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A FOUR SECTOR ECONOMETRIC MODEL OF THE CANADIAN ECONOMY*

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I. Introduction

Earlier the author, together with his colleague, developed a growth model of the Canadian economy [9] which concentrated on the gross domestic product (GDP) side, and from this earlier experience it was found desirable to incorporate not only the GDP side but also the gross national expenditure (GNE) and gross national product (GNP) sides. The present paper has evolved out of these considerations as well as it revises some of the behavioral equations of the earlier model.

Some of the salient features of this revised model may be described as

(1) the model attempts to allow for the interaction of supply and demand factors,

(2) the demand and supply relationships in the model are disaggregated by the four industrial sectors consisting of (i) agriculture, fishing and forestry, (ii) mining and manufacturing, (iii) construction, and (iv) utilities, transportation, trade, finance, public administration and other services,

(3) the model incorporates the interrelationships between the Canadian and United States economies which operate primarily through foreign trade and investment, wage and price determination,

(4) capacity considerations are incorporated in the model by using capacity production functions, and

(5) in the estimation of investment functions and some other relationships the gamma distributed lags described in [11] are used.

Section II gives the model, and in section III the formulation and estimation of the equations are discussed, and in section IV the model is simulated over a part of the sample period to examine how reasonably the model performs and finally forecasts of the Canadian economy based on a set of exogenous variables are presented to predict the Canadian economy from 1969 to 1975.

II. The Model

Annual data from 1947 to 1967 are used for the estimation. Since the dividends paid out to nonresidents, D_{VF}, are only available from 1955, the equation for this variable is estimated from 1955 to 1967 by the ordinary least squares (OLS). In an earlier stage of the estimation it was found that a large number of disturbance terms tended to be autocorrelated judged by the values of the Durbin-Watson test statistics. To cope with this problem we employed the modified Sargan's two-stage least squares procedure (MS2SLS) given by Amamiya [1], and we used Dhrymes' scanning method [2] to estimate the coefficients of the first-order autocorrelation. The equations involving the gamma distributed lags are estimated by the nonlinear least squares procedure (NLLS) given in [7], and the rest of the equations are estimated by the two-stage least squares (2SLS) or by the ordinary least squares (OLS).

In the model $\bar{R}^2$ and DW denote respectively the coefficients of determination corrected for degrees of freedom and the Durbin-Watson test statistic. The figure in parehtheses below each estimated coefficient indicates the value of t-test. All variables are defined in alphabetical order at the end of this section. Z in the gamma distributed lags is given by

$$Z = \sum_{k=1}^{20} k^{s-1} e^{-k}.$$

Consumption functions

(1) $$Cnd/N - .5(Cnd/N)_{-1} = \underset{(10.31)}{.3008}[(Yd/P_dN) - .5(Y_d/P_dN)_{-1}] - \underset{(3.44)}{.2428}[P_{nd}/P - .5(P_{nd}/P)_{-1}] + \underset{(4.47)}{.2346}$$

$\bar{R}^2 = .960$
DW = 1.96
MS2SLS

(2) $$Cd/N = \underset{(.37)}{.0100}[\frac{1}{Z}\sum_{k=1}^{6} k^{s-1}e^{-k}(Y_d/P_dN)_{-k+1}] - \underset{(16.9)}{.1609}(P_{cd}/P) + \underset{(59.13)}{.4212}(Cd/N)_{-1} + \underset{(44.13)}{.2359}$$

$s = \underset{(72.94)}{1.9912}$

$\bar{R}^2 = .944$
DW = 1.66
NLLS

(3) $$Cs/N = \underset{(1.73)}{.0870}(Y_d/P_dN) - \underset{(.35)}{.0179}(P_s/P) + \underset{(4.09)}{.7686}(C_s/N)_{-1} + \underset{(.47)}{.0152}$$

$\bar{R}^2 = .984$
DW = 1.91
2SLS

Investment functions

(4) $$Ipa = \underset{(3.46)}{.4829}[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}V_{a,-k+1}] + \underset{(.39)}{108.0443}(V_a/V_a^*)_{-1} - \underset{(1.39)}{.0605}K^u_{a,-1} - \underset{(1.70)}{336.2051}$$

$\bar{R}^2 = .631$
DW = .80
NLLS

(5) $$I_{pm} = \underset{(1.55)}{.5359}[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}V_{m,-k+1}] + \underset{(.15)}{.1122}[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}(D_I/P_k)_{-k+1}] + \underset{(1.06)}{1993.9756}(V_m/V_m^*)_{-1} - \underset{(.76)}{.2487}K^u_{m,-1} - \underset{(1.63)}{2655.5776}$$

$s = \underset{(1.17)}{2.0106}$

$\bar{R}^2 = .851$
DW = 1.23
NLLS

$$(6)\qquad I_{pc} = \underset{(2.08)}{.2018}\left[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}V_{c,-k+1}\right] - \underset{(.47)}{14.6544}\left[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}i_{L,-k+1}\right]$$

$$- \underset{(.89)}{.1134}\, K^{u}_{c,-1} - \underset{(.31)}{18.1747}$$

$s = \underset{(1.90)}{1.9688}$ $\bar{R}^2 = .533$
DW = 1.22
NLLS

$$(7)\qquad I_{PSG} - G_I/P_K = \underset{(1.47)}{.3382}\left[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}V_{s,-k+1}\right]$$

$$+ \underset{(1.23)}{1.7683}\left[\frac{1}{Z}\sum_{k=1}^{7} k^{s-1}e^{-k}(D_I/P_K)_{-k+1}\right] - \underset{(1.15)}{.1447}(K^{u}_{sG,-1} - K^{u}_{G,-1})$$

$$- \underset{(1.43)}{893.0647}$$

$s = \underset{(2.04)}{2.5795}$ $\bar{R}^2 = .846$
DW = .70
NLLS

$$(8)\qquad I_h = \underset{(13.05)}{8.2225}\left[\frac{1}{Z}\sum_{k=1}^{6} k^{s-1}e^{-k}I^{s}_{h,-k+1}\right] + \underset{(4.94)}{377.2559}$$

$s = \underset{(1.19)}{.7399}$

$\bar{R}^2 = .896$
DW = 1.13
NLLS

$$(9)\qquad I^{s}_{h} = \underset{(1.33)}{.0532}\left[\frac{1}{Z}\sum_{k=1}^{6} k^{s-1}e^{-k}(MTG/PK)_{-k+1}\right] + \underset{(8.83)}{75.0933}$$

$s = \underset{(2.56)}{2.4947}$

$\bar{R}^2 = .724$
DW = 1.54
NLLS

(10)
$$MTG/P_h = \underset{(2.00)}{.1482}\left[\frac{1}{Z}\sum_{k=1}^{6} k^{s-1}e^{-k}(Y_d/P_d)_{-k+1}\right] - \underset{(1.96)}{313.7134}\, i_L - \underset{(.44)}{210.2276}$$

$$s = \underset{(.75)}{3.5000}$$

$\bar{R}^2 = .716$
DW = 1.24
NLLS

(11)
$$\Delta I_{in}/P_k - .45(\Delta I_{in}/P_K)_{-1} = \underset{(4.90)}{.1720}[GNP/P - .45\,(GNP/P)_{-1}]$$

$$- \underset{(4.81)}{.7699}[I_{in,-1} - .45I_{in,-2}] - \underset{(4.09)}{1376.9768}$$

$\bar{R}^2 = .575$
DW = 2.04
MS2SLS

Exports and import functions

(12)
$$X_a = \underset{(4.01)}{2.5194}\, Y^W + \underset{(.84)}{.1813}\, X_{a,-1} + \underset{(1.41)}{182.2718}$$

$\bar{R}^2 = .848$
DW = 2.24
OLS

(13)
$$X_m - .2X_{m,-1} = \underset{(8.70)}{21.1321}[Y^W - .2Y^W_{-1}]$$

$$- \underset{(1.61)}{7222.7031}[P_m/P^W_m - .2(P_m/P^W_m)_{-1}] + \underset{(1.03)}{4123.0938}$$

$\bar{R}^2 = .852$
DW = 1.27
MS2SLS

(14)
$$F_m = \underset{(4.12)}{.1690}(Y_d/P_d) + \underset{(2.27)}{8246.0273}(P_m/P^F_m) + \underset{(3.35)}{.5573}\, F_{m,-1} - \underset{(3.12)}{9863.2656}$$

$\bar{R}^2 = .961$
DW = 1.58
2SLS

(15)
$$F_s = \underset{(6.73)}{.0805}(Y_d/P_d) + \underset{(2.83)}{1754.2883}\,(P_s/P^F_s) - \underset{(2.61)}{958.4468}$$

$\bar{R}^2 = .960$
DW = 1.86
2SLS

(16) $$F_I' - .65F_{I,-1}' = \underset{(2.68)}{.0084}\{[\sum_{i=0}^{5}(D_I + P_I)_{-k}]i_L - .65[\sum_{i=1}^{6}(D_I+P_I)_{-k}]i_{L,-1}\}$$

$$+ \underset{(3.97)}{131.1133}$$

$\bar{R}^2 = .850$
DW = 1.54
MS2SLS

Wage equations

(17) $$W_a - .35\, W_{a,-1} = \underset{(2.15)}{-2.0727}[u_n - .35u_{n,-1}] \quad \underset{(6.51)}{.0197}[P_d - .35\, P_{d,-1}]$$

$$+ \underset{(2.02)}{.0604}[V_a/L_a - .35(V_a/L_a)_{-1}] - \underset{(6.64)}{.8273}$$

