$

$$\text{PP: } -6.09 \quad \text{ADF: } -3.66 \quad \text{CV: } -3.58$$

## 12. Demand for Services other than Government Services

$$\begin{aligned} \text{DSER1} = & -206095.1 + 17404.9 * \text{PMGDS} * (1 + \text{TARFF}/100) / \text{PGNP} \\ & (-4.91) \quad (1.83) \\ & + 0.349 * (\text{VAR} + \text{VIR}) + 4883.60 * \text{POP} + 0.800 + \text{AR}(1) \\ & (6.13) \quad (8.56) \quad (7.66) \\ R^2 = & 0.996 \quad \text{D.W.} = 1.92 \quad F = 1489 \quad 1971-98 \end{aligned}$$

PP: -4.84      ADF: -3.56      CV: -3.58

## 13. Implicit Price Deflator for Services

$$\begin{aligned} \text{PSER} = & 0.016380 + 0.0423007 * \text{WPI} + 0.952494 * \text{PSER}(-1) \\ & (0.01) \quad (2.97) \quad (19.38) \\ R^2 = & 0.998 \quad \text{D.W.} = 1.41 \quad F = 6471.68 \quad 1968-98 \end{aligned}$$

PP: -3.49      ADF: -4.22      CV: -3.58

## B. Expenditure

### 14. Expenditure on Private Consumption

$$\begin{aligned} \text{CP} = & -82434.98 + 0.062984 * (\text{GDP} - \text{TOTTAX}/(\text{CPI}/100)) + 0.680552 * \text{MSR} \\ & (-5.45) \quad (2.47) \quad (6.73) \\ & + 4152.5455 * \text{POP} + 0.526042 * \text{CP}(-1) \\ & (5.01) \quad (5.62) \\ R^2 = & 0.999 \quad \text{D.W.} = 2.07 \quad F = 7349.25 \quad 1968-98 \end{aligned}$$

PP: -5.59      ADF: -2.67      CV: -3.58

### 15. Investment in Durable Equipment

$$\begin{aligned} \text{IDER} = & -442.2053 + 0.090791 * \text{TLR} + 0.755896 * \text{IDER}(-1) + 782.438 * \text{GDPGR} \\ & (-0.11) \quad (1.92) \quad (4.66) \quad (2.03) \\ & -187.6878 * \text{INFL} - 25254.29 * \text{DUM98} \\ & (-1.37) \quad (-4.11) \end{aligned}$$

$$R^2 = 0.962 \quad D.W. = 1.41 \quad F = 127.63 \quad 1968-98$$

$$PP: -3.72 \quad ADF: -4.65 \quad CV: -3.57$$

#### 16. Expenditure on Private Construction

$$CONSPR = -4537.54 + 0.029636 * TLR + 0.951151 * CONSPR(-1)$$

$$(1.50) \quad (2.24) \quad (10.32)$$

$$+ 1024.278 * GDPGR - 111.3315 * INFL - 8519.135 * DUM98$$

$$(4.36) \quad (-1.27) \quad (-2.16)$$

$$R^2 = 0.942 \quad D.W. = 12.02 \quad F = 80.89 \quad 1968-98$$

$$PP: -5.72 \quad ADF: -4.32 \quad CV: -3.57$$

#### 17. Expenditure on Breeding Stock

$$BREEDR = 625.0980 + 0.006642 * TLR + 0.824778 * BREEDR(-1)$$

$$(1.39) \quad (2.19) \quad (9.30)$$

$$R^2 = 0.940 \quad D.W. = 1.69 \quad F = 218.36 \quad 1968-98$$

$$PP: -4.39 \quad ADF: -3.51 \quad CV: -3.58$$

#### 18. Government Capital Expenditure at Current Prices

$$CGOVN = 797.5633 + 0.269682 * CAPUTO + 0.851903 * CGOVN(-1)$$

$$(0.44) \quad (1.94) \quad (6.44)$$

$$R^2 = 0.954 \quad D.W. = 2.38 \quad F = 282.02 \quad 1969-98$$

$$PP: -6.40 \quad ADF: -3.97 \quad CV: -3.57$$

#### 19. Government Consumption at Current prices

$$CGN = 1979.91 + 0.958014 * OPEXPO1$$

$$(1.77) \quad (122.96)$$

$$R^2 = 0.999 \quad D.W. = 2.00 \quad F = 151199.75 \quad 1975-98$$

$$PP: -4.44 \quad ADF: -4.28 \quad CV: -3.62$$

20. Implicit Price Deflator for Government Capital Expenditure

$$\text{PCGOV} = -32.70131 + 0.20633 * \text{WPI} + 3.058204 * \text{TIME} + 0.865365 * \text{AR}(1)$$