$\bar{R}^2 = .946$
DW = 1.31
MS2SLS

(18) $$W_m - .7W_{m,-1} = \underset{(.89)}{-2.3744}[u_n - .7u_{n,-1}] + \underset{(2.33)}{.2853}[V_m/L_m - .7(V_m/L_m)_{-1}]$$

$$+ \underset{(4.30)}{.4558}[W_m^{us} - .7W_{m,-1}^{us}] - \underset{(.24)}{.0377}$$

$\bar{R}^2 = .818$
DW = 1.19
MS2SLS

(19) $$W_c - .95W_{c,-1} = \underset{(1.50)}{-3.6575}[u_n - .95u_{n,-1}]$$

$$+ \underset{(7.79)}{.5599}[V_c/L_c - .95(V_c/L_c)_{-1}]$$

$$+ \underset{(6.40)}{1.2405}[W_c^{us} - .95\, W_{c,-1}^{us}] - \underset{(3.96)}{.3664}$$

$\bar{R}^2 = .882$
DW = 1.24
MS2SLS

(20) $$W_s - .55W_{s,-1} = \underset{(.27)}{.0536}[V_s/L_s - .55(V_s/L_s)_{-1}] + \underset{(15.29)}{.6324}[W_s^{us} - .55W_{s,-1}^{us}] - \underset{(.22)}{.0901}$$

$\bar{R}^2 = .974$
DW = 1.97
MS2SLS

Price equations

(21) $$P_a - .35P_{a,-1} = \underset{(3.84)}{1.8356}[W_aL_a/V_a - .35(W_aL_a/V_a)_{-1}] + \underset{(4.19)}{.4699}[V_a/V_a^* - .35(V_a/V_a^*)_{-1}] + \underset{(.83)}{.1080}$$

$\bar{R}^2 = .615$
DW = 1.30
MS2SLS

(22) $$P_m - .45P_{m,-1} = \underset{(2.85)}{.7307}[W_mL_m/V_m - .45(W_mL_m/V_m)_{-1}] + \underset{(1.47)}{.1386}[V_m/V_m^* - .45(V_m/V_m^*)_{-1}] + \underset{(2.82)}{.6463}[P_m^{us} - .45P_{m,-1}^{us}] - \underset{(1.46)}{.1189}$$

$\bar{R}^2 = .868$
DW = 1.75
MS2SLS

(23) $$P_c - .95P_{c,-1} = \underset{(6.39)}{.5104}[W_cL_c/V_c - .95(W_cL_c/V_c)_{-1}] + \underset{(1.77)}{.1451}[P_m - .95P_{m,-1}] + \underset{(1.62)}{.0544}[V_c/V_c^* - .95(V_c/V_c^*)_{-1}] + \underset{(6.48)}{.0408}$$

$\bar{R}^2 = .829$
DW = 1.41
MS2SLS

(24) $$P_s - .85P_{s,-1} = \underset{(1.89)}{.4230}[W_sL_s/V_s - .85(W_sL_s/V_s)_{-1}] + \underset{(.80)}{.1003}[V_s/V_s^* - .85(V_s/V_s^*)_{-1}] + \underset{(3.79)}{.6827}[P_s^{us} - .85P_{s,-1}^{us}] - \underset{(.10)}{.0021}$$

$\bar{R}^2 = .907$
DW = 2.00
MS2SLS

(25) $$P_{nd} - .35\,P_{nd,-1} = \underset{(14.14)}{.6453}[(Wgt_1P_s + Wgt_2P_m) - .35(Wgt_1P_s + Wgt_2P_m)_{-1}] + \underset{(8.01)}{.2417}$$

$$Wgt_1 = \frac{C_s}{C_{nd} + C_s}$$

$$Wgt_2 = 1 - Wgt_1$$

$\bar{R}^2 = .913$
DW = 1.25
MS2SLS

(26) $$P_{cd} - .45\,P_{cd,-1} = \underset{(1.74)}{.3984}[P_m - .45P_{m,-1}] + \underset{(2.53)}{.3277}$$

$\bar{R}^2 = .477$
DW = 2.04
MS2SLS

(27) $$P_h - .95\,P_{h,-1} = \underset{(15.76)}{1.1705}[P_c - .95P_{c,-1}] - \underset{(1.67)}{.0170}$$

$\bar{R}^2 = .930$
DW = 1.84
MS2SLS

(28)* $$P_K - .95\,P_{K,-1} = \underset{(9.66)}{.6354}[(.4697\,P_m + .5303\,P_c) - .95(.4697P_m + .5303P_c)_{-1}] + \underset{(5.84)}{.0334}$$

$\bar{R}^2 = .837$
DW = 1.15
MS2SLS

<u>Labor force participation and shares of available labor</u>

(29) $$L_{sup}/N = \underset{(7.84)}{.1810}\,(Y_d/P_dN) - \underset{(8.28)}{.0684}(W/P_d) + \underset{(32.22)}{.3106}$$

$\bar{R}^2 = .779$
DW = 1.35
2SLS

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* The weight of .4697 is the ratio of new machinery and equipment to I_p in 1967.

(30) $$L_m^A/L^A - .5(L_m^A/L^A)_{-1} = \underset{(1.57)}{.1533}[V_m/V - .5(V_m/V)_{-1}] - \underset{(1.40)}{.0174}[W_m/W - .5(W_m/W)_{-1}] + \underset{(6.08)}{.1214}$$

$\bar{R}^2 = .811$
DW = 1.46
MS2SLS

(31) $$L_c^A/L^A - .8(L_c^A/L^A)_{-1} = \underset{(2.25)}{.2683}[V_c/V - .8(V_c/V)_{-1}] - \underset{(2.72)}{.0193}[W_c/W - .8(W_c/W)_{-1}] + \underset{(10.57)}{.0156}$$

$\bar{R}^2 = .873$
DW = 1.19
MS2SLS

(32) $$L_s^A/L^A - .35(L_s^A/L^A)_{-1} = \underset{(5.26)}{1.6924}[V_s/V - .35(V_s/V)_{-1}] - \underset{(6.98)}{.7225}[W_s/W - .35(W_s/W)_{-1}] + \underset{(1.81)}{.2300}$$

$\bar{R}^2 = .777$
DW = 1.33
MS2SLS

<u>Production functions</u>

(33) $$\ln\left(\frac{Va}{La}\right) - .55\ln\left(\frac{Va}{La}\right)_{-1} = \underset{(5.30)}{.8758}\left[\ln\left(\frac{Ka^u}{La}\right) - .55\ln\left(\frac{Ka^u}{La}\right)_{-1}\right] - \underset{(1.38)}{.1792}$$

$\bar{R}^2 = .861$
DW = 2.11
MS2SLS

(34) $$\ln Vm - .6\ln Vm,-1 = \underset{(1.16)}{.4379}[\ln Lm - .6\ln Lm,-1] + \underset{(3.76)}{.6956}[\ln K_m^u - .6\ln K_{m,-1}^u] - \underset{(.36)}{.2000}$$

$\bar{R}^2 = .888$
DW = 1.54
MS2SLS

(35) $$\ln Vc - .55 \ln Vc_{,-1} = \underset{(1.71)}{.5417} [\ln Lc - .55 \ln Lc_{,-1}]$$

$$+ \underset{(3.41)}{.5119} [\ln K_c^u - .55 \ln Kc^u_{,-1}] + \underset{(.47)}{.3201}$$

$\bar{R}^2 = .904$
DW = 1.55
MS2SLS

(36) $$\ln Vs - .05 \ln V_{s,-1} = \underset{(22.52)}{1.1052} [\ln Ls - .05 \ln L_{s,-1}]$$

$$+ \underset{(2.92)}{.0714} [\ln K^u_{SG} - .05 \ln K^u_{SG,-1}] + \underset{(.59)}{.1030}$$

$\bar{R}^2 = .996$
DW = 1.60
MS2SLS

<u>Capacity production functions</u>

(37) $$\ln (V_a^*/L_a^A) = .8758 [\ln(K /L^A) - .55 \ln(K_a/L_a^A)_{-1}] - .1792 + .55 \ln(V_a^*/L_a^A)_{-1}$$

(38) $$\ln V_m^* = .4379[\ln L_m^A - .6 \ln L^A_{m,-1}] + .6956[\ln Km - .6 \ln K_{m,-1}] - .2000 + .6 \ln V^*_{m,-1}$$

(39) $$\ln V_c^* = .5417[\ln L_c^A - .55 \ln L^A_{c,-1}] + .5119[\ln K_c - .55 \ln K_{c,-1}] + .3201 + .55 \ln V^*_{c,-1}$$

(40) $$\ln V_s^* = 1.1052[\ln L_s^A - .05 \ln L^A_{s,-1}] + .0714[\ln K_{SG} - .05 \ln K_{SG,-1}] + .1030 + .05 \ln V^*_{s,-1}$$

<u>Birth and net migrate rate equations</u>

(41) $$br - .95\, br_{-1} = - \underset{(.87)}{.00523}[Y_d/P_dN) - .95(Y_d/P_dN)_{-1}]$$

$$- \underset{(1.81)}{.00138}[t - .95(t-1)] + \underset{(3.81)}{.00328}$$

$\bar{R}^2 = .944$
DW = 1.31
MS2SLS

(42) $$nm = \underset{(1.53)}{.0492} (Y_d/P_dN) - \underset{(1.59)}{.0215} (Y_d/P_dN)^{us} + \underset{(1.49)}{.2981} nm_{-1}$$

$$+ \underset{(3.03)}{.0091} D_{57} - \underset{(1.16)}{.0198}$$

$\bar{R}^2 = .332$
DW = 1.70
2SLS

Short term and long term interest rate equations

(43) $$i_S = \underset{(8.30)}{.8805} i_D + \underset{(3.01)}{13.7536} [\frac{TRB + DTDL}{TCA}] - \underset{(5.50)}{1.0180}$$

$\bar{R}^2 = .951$
DW = 2.15
OLS

(44) $$i_L = \underset{(.44)}{.0937} i_S + \underset{(2.75)}{.8855} i_{L,-1} + \underset{(.49)}{.5406}$$

$\bar{R}^2 = .815$
DW = 1.90
2SLS

Net direct and portfolio investment equations

(45) $$D_I/P_K = \underset{(.94)}{.0345}[\frac{1}{Z} \sum_{k=1}^{6} k^{s-1}e^{-k}\{(I/I^{us}er)GNP/P\}_{-k+1}$$

$$+ \underset{(2.43)}{.5218} (D_I/P_K)_{-1} + \underset{(.95)}{87.3940}$$

$$s = \underset{(.39)}{2.3887}$$

$\bar{R}^2 = .441$
DW = 1.62
NLLS

(46) $$P_I = \underset{(2.35)}{378.6594} (i_L - i_L^{us}) + \underset{(1.75)}{.2735} P_{I,-1} - \underset{(.79)}{155.1463}$$

$\bar{R}^2 = .432$
DW = 1.99
2SLS

<u>Sectoral domestic product equations</u>

(47)
$$V_a^d - .95\, V_{a,-1}^d = \underset{(1.19)}{.0336}[GNP/P - .95\,(GNP/P)_{-1}]$$
$$- \underset{(1.85)}{.4164}[V_{a,-1}^d - .95\, V_{a,-2}^d] - \underset{(4.11)}{.3673}[WETH - .95\, WETH_{-1}]$$
$$+ \underset{(1.97)}{.3143}[(\Delta I_{ia}/P_a)_{-1} - .95(\Delta I_{ia}/P_a)_{-2}] - \underset{(.48)}{43.0294}$$

$\bar{R}^2 = .607$
DW = 1.92
MS2SLS

(48)
$$V_m^d - .5V_{m,-1}^d = \underset{(1.18)}{.0447}[(Cd + Cnd + Ip + G_I/P_K)$$
$$- .5(Cd + Cnd + Ip + G_I/P_K)_{-1}] + \underset{(3.19)}{127.3252}$$

$\bar{R}^2 = .646$
DW = 1.16
MS2SLS

(49)
$$V_c - .45\, V_{c,-1} = \underset{(10.71)}{.1669}[(Ip + I_h + G_I/P_K) - .45(Ip + I_h + G_I/P_K)_{-1}]$$
$$+ \underset{(2.35)}{174.8186}$$

$\bar{R}^2 = .858$
DW = 1.68
MS2SLS

(50)
$$V_s = \underset{(27.68)}{.6435}(Y_d/P_d) + \underset{(1.67)}{.1917}(G_s/P_s) + \underset{(4.60)}{732.8945}$$

$\bar{R}^2 = .998$
DW = 2.39
2SLS

<u>Depreciation, corporate savings and interest payment equations</u>

(51)
$$D - .95D_{-1} = \underset{(4.17)}{.1457}[P_K I - .95\,(P_K I)_{-1}] + \underset{(7.53)}{213.9404}$$

$\bar{R}^2 = .996$
DW = 2.35
MS2SLS

(52) $S_c - .15\, S_{c,-1} = \underset{(29.58)}{.1427}[(P_m V_m + P_c V_c + P_s V_s) - .15(P_m V_m + P_c V_c + P_s V_s)_{-1}]$

$+ \underset{(.59)}{72.5772}$

$\bar{R}^2 = .844$
DW = 2.08
MS2SLS

(53) $IPD = \underset{(6.62)}{172.5668}\, i_L + \underset{(10.61)}{.1876}\, B_g - \underset{(14.00)}{2596.3789}$

$\bar{R}^2 = .966$
DW = 1.51
2SLS

<u>Taxes, and transfer payment equations</u>

(54) $T_p - .79\, T_{p,-1} = \underset{(14.87)}{.2198}[W - .79W_{-1}] - \underset{(4.54)}{326.8604}$

$\bar{R}^2 = .921$
DW = 1.88
MS2SLS

(55) $T_I - .65\, T_{I,-1} = \underset{(38.55)}{.1558}[GNP - .65\, GNP_{-1}] - \underset{(6.28)}{367.7986}$

$\bar{R}^2 = .987$
DW = 2.49
MS2SLS

(56) $T_c - .65\, T_{c,-1} = \underset{(8.32)}{.3449}[\Pi_{cB} - .65\, \Pi_{cB,-1}] + \underset{(2.47)}{137.8848}$

$\bar{R}^2 = .801$
DW = 1.49
MS2SLS

(57) $T_r - .8T_{r,-1} = \underset{(3.39)}{16457.0977}\, [u_n - .8u_{n,-1}]$

$- \underset{(.96)}{1136.4885}\, [\frac{\Delta GNP}{GNP} - .8\, (\frac{\Delta GNP}{GNP})_{-1}]$

$+ \underset{(12.14)}{.1314}\, [GNP - .8GNP_{-1}] - \underset{(4.38)}{539.6538}$

$\bar{R}^2 = .887$
DW = 1.99
MS2SLS

Accrued net income of farm and of nonfarm, and dividend payment to nonresident equations

(58) $$Y_{\Lambda} - .8Y_{\Lambda,-1} = \underset{(15.76)}{.7913}\,[P_aV_a - .8(P_aV_a)_{-1}] - \underset{(3.90)}{126.7500}$$

$\bar{R}^2 = .942$
DW = 1.73
MS2SLS

(59) $$Y_{NB} - .35Y_{NB,-1} = \underset{(36.27)}{.0489}[(P_mV_m + P_cV_c + P_sV_s)$$

$$- .35(P_mV_m + P_cV_c + P_sV_s)_{-1}] + \underset{(17.69)}{479.9390}$$

$\bar{R}^2 = .986$
DW = 1.94
MS2SLS

(60) $$D_{VF} = \underset{(10.61)}{.2763}\,\Pi_{c\Lambda} - \underset{(.37)}{21.7938}$$

1955 - 1967
$\bar{R}^2 = .903$
DW = 1.70
OLS

Identities

(61) $$L^{\Lambda} = L\frac{1-uf}{1-un}$$

(62) $$L^{\Lambda}_a/L_{\Lambda} = 1 - (L^{\Lambda}_m + L^{\Lambda}_c + L^{\Lambda}_s)/L^{\Lambda}$$

(63) $$Ka^u = \sum_{\gamma=0}^{9} (.934)^{\gamma} I_{pa,-\gamma}$$

(64) $$K^u_m = \sum_{\gamma=0}^{9} (.934)^{\gamma} I_{pm,-\gamma}$$

(65) $$K^u_c = \sum_{\gamma=0}^{9} (.934)^{\gamma} I_{pc,-\gamma}$$

(66) $$K^u_{SG} = \sum_{\gamma=0}^{9} (.934)^{\gamma} I_{PSG,-\gamma}$$

(67) $$K^u_G = \sum_{\gamma=0}^{9} (.934)^{\gamma} (G_I/P_K)_{-\gamma}$$

(68) $K_a = K_a^u \frac{L_a^A}{L_a}$

(69) $K_m = K_m^u \cdot \frac{L^{A_m}}{L_m}$

(70) $K_c = K_c{}^u \frac{L^{A_c}}{L_c}$

(71) $K_{SG} = K_{SG}^u \frac{L^{A_s}}{L_s}$

(72) $P_x = (P_a X_a + P_m X_m)/(X_a + X_m)$

(73) $C = C_{nd} + C_d + C_s$

(74) $I_p = I_{pa} + I_{pm} + I_{pc} + (I_{PSG} - G_I/P_K)$

(75) $P_K I = P_K I_p + P_h I_h$

(76) $I = I_p + I_h$

(77) $\Delta I_i = \Delta I_{in} + \Delta I_{ia}$

(78) $I_{in} = I_{in,-1} + \Delta I_{in}/P_K$

(79) $X = X_a + X_m$

(80) $F = F_m + F_s + F_i'/P_F$

(81) $GNP/P = C + I + \Delta I_{in}/P_K + \Delta I_{ia}/P_a + X - F + G_{const} + S_e/P$

(82) $W = W_a L_a + W_m L_m + W_c L_c + W_s L_s$

(83) $w = W/(L_a + L_m + L_c + L_s)$

(84) $u_n = (L_{sup} - L)/ L_{sup}$

(85) $L = L_a + L_{mt} + L_c + L_s$

(86) $N = N_{-1}(1 + br - dr + nm)$

(87) $V = V_a + V_m + V_c + V_s$

(88) $B = P_X X - P_F F + D_I + P_I + STK$

(89) $GNP = P_{nd}C_{nd} + P_{cd}C_d + P_sC_s + P_KI_p + P_hI_h + \Delta I_{in} + \Delta I_{ia}$

$+ \Delta I_{ia} + P_xX - P_FF + G + S_e$

(90) $Y_d = NI - T_p + T_r + IPD - S_c$

(91) $NI = GNP - T_I - D - S_e$

(92) $\Pi_{cB} = NI - (W + M_A + RI + Y_A + Y_{NB} + IVA - D_{VF})$

(93) $\Pi_{cA} = \Pi_{cB} - T_c$

(94) $P_d = (P_{nd}C_{nd} + P_{cd}C_d + P_sC_s)/C$

(95) $P = GNP/(GNP/P)$

(96) $V_a = V_a^d + X_a$

(97) $V_m = V_m^d + X_m$

<u>List of Variables</u>

A variable with an asterisk on the upper left hand side is endogenous to the system.