(-1.17)      (7.06)      (1.93)      (10.50)

$$R^2 = 0.998 \quad \text{D.W.} = 1.30 \quad F = 3692.54 \quad 1968-98$$

$$\text{PP: } -3.16 \quad \text{ADF: } -2.86 \quad \text{CV: } -3.57$$

21. Implicit Deflator for Government Consumption

$$\text{PCG} = 25.85356 + 0.00048 * \text{WPI2} + 0.557333 * \text{AR}(1)$$

(3.14)      (24.51)      (3.36)

$$R^2 = 0.989 \quad \text{D.W.} = 2.15 \quad F = 1210.94 \quad 1968-98$$

$$\text{PP: } -5.72 \quad \text{ADF: } -1.11 \quad \text{CV: } -3.57$$

22. Consumer Price Index

$$\text{CPI} = -1.40 + 0.877 * \text{PGNP} + 0.688 * \text{AR}(1)$$

(-.85)   (84.76)      (5.02)

$$R^2 = 0.999 \quad \text{D.W.} = 1.68 \quad F = 10384.79 \quad 1975-96$$

$$\text{PP: } -3.92 \quad \text{ADF: } -4.24 \quad \text{CV: } -3.57$$

23. Capital Consumption Allowance (real)

$$\text{KCAR} = -16944.68 + 0.024471 * \text{GDP} + 0.055957 * \text{K46NW}(-1) - 3546.812 * \text{TIME}$$

(-2.14)      (1.62)      (5.36)      (-3.42)

$$+ 0.7762 * \text{AR}(1)$$

(7.51)

$$R^2 = 0.994 \quad \text{D.W.} = 1.54 \quad F = 961.27 \quad 1969-97$$

$$\text{PP: } -3.96 \quad \text{ADF: } -3.20 \quad \text{CV: } -3.58$$

**FINANCIAL SECTOR**

24. Demand for Broad Money

$$\text{TLR} = -13223.59 + 0.192588 * \text{GNP} - 2844.9455 * \text{TBILL} + 0.688649 * \text{TLR}(-1)$$

(-1.00)      (4.44)      (-6.05)      (7.35)

$$R^2 = 0.980 \quad D.W. = 1.88 \quad F = 416.33 \quad 1970-98$$

PP: -4.63      ADF: -3.85      CV: -3.58

#### 25. Demand for Narrow Money

$$MSR = 10031.32 + 0.048952 * GNP - 920.5845 * TBILL + 0.599395 * MSR(-1)$$

(2.18)      (4.83)      (-4.97)      (5.45)

$$R^2 = 0.929 \quad D.W. = 1.89 \quad F = 108.76 \quad 1970-98$$

PP: -4.84      ADF: -3.42      CV: -3.58

#### 26. Wholesale Price Index

$$\log WPI = 3.576 + 0.129 * \log TL/GNP + 0.467 * \log (PMDOL * ER * (1 + TARFF/100))$$

(5.86)      (1.74)      (4.25)

$$- .028 * K46NWGR + 0.007 * TBILL + 0.425 \log WPI(-1)$$

(-3.12)      (1.99)      (4.62)

$$R^2 = 0.997 \quad D.W. = 1.58 \quad F = 1742 \quad 1970-97$$

PP: -3.73      ADF: -3.25      CV: -3.59

#### 27. 91-day Treasury Bill Rate

$$TBILL = -1.105595 + 0.299336 * INFLCPI + 56.78275 * DEFG/GNPN$$

(-0.60)      (7.03)      (2.54)

$$-13.04455 * NFA/GNPN + 0.273252 * TIME + 0.416614 * TBILL(-1)$$

(-2.40)      (4.77)      (3.73)

$$R^2 = 0.868 \quad D.W. = 1.79 \quad F = 26.00 \quad 1971-98$$

PP: -4.46      ADF: -4.60      CV: -3.58

### **FISCAL SECTOR**

#### 28. Direct Taxes and Other Domestic Taxes

$$DTAX = -37137.08 + 0.134496 * GNPN + 0.841315 * AR(1)$$

(-1.53)      (12.41)      (5.99)