*B = balance of payments, millions of current dollars

B_g = unamortized government bonds, millions of current dollars

*br = birth rate per person

*C = total consumption, millions of 1957 dollars

*C_d = durable consumption, millions of 1957 dollars

*C_{nd} = nondurable consumption, millions of 1957 dollars

*C_s = consumption of services, millions of 1957 dollars

*D = depreciation, millions of current dollars

D_{57} = Dummy variable, 1957 = 1.0, otherwise zero

*D_I = net direct foreign investment, millions of current dollars

DTDL = day-to-day loans, millions of current dollars

*D_{VF} = dividends paid out ot nonresidents, millions of current dollars

dr = death rate per person

er = exchange rate, one U.S. dollar in terms of Canadian dollars

$*F$ = total imports, millions of 1957 dollars

$*F_i'$ = interest and dividend payments to the foreigners, millions of current dollars

$*F_m$ = imports of mining and manufacturing goods, millions of 1957 dollars

$*F_s$ = imports of other goods and services, millions of 1957 dollars

G = total government expenditures, millions of current dollars

G_{const} = total government expenditures, millions of 1957 dollars

G_I = government investment expenditures, millions of current dollars

*GNP = gross national product, millions of current dollars

*GNP/P = gross national product, millions of 1957 dollars

G_s = government expenditures on services, millions of current dollars

$*I$ = total gross investment, millions of 1957 dollars

$*I_h$ = new residential construction, millions of 1957 dollars

$*I_{in}$ = stock of nonfarm inventories, millions of 1957 dollars

$*I_h^s$ = housing starts, thousands of units

$*I_p$ = new nonresidential construction, new machinery and equipment investment in all sectors, millions of 1957 dollars

$*I_{pa}$ = plant, machinery and equipment investment in agriculture, fishing and forestry, millions of 1957 dollars

$*I_{pc}$ = plant, machinery and equipment investment in construction, millions of 1957 dollars

*IPD = interest on the public debt, millions of current dollars

$*I_{pm}$ = plant, machinery and equipment investment in mining and manufacturing, millions of 1957 dollars

$*I_{PSG}$ = plant, machinery and equipment investment in services including government capital formation, millions of 1957 dollars

I^{us} = gross investment in U.S., millions of 1958 U.S. dollars

IVA = inventory value adjustment, millions of current dollars

i_D = discount rate, percentage

$*i_L$ = long-term interest rate, percentage

i_L^{us} = long-term interest rate in U.S. (Moody's AAA), percentage

$*i_s$ = short-term interest rate, percentage

$*\Delta I_i$ = changes in total investories, millions of current dollars

ΔI_{ia} = changes in farm inventories, millions of current dollars

$*\Delta I_{in}$ = changes in nonfarm business inventories, millions of current dollars

$*K_a$ = net capital stock in agriculture, fishing and forestry, millions of 1957 dollars

$*K_c$ = net capital stock in construction, millions of 1957 dollars

$*K_m$ = net capital stock in mining and manufacturing, millions of 1957 dollars

$*K_{SG}$ = net capital stock in services, millions of 1957 dollars

$*K_a^u$ = net capital stock utilized in agriculture, fishing and forestry, millions of 1957 dollars

$*K_c^u$ = net capital stock utilized in construction, millions of 1957 dollars

$*K_G^u$ = net government capital stock, utilized millions of 1957 dollars

$*K_m^u$ = net capital stock utilized in mining and manufacturing, millions of 1957 dollars

$*K_{SG}^u$ = net capital stock utilized in services (including government capital formation), millions of 1957 dollars

$*L$ = total employment, 1000 of persons

$*L_a$ = employment in agriculture, fishing and forestry, 1000 of persons

$*L_c$ = employment in construction, 1000 of persons

$*L_m$ = employment in mining and manufacturing, 1000 of persons

$*L_s$ = employment in services, 1000 of persons

$*L_{sup}$ = total labor force, 1000 of persons

$*L^A$ = total available labor force, 1000 of persons

$*L_a^A$	=	available labor in agriculture, 1000 of persons
$*L_c^A$	=	available labor in construction, 1000 of persons
$*L_m^A$	=	available labor in mining and manufacturing, 1000 of persons
$*L_s^A$	=	available labor in services, 1000 of persons
M_A	=	military pay and allowances, millions of current dollars
*MTG	=	all housing mortgage loans approved by lending institutions, millions of current dollars
*N	=	Candian population, thousands of persons
*NI	=	net national income, millions of current dollars
*nm	=	net migration rate per person
*P	=	price index of gross national product, 1957 = 1.0
$*P_a$	=	price index of agriculature, fishing, forestry, 1957 = 1.0
$*P_c$	=	price index of construction, 1957 = 1.0
$*P_{cd}$	=	price index of durable goods, 1957 = 1.0
$*P_d$	=	price index of personal expenditures on consumer goods, 1957 = 1.0
P_F	=	price index of total imports, 1957 = 1.0
$*P_h$	=	price index of residential construction, 1957 = 1.0
*PI	=	net long-term portfolio investment, millions of current dollars
$*P_k$	=	price index of investment, 1957 = 1.0
$*P_m$	=	price index of mining and manufacturing, 1957 = 1.0
P_m^F	=	import price index of mining and manufacturing goods, 1957 = 1.0
P_m^{us}	=	price index of mining and manufacturing in U.S., 1957 = 1.0
P_m^W	=	world price index of mining and manufacturing goods, 1957 = 1.0
$*P_{nd}$	=	price index of nondurable goods, 1957 = 1.0
$*P_s$	=	price index of services, 1957 = 1.0
P_s^F	=	import price index of services, 1957 = 1.0
P_s^{us}	=	price index of services in U.S., 1957 = 1.0

$*P_x$	=	price index of total exports, 1957 = 1.0
$*\Pi_{cA}$	=	corporate profits after taxes, millions of current dollars
$*\Pi_{cB}$	=	corporate profits before taxes, millions of current dollars
RI	=	rent, interest and miscellaneous investment income, millions of current dollars
$*S_c$	=	earnings not paid out to persons, millions of current dollars
S_e	=	residual error of estimate, millions of current dollars
STK	=	net short-term capital movements, millions of current dollars
$*T_c$	=	corporate direct taxes, millions of current dollars
TCA	=	total Canadian and net foreign assets in Canadian chartered banks, millions of current dollars
$*T_I$	=	indirect taxes, millions of current dollars
$*T_p$	=	personal direct taxes, millions of current dollars
$*T_r$	=	transfer payments, millions of current dollars
TRB	=	treasury bills, millions of current dollars
uf	=	frictional unemployment rate, percentage
*un	=	unemployment rate, percentage
*V	=	gross domestic product, millions of 1957 dollars
$*V_a$	=	gross domestic product originating in agriculture, fishing and forestry, millions of 1957 dollars
$*V_a^d$	=	domestic demand for gross domestic product originating in agriculture, fishing and forestry, millions of 1957 dollars
$*V_c$	=	gross domestic product originating in construction, millions of 1957 dollars
$*V_m$	=	gross domestic product originating in mining and manufacturing, millions of 1957 dollars
$*V_m^d$	=	domestic demand for gross domestic product originating in mining and manufacturing, millions of 1957 dollars
$*V_s$	=	gross domestic product originating in services, millions of 1957 dollars

$*V_a^*$ = capacity production of agriculture, fishing and forestry, millions of 1957 dollars

$*V_c^*$ = capacity production of construction, millions of 1957 dollars

$*V_m^*$ = capacity production of mining and manufacturing goods, millions of 1957 dollars

$*V_s^*$ = capacity production of services, millions of 1957 dollars

$*W$ = wages, salaries and supplementary labor income, millions of current dollars

$*w$ = aggregate wage rate, thousands of current dollars

$*w_a$ = wage rate in agriculture, fishing and forestry, thousands of current dollars

$*w_c$ = wage rate in construction, thousands of current dollars

WETH = weather adjustment for agricultural output, millions of 1949 dollars

$*w_m$ = wage rate in mining and manufacturing, thousands of current dollars

$*w_s$ = wage rate in services, thousands of current dollars

w_c^{us} = wage rate in US construction, thousands of current U.S. dollars

w_m^{us} = wage rate in U.S. mining and manufacturing, thousands of current U.S. dollars

w_s^{us} = wage rate in U.S. services, thousands of current U.S. dollars

$*X$ = total exports, millions of 1957 dollars

$*X_a$ = exports of agriculture, fishing and forestry, millions of 1957 dollars

$*X_m$ = exports of mining and manufacturing goods, millions of 1957 dollars

$*Y_A$ = accrued net income of farm operators from farm production, millions of current dollars

$*Y_d$ = disposable income, millions of current dollars

$*Y_{NB}$ = net income of nonfarm unincorporated business, millions of current dollars

$(Y_d/P_dN)^{us}$ = per capita disposable income in U.S., thousands of 1958 U.S. dollars

Y^W = weighted national income of the Unites States, United Kingdom and Japan: weights being the ratios of Canadian exports to these countries to the total Canadian exports, billions of 1958 dollars.

III. Discussion of the Equations

Consumption: The consumption sector follows the national account classification of nondurable, durable, and services, and per capita consumption is estimated for each category. The per capita consumption functions are simply based on the real per capita income and on the relative prices. Since the model is based on annual data it may be plausible to say that current real income is the major determinant of consumption except for durable goods. In this case consumption is likely to be influenced by the current as well as past income in some weighted fashion. To determine the weights of the lags on the part of income, we introduced the gamma distributed lags proposed in [11], and the estimated time form of lags is presented in Table 1.

Table 1. The Distributed Lag Coefficients of the Durable Consumption Equation: $k^{\hat{s}-1}e^{-k}$, $\hat{s} = 1.9912$

Lagged period	Coefficients
0	.4017
1	.2938
2	.1615
3	.0790
4	.0363
5	.0160
6	.0069

Investment functions: "Business gross fixed capital formation" in the national income accounts are divided into residential construction, I_h, and plant (i.e. nonresidential construction), machinery and equipment, I_p. The latter is further broken down to four sectors. If we denote net investment by IN, and if we introduce an overall stock adjustment of the form such as in [4 p. 25], then IN will be given as

$$\text{(98)} \quad IN = \lambda(K^* - K_{-1}) + \gamma C_{p-1}$$

where λK^*, K_{-1}, C_{p-1} are respectively, an adjustment coefficient, desired capital stock, lagged capital stock and lagged capacity utilization rate. Gross investment, IG, is related to net investment, IN, by the following identity if we assume a depreciation rate of δ,

$$\text{(99)} \quad IG = IN + \delta K_{-1}$$

Substituting (99) into (98), we obtain

$$\text{(100)} \quad IG = \lambda K^* - (\lambda - \delta)\, K_{-1} + \gamma C_{p-1}$$

We make a hypothesis that desired capital stock, K^*, is determined by

$$\text{(101)} \quad K^* = \sum_{\gamma=1}^{m} P_{-\gamma}(\alpha V_{-\gamma+1} + \beta F_{-\gamma+1})$$

where V and F are output and a financial variable respectively and the distributed lag coefficient $\{P_\gamma\}$ is given by the gamma lags:

$$P_\gamma = \gamma^{s-1} e^{-\gamma}$$

Substitution of (101) into (99) gives rise to

$$\text{(102)} \quad IG = \alpha\lambda \sum_{\gamma=1}^{m} P_{-\gamma} V_{-\gamma+1} + \beta\lambda \sum_{\gamma=1}^{m} P_{-\gamma} F_{-\gamma+1} + \gamma C_{p-1} - (\lambda-\delta) K_{-1}$$

Equation (102) is used to estimate investment of the four sectors. The mining and manufacturing and service sectors have net direct foreign investment as a financial variable, while the construction sector uses the long-term interest rate. The agricultural, fishing and forestry sector and mining and manufacturing sector retain the capacity utilization variables which are not statistically significant but have the right sign.

The estimated time forms of the gamma distributed lags are presented in Table 2.

Table 2. Gamma Distributed Lag Coefficients: Investment

Lagged periods	I_{pa}	I_{pm}	I_{pc}	I_{PSG}-G_I/P_K
0	.5065	.3970	.4071	.2663
1	.2742	.2943	.2931	.2928
2	.1265	.1631	.1597	.2044
3	.0546	.0802	.0778	.1184
4	.0228	.0370	.0355	.0620
5	.0093	.0164	.0156	.0304
6	.0037	.0070	.0067	.0143
7	.0015	.0030	.0028	.0065
8	.0006	.0012	.0012	.0029

Except for the service sector, the distributed lag coefficients decline like a Koyck lag.

Residential construction, I_h, housing starts, I_h^s, and housing mortgages form a triangular block: mortgages are determined by the distributed lags of disposable income and by the long-term interest rate, and the distributed lags of housing mortgages determine housing starts. In turn the distributed lags of the housing starts determine residential construction. The distributed lag structures are presented in Table 3.

Table 3. Gamma Distributed Lag Coefficients: Residential Construction, Housing Starts and Mortgages

Lagged periods	I_h	I_h^s	MTG/P_h
0	.6839	.2846	.1106
1	.2101	.2950	.2301
2	.0696	.1990	.2333
3	.0237	.1125	.1762

Table 3. (cont'd)

Lagged periods	I_h	I_h^s	MTG/P_h
4	.0082	.0578	.1132
5	.0029	.0279	.0657
6	.0010	.0129	.0355
7	.0003	.0058	.0183

As expected the distributed lags of housing starts to determine residential construction are short: roughly 70% of the current housing starts determine the residential construction. The distributed lags of mortgages to determine housing starts and those of disposable income to determine mortgages are longer: the peak of the former lags is in the first lag-period while that of the latter lags is in the second lag-period. The high interest rate tends to discourage the demand for housing mortgages.

A change in nonfarm inventories is explained by the real gross national product, and the stock of inventories in the previous period. The stock of inventories has an abritrary origin of zero in 1947.

Exports and imports: Exports are divided into two groups -- exports of agricultural, fishing and forestry products, X_a and exports of mining and manufacturing products, X_m. The former is determined by the world real income, Y^W and the lagged dependent variable X_{a-1}. Attempts to introduce relative prices were not successful. The omission of the relative prices cannot catch the recent development in the international wheat market.

The world income Y^W is the weighted average of national income of United States, of United Kingdom and of Japan, weights being the portions of total Canadian exports going to these countries. The world price of mining and manufacturing goods is constructed by the weighted average of price indexes of the three countries above and the weights are the same as the ones used for Y^W. The relative price variable, P_m/P_m^W. is retained in the equation for exports of mining and manufacturing goods.

Imports are divided into three categories: imports of mining and manufacturing goods, F_m, imports of services, F_s, and interest and dividend payments to the foreigners, F_i'. The first two groups, i.e. F_m and F_s are explained by real income and relative price variables, while the last group, F_i' , is explained by a stock of net direct and portfolio investments and the long-term interest rate. The stock of net direct and portfolio investments is constructed by taking a moving sum of six years, $\sum_{i=0}^{5} (D_I + P_I)_{-i}$ in view of the fact no data on stock of foreign investment are available.

Wages and prices: The wage rate in each sector is defined as the annual wages, salaries and supplementary income divided by the total number of employment in that sector. The wage rate functions are based on the general formulation of the Phillip curve and of the average labor productivity and they are modified by the wage rates of the United States. Most of the Canadian labor unions are in close contact with their counterparts in the United States and their wage demand may be influenced by how much the U.S. workers may get.

The price equations of the four sectors are the basis of all price equations of the model, since once the sectoral prices are determined, they in turn determine other prices.

The four sectoral prices, i.e. P_a, P_m, P_c, and P_s are determined basically by mark-up equations, modified by the rates of capacity utilization and by the "price synchronization" between the United States and Canada, because in sectors other than the agriculture large Canadian corporations tend to be U.S. subsidiaries and their pricing policies may closely coordinate with those of their parent companies.

Labor force participation and shares of available labor: The aggregate labor participation rate, L_{sup}/N, is determined by real per capita disposable income, Y_d/P_dN, and the real wage rate, w/P_d. The negative coefficient of the real wage rate may indicate a trade-off between work and leisure. However, this aggregate participation rate does not catch any changes in the supply of labor due to changes in age composition of population or due to a change in women's participation rate.

To explain the equations to determine the shares of available labor, L_i^A/L^A (i = a, m, c, s) we shall start with the total available labor, L^A. The determination of L^A follows the formulation of Klein and Preston [6]:

$$(103) \qquad L^A = L\,\frac{1 - uf}{1 - un}$$

where uf and un are the frictional rate and the national rate of unemployment respectively. L is the total employment. The frictional unemployment rate may be regarded as the rate which determined the effective full employment, and it will change according to the institutional arrangements and statistical definitions of the unemployment rate. In our model it is set at 2%, the minimum actual unemployment rate reached in the sample period.

Once L^A is computed by equation (103), the problem is how to distribute it among the industrial sectors. Over the long-run the sectoral distribution of labor follows a trend, and hence this trend may be used to distribute the aggregate available labor L^A.

In the model, the trend of each sectoral share, L_i^A/L^A (i = c, m, s) was constructed by fitting linear segments between the share of labor in each sector at peak points of aggregate labor demand rather than at peak points of sectoral labor demand. This is because when the aggregate labor demand reaches a peak, the unemployment rate, un, will tend towards the frictional unemployment rate, uf, and thus the aggregate available labor L^A will be close to the actual employment. However, this is not necessarily true for an individual sector. The peaks of the aggregate employment were at 1947, 1953, 1957, 1959, 1962, 1966 and 1967.

Assuming that each sector experiences the same type of technological change of the similar magnitude, we may say that in the long-run, the labor share of a sector may depend on the share of production in that sector. However, if the wage rate of the sector is high relative to the wage rate of the other sectors, demand for labor in the sector under consideration may be discouraged. Based on this argument the share of available labor, in sector i, L_i^A/L^A, is formulated as

$$(104) \qquad \frac{L^A{}_i}{L^A} = \alpha_0 + \alpha_1 \frac{V_i}{V} + \alpha_2 \frac{w_i}{w} ,$$

where V_i/V and w are respectively the share of output wage rate in sector i and the aggregate wage rate.

<u>Production functions</u>: The production functions in the model follow the general Cobb-Douglas form.(1) Since we do not have reasonable data on capital stock which are consistent with the investment series of the national account, we created utilized capital stock for sector i, K_i^u, by

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1. The use of Cobb-Douglas functions is supported by a partial evidence [10] that in the manufacturing industry the elasticity of substitution estimate by the CES production function was quite close to one, hence indicating that the CES tends to collapse to the Cobb-Douglas production function. The omission of technological change is due to the fact that when labor and capital have trends in themselves separate estimation os technologocal change by time trend tends to be difficult and thus meaningless [10].

$$(105) \qquad K_i^u = \sum_{k=0}^{9} (.934)^k I_{pi,-k}$$

where I_{pi} is gross investment in sector i, and the depreciation rate .934 is taken from the estimate of the depreciation rate in the manufacturing industries.(1)

In estimating the production function for agriculture, fishing and forestry we a priori restricted it to the constant returns to scale. This is because the estimated coefficient of labor in the unrestricted production function tended to be negative and insignificant. Employment in this sector has been declining over the years and thus it has a negative correlation with output. For the other sectors the coefficients are not restricted, but their estimates tend to indicate constant returns to scale in these sectors.