$$R^2 = 0.995 \quad D.W. = 2.30 \quad F = 2106.22 \quad 1976-98$$

$$PP: -5.52 \quad ADF: -3.20 \quad CV: -3.63$$

### 29. Taxes on International Trade

$$TRADET = 3691.2 + 0.112 * MGDS * (PMGDS/100) * (1 + TARFF/100) +$$

$$(1.55) \quad (18.72)$$

$$-66044.12 * D9798$$

$$(7.80)$$

$$R^2 = 0.953 \quad D.W. = 2.18 \quad F = 212.96 \quad 1975-98$$

$$PP: -5.46 \quad ADF: -2.09 \quad CV: -3.63$$

### 30. Total Tax

$$TOTTAX = 630.0004 + 0.847256 * TAXREV + 0.229227 * TOTTAX(-1)$$

$$(0.39) \quad (12.38) \quad (3.22)$$

$$R^2 = 0.999 \quad D.W. = 2.03 \quad F = 7703.25 \quad 1975-98$$

$$PP: -4.60 \quad ADF: -1.45 \quad CV: -3.62$$

## **EXTERNAL SECTOR**

### 31. Merchandise Exports

$$XGDS = -44955.15 - 6457.434 * PXGDS/ER + 21.91155 * GNPUS +$$

$$(1.20) \quad (-1.89) \quad (2.31)$$

$$0.445748 * MDGS + 32878.61 * DUM98 + 0.614830 * AR(1)$$

$$(5.04) \quad (2.30) \quad (3.48)$$

$$R^2 = 0.984 \quad D.W. = 2.09 \quad F = 313.66 \quad 1968-98$$

$$PP: -5.60 \quad ADF: -4.32 \quad CV: -3.57$$

### 32. Implicit Price Index of Merchandise Exports

$$\text{Log PXGDS} = -1.160276 + 0.994914 * \text{Log WPI} + 0.89914 * AR(1)$$

$$(-0.80) \quad (4.42) \quad (8.46)$$

$$R^2 = 0.980 \quad D.W. = 1.60 \quad F = 702.59 \quad 1968-98$$

$$PP: -3.91 \quad ADF: -3.39 \quad CV: -3.56$$

### 33. Merchandise Imports

$$MGDS = 46167 - 85152 * PMGDS * (1 + TARFF/100) / PGNP + 40.38 * NFA / PGNP$$

$$(1.15) \quad (-4.26) \quad (4.64)$$

$$+ 0.286 * GDP + 0.454 * MGDS(-1)$$

$$(4.12) \quad (4.02)$$

$$R^2 = 0.983 \quad D.W. = 1.41 \quad F = 342.5 \quad 1970-98$$

$$PP: -3.23 \quad ADF: -3.78 \quad CV: -3.58$$

### 34. Implicit Price Index of Merchandise Imports

$$PMGDS = 0.81643 + 103.654 * PMDOLR$$

$$(1.93) \quad (276.88)$$

$$R^2 = 0.999 \quad D.W. = 2.16 \quad F = 76661.14 \quad 1970-98$$

$$PP: -5.51 \quad ADF: -5.00 \quad CV: -3.58$$

## **LIST OF IDENTITIES**

$$GDPGR = (GDP/GDP(-1) - 1) * 100$$

$$INFL = (PGDP/PGDP(-1) - 1) * 100$$

$$INFLCPI = (CPI/CPI(-1) - 1) * 100$$

$$DEFG = CGN + CGOVN - TOT TAX$$

$$GNPN = GNP * PGNP / 100$$

$$TLGNP = TL / GNP$$

$$K46NWGR = (K46NW/K46NW(-1) - 1) * 100$$

$$WPI = EXP(LWPI)$$

$$PXGDS = EXP(LPXGDS)$$

$$\text{PMDOLR} = \text{PMDOL} * \text{ER}$$

$$\text{TRABAL} = \text{XGDS} - \text{MGDS}$$

$$\text{GDP} = \text{VIR} + \text{VAR} + \text{DSER}$$

$$\text{VIR} = \text{DMFG} + \text{DMQ} + \text{DCONS} + \text{SEGW}$$

$$\text{DSER} = \text{DSER1} + \text{GSER}$$

$$\text{STATD} = \text{GDP} - (\text{CP} + \text{CG} + \text{CONSGO} + \text{CONSPR} + \text{IDER} + \text{IINV} + \text{BREEDR} + \text{XGDS} + \text{XSV} - \text{MGDS} - \text{MSV})$$