Now we turn to the capacity production functions which follow the Klein and Preston formulation [6]. The parameters of the capacity production are the same as those for actual production function but available labor, L^A_i, and capital stock, K_i, are now used to compute the capacity output, V_i^*.

We assumed the following relationship between utilized capital and labor:

$$(106) \qquad \frac{K_i^u}{K_i} = \frac{L_i}{L_i^A} \qquad i = a, m, c, s.$$

which states that the capital utilization rate is the same as the labor utilization rate. Then we will have

$$(107) \qquad K_i = K_i^u \left(\frac{L^A_i}{L_i}\right)$$

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1. Dominion Bureau of Statistics, Fixed Capital Flows and Stocks Manufacturing Canada, 1926 - 1960, Ottawa, 1966, p. A1. .934 is the average depreciation rate between 1947 and 1967. The utilized capital stock series may underestimate real capital stocks, but in the absence of capacity utilization and capital stock data, any other attempt will also be subject to this criticism.

Birth rate, net migration rate and population: Demographic variables such as the birth and net migration rates should be treated as endogenous variables when we are analyzing a long-run economic growth. These demographic variables are difficult to be explained only by economic reasoning because they involve sociological and institutional factors. Equations formulated in the model are rudementary and much to be improved. For example, to explain net migration it will be better to treat immigration into Canada and emmigration from Canada separately. Preferably they should be divided according to the countries from which immigrants come and to which emmigrants go from Canada.

In the model the net migration rate is a function of per capita disposable income in Canada and the United States and of lagged net migration rate. The estimated negative coefficient of U.S. per capita disposable income indicates as it goes up, ceteris paribus, the net migration to Canada tends to decrease. The dummy variable, D_{57}, is used to account for a sudeen change in migration in 1957. The birth rate has negative coefficients of per capita disposable income and of time trend, thus indicating that in post-war Canada the birth rate has tended to decrease as income increased.

Short- and long-term interest rates: The short-term interest rate is determined by the discount rate, i_D, and the proportion that the treasury bills and day-to-day loans take up in the total assets of the chartered banks. The inclusion of the latter variable is due to the fact that the 1967 Bank Act instituted the secondary reserve ratio which may be imposed by the Bank of Canada. The secondary reserves consist of bank cash, Canadian treasury bills issued for a term of one year or less and day loans to money-market dealers. Hence, it will be reasonable to expect that as the money situation becomes tight the banks tend to switch more to these assets from much longer commitments. The long-term interest rate is determined by the short-term interest rate and by the lagged long-term interest rate.

Net direct and portfolio investment equations: Foreign investment in Canada is divided into net direct and portfolio investment. The former is determined by the distributed lags of a composite variable $(I/I^{us}_{er})GNPP/P$ ... the lagged net direct investment. The composite variable is introduced on the hypothesis that an increase in Canadian domestic investment relative to that of the United States which is the major supplier of funds will indicate an opportunity for investment and hence profitability in Canada. The size of direct foreign investment Canada can absorb may be related to the size of Canadian economy which is represented by gross national product, GNP/P The distributed lags are introduced because there will be some time lags between the investment decision and realization of investment.

For portfolio investment, the differential between the Canadian and U.S. long-term interest rates may serve as an indication of profitability of investment in Canadian stocks and bonds.

A better treatment of direct and portfolio foreign investment will be to separate them into two parts: investment into Canada, and Canadian investment abroad. In the absence of appropriate data to carry out this, we treated foreign investment in net figures.

Sectoral domestic products: The sectoral domestic products are determined in the model of such demand variables as consumption, investment, and government expenditures. Once the domestic products are determined then the production functions are used to find labor requirements to produce the level of output which meet the demand.

We had difficulties in estimating domestic demand for agricultural, fishing and forestry products, V_a^d, and for mining and manufacturing products, V_m^d. This is mainly because V_a^d and V_m^d are residually defined as $V_a^d = V_a - X_a$ and $V_m^d = V_m - X_m$ and because the sources of statistics for X_a and X_m are not consistent with those of V_a and V_m.

The determination of V_a^d is done in a synthetic fashion because it has the change in farm inventories $\Delta I_{ia}/P_a$ and the adjustment for weather condition WETH.

If data on a change in inventory which is consistent with data on domestic product V_a are available, then it is desirable to explain inventory change and supply separately: then demand will be determined residually from the identity: demand = supply - change in inventories.

The domestic demand for mining and manufacturing is determined by the sum of consumer durables, C_d, nondurables, C_{nd}, plant and equipment investment, I_p, and government investment, G_I/P_K, while the demand for gross domestic product originating in construction, V_c, is determined by the sum of plant and equipment investment, I_p, residential construction, I_h, and government investment, G_I/P_K. The demand for gross domestic product originating in services is determined by disposable income, Y_d/P_d, and government expenditures on services, G_s/P_s.

Depreciation, corporate savings and interest on the public debt:

Depreciation allowances will be determined by the level of net capital stock existing in the society at the beginning of the period, K_{-1}: If we have an estimate of K_{-1}, then the real depreciation investment is given by δK_{-1} where δ is the depreciation rate. However, depreciation allowances, D, in the model include value adjustments due to price fluctuations and furthermore the net capital stock of Canada, K_{-1} is not available. Rather than getting a proxy for K_{-1} and determining real depreciation investment, and then adjusting it for price fluctuations, we simply made the current value of depreciation, D, determined by the current value of gross investment, $P_K I$.

Earnings not paid out to persons, S_c, is determined by gross domestic product of all sectors except that originating in agriculture, fishing and forestry, while interest on the public debt, IPD, is determined by the long-term interest rate, i_L, and the level of unamortized government, B_g.

Taxes and transfer payments: In the model the taxes collected by all level of governments are divided into personal direct taxes, T_p, indirect taxes, T_I, and corporate direct taxes, T_c. The personal direct taxes, T_p, are determined by the total wage bills, W, while the corporate direct taxes are determined by the corporate profits before taxes, Π_{cB}. The indirect taxes, T_I, are determined by gross national product, GNP.

The transfer payments, T_r, will increase as the unemployment rate, un, increases while the gross national product, GNP, indicates economy's capacity to pay the transfer payments.

Accrued net income of farm, and nonfarm, and dividend payment to nonresidents: Accrued net income of farm operators from farm production, Y_A, is a function of the value of output in agricultural, fishing and forestry, $P_a A_a$, while net income of nonfarm unincorporated business, Y_{NB}, is determined by the current value of gross domestic product originating in all sectors but agriculture, fishing and forestry.

Dividends paid to non-residents, D_{VF}, is determined by the corporate taxes after taxes, and since D_{VF} series are only available from 1955, this equation is estimated by ordinary least squares using data from 1955 to 1967.

IV Sample Simulation and Forecast of the Canadian Economy, 1968 - 1975

The model consisting of 60 behavioural equations and 37 identities includes nonlinear equations such as production functions, price and wage equations, and the shares of available labor equations among others. Hence the entire system was solved by a modified Seidel method. As a set of initial values for iteration, the solution of the previous period was used.

To examine whether the model performs reasonably well or not a controlled simulation was made for the sample period of 1952 to 1967, using the actual values of all exogenous variables and replacing the lagged endogenous variables by the computed values as the latter become available. Table 4 presents the computed Theil inequal coefficients for the endogenous variables. A Theil inequality coefficient takes the value between zero and one, and the closer it is to zero, the better it is. There is no statistical test available for this coefficient. Most of the computed endogenous variables seem to be reasonably close to the actual values except for the following variables whose Theil inequality values are more than .20: ΔI_{in}, L_a, V_a^*, nm, PI, K_a, un, B, and π_{cB}.

Examining these variables we recognize that the following five variables: labor requirement for agriculture, fishing and forestry, L_a, net migration rate, nm, net portfolio investment, P_I, and a change in nonfarm inventory, ΔI_{in} are the equations which should be improved in the future and their improvements will reduce the errors of the other variables listed above.

Using a set of exogenous variables most of which are based on the time trend estimates, we made the forecast of the Canadian economy from

1968 to 1975. The values of exogenous variables used for the forecast are presented in Table 5. The time trend equations for the exogenous variables are given in Appendix A.

Table 4. The Theil Inequality Coefficients for Sample Period Controlled Simulation 1952-1967

Variables	Coefficients	Variables	Coefficients
C_{nd}/N	.012	i_L	.050
C_d/N	.045	P_I/P_K	.169
C_s/N	.007	P_I	.272
I_{pa}	.108	V_a	.093
I_{pm}	.077	V_a^d	.196
I_{pc}	.127	V_m	.023
$I_{ps}-G_I/P_K$	.059	V_m^d	.076
I_h	.065	V_c	.053
I_h^s	.085	V_s	.015
MTG/P_h	.151	D	.017
$\Delta I_{in}/P_K$	.577	S_c	.026
X_a	.041	IPD	.035
X_m	.045	T_p	.044
F_m	.054	T_I	.016
F_s	.045	T_c	.194
F_I'	.113	T_r	.087
W_a	.070	Y_A	.199
W_m	.032	Y_{NB}	.012
W_c	.055	L_A	.030
W_s	.008	K_a^u	.096
P_a	.133	K_m^u	.024

Table 4. (cont'd)

Variables	Coefficients	Variables	Coefficients
P_m	.017	K_c^u	.067
P_c	.036	K_{sg}^u	.020
P_s	.008	K_a	.284
P_{nd}	.010	K_m	.028
P_{cd}	.026	K_c	.071
P_h	.050	K_{sg}	.040
P_k	.014	P_x	.033
L_{sup}/N	.019	C	.013
L_a^A/L^A	.088	I_p	.045
L_a^A/L^A	.009	$P_k I$	.042
L_c^A/L^A	.027	X	.036
L_s^A/L^A	.021	F	.049
L_a	.229	GNP/P	.020
L_m	.045	W	.016
L_c	.050	un	.252
L_s	.016	N	.010
V_a^*	.244	V	.012
V_m^*	.020	B	.453
V_c^*	.050	GNP	.012
V_s^*	.033	Y_d	.014
br	.045	NI	.014
nm	.278	Π_{cB}	.268
i_s	.053	P_d	.008
		P	.014

Table 5. The Values of the Exogenous Variables Used for the Forecast 1968 - 1975

Variables	1968[3]	1969	1970	1971	1972	1973	1974	1975
dr	.0072	.0072	.0071	.0071	.0070	.0069	.0069	.0068
GI	2925	3016	3165	3313	3461	3610	3758	3906
G	13329	13357	14013	14668	15324	15980	16635	17291
ΔI_{ia}[1]	531.0	25.27	25.27	25.27	25.27	25.27	25.27	25.27
STK[1]	-1032.0	45.66	45.66	45.66	45.66	45.66	45.66	45.66
Y^W	579	596	618	639	660	682	703	725
W_m^{us}	7.276	7.460	7.670	7.880	8.089	8.299	8.509	8.718
W_c^{us}	7.784	7.901	8.149	8.398	8.647	8.895	9.143	9.392
W_s^{us}	7.048	7.283	7.507	7.732	7.956	8.180	8.405	8.629
N^{us}	201.2	207.0	210.6	213.3	216.1	218.8	221.5	224.2
DTDL	193.0	377.0	397.3	417.7	438.0	458.3	478.7	499.0
TRB	2124.0	1843.4	1924.6	2005.8	2087.0	2168.2	2249.4	2330.6
TCA	29321.0	27473	28753	30033	31313	32593	33874	35154
er[2]	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
I^{us}	99.1	115.7	120.1	124.5	128.9	133.4	137.8	142.2
i_L^{us}	6.18	5.47	5.60	5.73	5.85	5.98	6.11	6.24
WETH[1]	77.0	-22.9	-22.9	-22.9	-22.9	-22.9	-22.9	-22.9
S_e[2]	-41.0	0	0	0	0	0	0	0
M_A	696.0	722.2	742.1	762.1	782.0	802.0	822.0	841.9

Table 5. (cont'd)

Variables	1968[3]	1969	1970	1971	1972	1973	1974	1975
RI	4758	4780	5012	5243	5474	5706	5937	6168
IVA	305.0	406	438	469	500	532	563	594
P_F	1.21	1.254	1.276	1.297	1.319	1.340	1.361	1.383
P_s^F	1.16	1.182	1.195	1.207	1.220	1.232	1.244	1.257
P_m^F	1.25	1.281	1.306	1.330	1.354	1.378	1.402	1.426
P_m^W	1.22	1.220	1.234	1.253	1.272	1.291	1.310	1.328
P_s^{us}	1.16	1.383	1.412	1.441	1.470	1.499	1.528	1.557
P_m^{us}	1.13	1.104	1.111	1.119	1.127	1.134	1.142	1.150
Y_p^{us}	590.0	598.2	623.0	647.7	672.5	697.3	722.1	746.8
B_g	18493	19188	19652	20116	20580	21044	21508	21972
i_D	6.84	5.39	5.58	5.78	5.98	6.17	6.37	6.57

Notes:
1. The values for change in farm inventories, ΔI_{ia}; net short-term capital inflow, STK, weather adjustment for agricultural output, WETH, are set at the sample averages between 1958 and 1967.
2. The exchange rate, er, is assumed to be fixed at 1.08, and residual error of estimate is assumed to be zero in the entire period.
3. The values for 1968 are preliminary actual values.

Table 6. Forecast of Gross National Expenditure, 1968-1975

Millions of 1957 Dollars

	1968	1969	1970	1971	1972	1973	1974	1975
Personal consumption	32828	33585	34793	35846	36795	37642	38489	39378
nondurable	16419	16549	17105	17538	17912	18240	18597	19001
durable	4407	4523	4629	4735	4841	4944	5046	5150
service	12002	12515	13059	13573	14042	14458	14846	15227
Government expenditure	8792	8794	8960	9116	9216	9411	9544	10028
Capital formation	9738	10636	10980	11212	11420	11591	11755	11986
plant, machinery and equipment	7938	8621	8874	9024	9152	9251	9352	9527
agriculture, fishing, forestry	785	808	826	845	863	880	903	927
mining and manufacturing	2692	3028	3121	3139	3177	3236	3285	3381
construction	189	213	217	219	220	218	218	222
services	4173	4572	4710	4821	4892	4917	4946	4997
new residential construction	1899	2015	2106	2188	2268	2340	2403	2459
Value of physical change in inventories	404	511	628	568	377	311	198	333
nonfarm	314	489	604	543	352	186	173	309
farm	90	22	24	25	26	25	25	24
Exports of goods and services	12837	13327	13968	14631	15266	15881	16445	16984
Imports of goods and services	13515	13677	13864	13986	14096	14176	14366	14647
Gross National Expenditure	51118	53176	55465	57387	58978	60566	62065	64062
Percentage growth of GNE		4.03	4.30	3.47	2.77	2.68	2.49	3.22

Table 7. Forecast of Price Deflators, 1968-1975

	1968	1969	1970	1971	1972	1973	1974	1975
Nondurable Consumption	1.197	1.209	1.203	1.204	1.210	1.217	1.228	1.241
Durable Consumption	1.061	1.067	1.060	1.057	1.055	1.055	1.058	1.062
Services	1.357	1.416	1.432	1.453	1.478	1.505	1.565	1.596
Plant, machinery and equipment	1.381	1.421	1.422	1.430	1.439	1.451	1.469	1.493
New residential construction	1.580	1.696	1.699	1.713	1.725	1.745	1.780	1.828
Total exports	1.197	1.197	1.158	1.144	1.135	1.135	1.143	1.158
Gross National Product	1.319	1.336	1.329	1.333	1.341	1.353	1.371	1.394

The forecast values of GNE accounts and of the implicit price deflators are presented in Table 6 and Table 7. With the set of exogenous variables given in Table 5, we find from the model that the real economic growth tends to slow down from 1971 to 1974, since the growth rates decline from 4.30% in 1970 to 3.47% in 1971, and then they stay between 3% and 2.5% from 1972 to 1974.

One of the reasons of this pattern of growth seems to lie on the government expenditures, which are exogenous to the model. As clear from Table 6, in 1969 the government expenditures in 1957 dollars stay the same level as in 1968, and from 1970 to 1974 the growth rate in government expenditures is between one and two per cents. This slow-down in the government spendings in 1969 seems to exert an impact on the economy in 1971, hence with almost two year lags, because in 1971 the growth rates slows down to 3.47%. The price rises tend to slow down in 1970 and 1971.

Table 8 compares the annual rate of growth of government expenditures in 1957 constant dollars between 1962 and 1967, and between 1970 and 1975. In 1975, the government expenditures increase by 50.7% and this seems to be a major reason in the gain in growth rate from 2.49% in 1974 to 3.22% in 1975. We note here that the reaction lag between the government spending

Table 8. Annual Rate of Growth in Government Expenditures: Sample Period vs. Forecasting Period

	1962	1963	1964	1965	1966	1967
Percentage growth	3.79	.54	3.87	5.78	10.78	3.25
	1970	1971	1972	1973	1974	1975
Percentage growth	1.89	1.74	1.12	2.12	1.41	5.07

and economic growth is not symmetric: spending-cut seems to have a longer reaction time until its effects are felt in the growth rate, whereas spending-increase has a quicker reaction.

The tightening of the government expenditures seems to slow down the price rises, but if it persists long then it may dampen the economic growth which is not too desirable. Moreover, we have to remind ourselves that wage and price determination in our forecast of the model is assumed to follow its sample period behaviour pattern. Consequently if the economy were to observe intensive price-fixing activities in the product as well as in the labour markets, then the government policy to cut down its expenditure may only lead to a low economic growth with higher price levels,(1) and a higher unemployment rate may follow.

The pattern of price rises is different depending on the types of goods and services: a noticeable rise is observed in construction and services, and as given in Table 9 below the rise in construction wage seems to be the fastest in all sectors.

Let us check the performance of the forecast against 1968 preliminary actual values. Table 10 compares the predicted against actual values and gives percentage errors.

From Table 10 we find the largest errors in the investment of mining and manufacturing (12.54%) and nonfarm inventory change (30.99%). The reason for the former is that as far as the preliminary actual figures are concerned investment in mining and manufacturing went down from 2653 in 1967 to 2392 in 1968, and the investment equation in the model did not catch it.

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1. This point is well demonstrated in the wage-parity exercise using the model. In this experiment we assumed the wage-parity between U. S. and Canada takes place between 1970 and 1975, and the result is higher prices and slower economic growth. See [12].