$$\text{GNP} = \text{CP} + \text{CG} + \text{CONSGO} + \text{CONSPR} + \text{IDER} + \text{IINV} + \text{BREEDR} + \text{XGDS} + \text{XSV} - \text{MGDS} - \text{MSV} + \text{NFIA} + \text{STATD}$$

$$\text{GDCF} = \text{CONSGO} + \text{CONSPR} + \text{IDER} + \text{BREEDR} + \text{IINV}$$

$$\text{CG} = \text{CGN} / (\text{PCG} / 100)$$

$$\text{CONSGO} = \text{CGOVN} / (\text{PCGOV} / 100)$$

$$\text{K46NW} = \text{K46NW}(-1) + \text{GDCF} - \text{KCAR}$$

$$\text{TL} = \text{TLR} * \text{PGNP} / 100$$

$$\text{PGDP} = (\text{PVAR} * \text{VAR} + \text{PMFG} * \text{DMFG} + \text{PMQ} * \text{DMQ} + \text{PCONS} * \text{DCONS} + \text{PEGW} * \text{SEGW} + \text{PSER} * \text{DSER}) / \text{GDP}$$

$$\text{PGNP} = (\text{GDP} * \text{PGDP} + \text{NFIA} * \text{PNFIA}) / \text{GNP}$$

$$\text{PVAR} = \text{PVARR} * \text{PGNP}$$

$$\text{TAXREV} = \text{TRADET} + \text{DTAX}$$

$$\begin{aligned} \text{PVARR} = & -0.3902 + 0.000004149 * \text{DEMAGRI} + 0.05571 * \text{POP} - 0.00302 * \text{TIME2} \\ & - 0.0000881 * \text{HCTRG} - 0.00000001 * \text{GOVAGRIR} - 12138 * \text{DUM80} \\ & + 0.00231 * \text{PFEEDSR} - 0.00000925 * \text{VAR}(-1) \end{aligned}$$

## LIST OF VARIABLES

### List of Endogenous Variables

VARIABLE	DESCRIPTION	YEAR
BREEDR	Expenditure on Breeding Stock	1968-98
CGN	Expenditure on Government Consumption (at current prices)	1975-98
CGOVN	Expenditure on Government Construction (at current prices)	1969-98
CONSPR	Expenditure on Private Construction (at constant prices)	1968-98
CP	Expenditure on Private Consumption (at constant prices)	1968-98
CPI	Consumer Price Index	1975-96
DCONS	Value added in Construction (Demand, at constant prices)	1970-98
DMFG	Value added in Manufacturing (Demand, at constant prices)	1970-98
DMQ	Value added in Mining and Quarrying (Demand, at constant prices)	1968-98
DSER1	Value Added in Services other than Gov't. Services (Demand)	1971-98
DTAX	Direct Taxes and Other Taxes	1976-98
DVAR	Demand for Agriculture	1967-98
GSER	Value added in Government Services	1968-98
IDER	Investment In Durable Equipment (at constant prices)	1968-98
KCAR	Capital Consumption Allowance, real	1969-97
LPXGDS	Implicit Price Index of Merchandise Exports (logarithm)	1968-98
MGDS	Merchandise Imports	1970-98
MSR	Demand for M1(real)	1970-98
PCG	Implicit Price Deflator for Government Consumption	1968-98
PCGOV	Implicit Price Deflator for Government Construction	1968-98
PCONS	Implicit Price Index for Construction	1968-98
PEGW	Implicit Price Deflator for Electricity, Gas and Water	1968-98
PMFG	Implicit Price Index for Manufacturing	1968-98
PMGDS	Implicit Price Index of Merchandise Imports	1970-98
PMQ	Implicit Price Index for Mining and Quarrying	1968-98
PSER	Implicit Price Index for Services	1968-98
SEGW	Value added in Electricity, Gas and Water (Supply)	1970-98
TBILL	Treasury Bill, 91-day	1971-98
TLR	Demand for M3 (real)	1970-98
TOTTAX	Total Taxes (National Income Accounts)	1975-98
TRADET	Taxes on International Trade	1976-98
VAR	Value added in Agriculture (Supply, at constant prices)	1975-96
WPI	Wholesale Price Index	1971-97
XGDS	Merchandise Exports	1968-98

**PIDS MACROMODEL**  
**List of Exogenous Variables**

VARIABLE	DESCRIPTION
CAPUTO	Capital expenditures, obligation basis (nominal)
CGN	Government consumption, nominal terms
D8485	Dummy 1984-85=1, 0 otherwise
DUM80	Dummy 1980=1, 0 otherwise
DUM85	Dummy 1985=1, 0 otherwise
DUM98	Dummy 1998=1, 0 otherwise
ER	Exchange rate
GNPUS	Gross National Product of United States
GOVAGRI	Government expenditures on agricultural sector
HCTRG	Hectarage of Agricultural Land
NFA	Net Foreign Assets
OPEXPO1	Current Operating Expenditures, obligation basis
PCOPPER	International price of copper
PFEEDS	Imported price of feeds
PGOLD	International price of gold
PMDOL	Derived dollar import price
POP	Population
TARFF	Average Nominal Tariff
TIME	Variable for time
TIME2	Variable for time squared
WPI2	Square of WPI
XAGRRL	Exports of agricultural products
D9798	Dummy 1997-98 =1, 0 otherwise

**List of Identities**

VARIABLE	DESCRIPTION
CG	Government Consumption
CONSGO	Government Construction, real
DEFG	Government Deficit
DSER	Value added in Services, total
GDCF	Gross Domestic Capital Formation
GDP	Gross Domestic Product, real
GDPGR	Gross Domestic Product, growth rate
GNP	Gross National Product, real

GNPN	Gross National Product, nominal
INFL	Inflation, growth in GDP deflator
INFLCPI	Inflation, growth in CPI
K46NW	Capital stock
K46NWGR	Capital stock, growth rate
PGDP	Implicit Price Deflator for GDP
PGNP	Implicit Price Deflator for GNP
PMDOLR	PMDOL*ER
PVAR	Implicit price index for agriculture
PVARR	Implicit price of agriculture in real terms
STATD	Statistical Discrepancy
TAXREV	Tax Revenue
TL	Total Liquidity
TLGNP	Ratio of TL to GNP
TRABAL	Trade Balance
VIR	Gross Value Added for Industry

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**Table 1**  
**Mean Absolute Percentage Error (MAPE)**  
**of Selected Variables**

Variable	V2000 1976-96	
	w/ Tbill	w/o Tbill
<b>GDP</b>	6.79	3.85
<b>PGDP</b>	6.24	8.47
<b>VAR</b>	2.36	1.56
<b>DMFG</b>	8.89	4.98
<b>DCONS</b>	34.81	21.75
<b>VIR</b>	13.17	6.84
<b>DSER</b>	4.66	3.49
<b>CPI</b>	5.98	8.70
<b>XGDS</b>	19.45	8.14
<b>MGDS</b>	10.53	10.21
<b>CP</b>	3.18	1.30
<b>IDER</b>	23.63	14.74
<b>CONSPR</b>	40.88	17.65
<b>TBILL</b>	25.42	-----
<b>TLR</b>	20.67	6.59

**Table 2**  
**FOREIGN EXCHANGE LIBERALIZATION (Counterfactual)**  
**(1993 - 1999)**

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Percent Deviation from Baseline							
	1993	1994	1995	1996	1997	1998	1999
GDP	-0.0718	-0.3977	-0.7941	-1.4370	-1.7156	-1.2992	-1.0019
Agriculture	-0.0717	-0.1613	-0.2667	-0.3664	-0.3731	-0.3567	-0.3421
Industry	-0.0037	-0.2884	-0.5946	-1.1054	-1.5128	-1.5041	-1.3982
Services	-0.1223	-0.5973	-1.1991	-2.1925	-2.4838	-1.5566	-0.9780
PGDP	1.0424	1.9203	2.7575	3.2618	2.5061	1.9738	1.6395
Deviation from Baseline							
Trade Balance	3547.94	6973.42	8170.32	11616.48	8215.23	7817.07	7934.64
(million ₪, at constant prices)							

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