Table 9. Forecast of Some Endogenous Variables of the Model: 1968-1975

	1968	1969	1970	1971	1972	1973	1974	1975
Wages								
mining and manufacturing	5.14	5.52	5.60	5.74	5.88	6.03	6.17	6.29
construction	5.68	6.37	6.59	6.87	7.18	7.49	7.77	8.02
services	4.61	4.87	4.94	5.04	5.16	5.29	5.42	5.56
Prices								
agriculture, fishing and forestry	1.12	1.17	1.05	1.02	.99	1.00	1.02	1.07
mining and manufacturing	1.21	1.20	1.17	1.16	1.16	1.16	1.16	1.17
construction	1.51	1.61	1.62	1.63	1.65	1.67	1.70	1.74
services	1.36	1.42	1.43	1.45	1.48	1.50	1.53	1.56
Employment								
agriculture, fishing and forestry	639	743	649	644	625	641	676	725
mining and manufacturing	2165	2133	2122	2111	2110	2109	2129	2167
construction	536	569	566	560	551	546	550	565
services	4495	4504	4666	4775	4864	4936	5021	5123
Unemployment rate	.059	.035	.056	.061	.065	.065	.061	.056
Gross domestic product								
agriculture, fishing and forestry	2807	2950	2989	3068	3123	3185	3249	3318
mining and manufacturing	14521	15309	16088	16805	17454	18059	18606	19128
construction	2358	2480	2533	2578	2623	2663	2702	2750
services	25758	25933	27090	27905	28585	29162	29806	30544
Interest rates								
short-term	6.09	4.84	5.01	5.18	5.35	5.53	5.70	5.87
long-term	7.83	7.93	8.03	8.14	8.25	8.36	8.48	8.60
Population	20954	21266	21581	21882	22155	22392	22597	22778

Table 10. Comparison of Predicted and Actual Values, 1968 Gross National Expenditure Account and Implicit Price Deflators

Millions of 1957 dollars			
	Actual	Predicted	% Error
Personal consumption	32740	32828	-.27
nondurable	16136	16419	-1.75
durable	4626	4407	4.73
service	11978	12002	-.20
Plant, machinery and equipment investment	7509	7839	-3.98
agriculture, fishing and forestry	810	785	3.09
mining and manufacturing	2392	2692	-12.54
construction	186	189	1.61
service	4151	4173	-.53
New residential construction	1823	1899	-4.17
Non-farm inventory change	455	314	30.99
Exports of goods and services	14106	12837	8.99
Imports of goods and services	14127	13515	4.33
Gross National Expenditure	51451	51118	.65

Price Deflators 1957 = 1.00			
	Actual	Predicted	% Error
Nondurable consumption	1.221	1.197	1.96
Durable consumption	1.039	1.061	-2.12
Services	1.371	1.357	1.02
Plant, machinery and equipment	1.362	1.381	-1.39
New residential construction	1.553	1.580	-1.74
Total exports	1.186	1.197	- .93
Gross National Product	1.309	1.319	- .76

Nonfarm inventory change equation is much to be improved. The next largest error is in exports, and here the export equation of mining and manufacturing goods did not catch a great increase which occurred in this sector: 10896 in 1967 and 12604 in 1968. The export statistics as discussed in the preceding section are not consistent with GNP account's exports, and if possible more accurate definition of "exports of mining and manufacturing goods" should be made.

Table 11 compares predicted and actual values of some of the engodenous variables in the model. Here we note that unemployment rate, employment in construction, and long-term interest rates scored the largest errors in prediction.

Table 11. Comparison of Predicted and Actual Values of Some of the Endogenous Variables, 1968

	Actual	Predicted	% Error
Wages			
mining and manufacturing	5.39	5.15	4.45
construction	5.99	5.68	5.18
services	4.56	4.61	-1.10
Prices			
agriculture, fishing and forestry	1.17	1.12	4.27
mining and manufacturing	1.18	1.21	-2.54
construction	1.49	1.51	-1.34
services	1.37	1.36	.73
Employment			
agriculture, fishing and forestry	599	639	-6.26
mining and manufacturing	1974	2165	-9.69
construction	470	536	-14.04
services	4494	4495	0.0
Unemployment rate	.06	.05	+20.0
Gross domestic product			
agriculture, fishing and forestry	2718	2808	-.70
mining and manufacturing	14537	14521	.11
construction	2403	2357	1.91
services	25355	25718	-1.43
Interest rates			
short-term	6.27	6.09	2.87
long-term	8.95	7.83	12.51
Population	20940	20954	-.07

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APPENDIX A: Time Trend Estimates of the Exogenous Variables

The exogenous variables in Table 5 of the text, except for those which are qualified in the notes there, are estimated from the following time trend equations estimated by the data from 1958 to 1967. The time trend, t, takes the initial of 1 in 1958.

Death Rate:

(A-1) $$dr = -.000065\,t + .0080 \qquad \bar{R}^2 = .872$$
$$\quad (7.90) \qquad\qquad (156.90)$$

Government investment expenditures

(A-2) $$G_I = 148.3444\,t + 1087.8062 \qquad \bar{R}^2 = .853$$
$$\quad (7.29) \qquad\qquad (8.62)$$

Government total expenditures

(A-3) $$G = 655.6479\,t + 4833.7344 \qquad \bar{R}^2 = .903$$
$$\quad (9.18) \qquad\qquad (10.91)$$

Weighted world national income

(A-4) $$Y^W = 21.4841\,t + 316.7271 \qquad \bar{R}^2 = .911$$
$$\quad (9.62) \qquad\qquad (22.87)$$

Wage rate in U.S. mining and manufacturing

(A-5) $$W_m^{us} = .2097\,t + 4.7370 \qquad \bar{R}^2 = .994$$
$$\quad (38.37) \qquad\qquad (139.60)$$

Wage rate in U.S. construction

(A-6) $$W_c^{us} = .2[illegible]86\,t + 4.6691 \qquad \bar{R}^2 = .982$$
$$\quad (22.18) \qquad\qquad (67.12)$$

Wage rate in U.S. service sector

(A-7) $$W_s^{us} = .22[illegible]2\,t + [illegible].3689 \qquad \bar{R}^2 = .9944$$
$$\quad (40.00) \qquad\qquad (125.62)$$

U. S. population

(A-8) $N^{us} = 2.7168\,t + 172.5873$
$\qquad\qquad (49.35) \qquad (505.28)$

$\bar{R}^2 = .996$

Day-to-day loans by Chartered banks

(A-9) $DTDL = 20.3333\,t + 112.6667$
$\qquad\qquad (5.02) \qquad (4.49)$

$\bar{R}^2 = .729$

Treasury-bills held by chartered banks

(A-10) $TRB = 81.2000\,t + 787.8000$
$\qquad\qquad (9.27) \qquad (14.50)$

$\bar{R}^2 = .904$

Total assets of chartered banks

(A-11) $TCA = 1280.0906\,t + 10832.0000$
$\qquad\qquad (11.25) \qquad (706.28)$

$\bar{R}^2 = .933$

U. S. business capital formation

(A-12) $I^{us} = 4.4279\,t + 58.1065$
$\qquad\qquad (7.79) \qquad (16.48)$

$\bar{R}^2 = .869$

U. S. long-term interest rate

(A-13) $i_L^{us} = .1285\,t + 3.7980$
$\qquad\qquad (3.95) \qquad (18.80)$

$\bar{R}^2 = .618$

Military pay and allowances

(A-14) $M_A = 19.9574\,t + 462.7339$
$\qquad\qquad (7.27) \qquad (27.17)$

$\bar{R}^2 = .852$

Rent, interest and miscellaneous investment income

(A-15) $RI = 231.3641\,t + 1772.5977$
$\qquad\qquad (17.02) \qquad (21.02)$

$\bar{R}^2 = .970$

Inventory value adjustment

(A-16) $IVA = 31.3212\,t - .8668$
$\qquad\qquad (5.47) \qquad (.02)$

$\bar{R}^2 = .763$

Price index of total imports

(A-17) $$P_F = .0214\,t + .9767$$
$$(13.02) \quad (95.99)$$
$\bar{R}^2 = .949$

Price index of imports of services

(A-18) $$P_s^F = .0124\,t + 1.0212$$
$$(3.68) \quad (48.65)$$
$\bar{R}^2 = .582$

Price index of imports of mining and manufacturing goods

(A-19) $$P_m^F = .0242\,t + .9675$$
$$(12.90) \quad (83.30)$$
$\bar{R}^2 = .948$

Price index of world's mining and manufacturing goods

(A-20) $$P_m^W = .0188\,t + .9713$$
$$(7.13) \quad (59.38)$$
$\bar{R}^2 = .847$

U. S. price index of services

(A-21) $$P_s^{us} = .0290\,t + 1.0064$$
$$(27.71) \quad (155.19)$$
$\bar{R}^2 = .988$

U. S. price index of mining and manufacturing goods

(A-22) $$P_m^{us} = .0077\,t + 1.0038$$
$$(8.11) \quad (171.06)$$
$\bar{R}^2 = .878$

U. S. disposable income

(A-23) $$Y_D^{us} = 24.7737\,t + 276.1343$$
$$(14.79) \quad (20.57)$$
$\bar{R}^2 = .960$

Government unamortized debt

(A-24) $$B_g = 463.9302\,t + 13157.2852$$
$$(11.66) \quad (53.30)$$
$\bar{R}^2 = .938$

Discount rate

(A-25) $$i_D = .1967\,t + 2.8293$$
$$(2.45) \quad (5.68)$$
$\bar{R}^2 = .357$