

## NEW CLASSICAL MACRO-ECONOMETRIC MODEL VARIANTS FOR THE INDIAN ECONOMY\*

By

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1. Macro-econometric models serve a number of purposes. They can be used to test alternative macroeconomic theories/theoretical systems. Here the primary goal is that of knowing which hypothesis or which sets of hypotheses, generally formulated on an *a priori* basis, help us to understand reality best. Such an understanding though an end in itself like all knowledge can also facilitate an objective formulation of economic policies and this may help attainment of a measure of agreement among economists on policy issues. In one of his early papers in an area of which he is a pioneer, L.R. Klein set out the hope that economic models may eventually lead "all investigators to the same propositions, independent of their personal whims". Another objective in formulating macro-econometric models and in testing them is to ascertain as to which of the above serves more accurately as a basis for predictions concerning future values of economic variables. A fourth objective related to all the above, more particularly to the first, is to find out which of the macro theories serves best as a basis for understanding economic history.<sup>1</sup>

2. Though the history of the development of macro-econometric models has been often discussed not due credit seems to have been accorded to the outstanding contribution of G. Cassel who in his 'Social Economics' (published around early 30's) presented a reasonably full scale treatment of the leading components in macroeconomics particularly from a dynamic angle. As is now

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1. J. Marques in his introduction to Klein's "Economic Theory and Econometrics" mentions that econometric models are also vehicles to make explicit the assumptions about the behaviour of the economy, to ensure internal consistency through the use of identities and constraints, and finally as a way of accumulative knowledge'

well known he was the originator of what was later famous as the Harrod-Domar growth equation. But he was also a pioneer in identifying the crucial macroeconomic variables in the cyclical process of an economy. Tinbergen's early work was connected with business cycles and his efforts to test different theories on the basis of statistical evidence has been rightly considered as a major landmark though he seems to have met with stiff resistance from the great Keynes himself. Keynes' own macro-economic theory with portions of Kalecki mixed into it was successfully outlined in a macro-econometric form by Klein. There is now an ocean of Keynesian empirical macro-econometric models, huge, medium and small, not only for the U.S. economy, but also for other economies; however not many coral islands even containing the rival theoretical frames of Classical Theory which Keynes sought to displace seem to have been publicly presented so far.

3. Macro-econometric models for the Indian economy, surveyed by a number of scholars, have been experimented/explored by N.V.A. Narasimham (1956), N.K. Choudhry (1963, 1974), Kanta Marwa (1963, 1972), K. Krishnamurthy (1984, 1974, 1984), A. Agarwala (1971), Mammen, T. (1973), A.L. Nagar (1974), K.L. Krishna (1974), M.J. Desai (1973, 1974), Pani (1977), Narain Sinha (1977), I.J. Ahluwalia (1979), Bhattacharya (1984), and V.R. Pandit (1984), and National Council of Applied Economic Research (1983). Special aspects have been studied by B.B. Bhattacharya (1975, 1984), S.K. Chakravarty (1977), V.R. Pandit (1973), Sampath Iyengar, M.A. Srinivasa (1971), D.K. Srivastava (1979), A. Ramanathan (1980), V.K. Chetty (1985) and others. Almost all full-economy models with the exception of that by R. Agarwala, which has a sort of a dualistic approach, are Keynesian in one sense or the other; either they depend upon investment, autonomous expenditure as determinant of real income or they bring in the wage-cost mark up theory in the determination of the price level. Often mongrels are constituted in the form of part of income being partly determined by supply and partly by demand. Even when Friedmannian variants have been presented in one or the other equations, it is the demand aspect that seems to be getting emphasised. In the "Determinants of Real National Income" (1977) the author presented a host of single equation models pertaining to determination of real income and the price level. These models brought in for the first time capital stock and/or supply/output of wage-goods a crucial determinants of real national income. Money and output were brought in the determination of the price level. Exercises in terms of original values, double logs and first differences of both, were presented. In order to show the superiority of the Classical model over the Keynesian models some results pertaining to the latter were also given. In "Falling Economy" (1977) the author extended classical analysis to the understanding of the determination of a wide range of variables in the Indian economy, like diminishing returns, subsistence-population link, supply of and demand for money, employment, link between factor-price changes and employment, distribution shares etc. The results seemed again to bear out the

empirical robustness of the Classical theory. One criticism of the above type of work was that these were collections of single equation models. Since then the author has been working on the examination of the empirical validity of a number of Classical models by means of various simultaneous equation system variants incorporating the essentials of the Classical theory. These exercises have been carried out extensively both for American economy and in a simplified form for the Indian economy. It is proposed in the following article to present the results of some tiny-sized models for the Indian economy for the period between 1953-54 to 1974-75.

4. The macro-econometric model pertaining to the whole economy can be visualised as consisting of several interconnected blocks. First there is the subset concerned with determination or generation or real national income (and employment if data is available) and the price level. Here Keynesian models would make income a determinant of volume of investment/autonomous expenditure. Models *a la* Friedman would make nominal income a function of nominal money and in some cases in the Keynesian models nominal money would also be introduced as an additional independent variable. In the classical macro-econometric models real fixed capital stocks as such and circulating capitals or current capital inputs in the form of inventories plus replacement provisions would figure among independent variables. Data regarding circulating capitals as such may not be available in an all-inclusive manner. A proxy in the sort of a flow variable of output of wage-goods has to be brought in. If data is available, a measure of profit rate, the average rate of profits, is also entered in. The second block deals with the index of the price level or of national income deflator. The Keynesian models would introduce the index of money wage rates and some measures of labour productivity among independent variables. The classical models would bring in quantity of money and the real national income; some time they would also include income velocity of money as an independently determined variable. The Keynesian model would require an equation for the determination of wage-rate (index). Classical models will have to bring in an equation for determining income velocity; here the independent variable may include estimated price level, the expected rate of inflation, wage-income ratio, the rate of interest (estimated value if there is a separate equation for the rate of interest). Since velocity is determined by a number of factors one should not hope for too high an extent of the explained portion. The classical models may treat money as a dependent variable, depending upon bank loans, real capital stock, interest rate or estimated values thereof, the estimated price level and so on.

5. The above blocks would suffice for understanding the economy but we may include a 3rd block to deal with interest rate and say savings. In the Keynesian model the independent variables will have to be investment (or income), money or a measure of excess liquidity. In the classical model one has to introduce savings, ratio of income to capital, expected rate of inflation, the

index of the price level as independent variables. In the Keynesian model it is investment that has to be accounted. This can be done by bringing in the past rate of income growth, index of share prices and the rate of interest among the independent variables; the classical model will have to account for savings. This can be done by bringing in income and the rate of inflation among the independent variables.

6. Let us begin with a 2 equations model with Y, real national income, and P, the index of wholesale prices, as the endogenous variables. Y is (hypothesized to be) determined by K, real capital stock and  $Y_w$ , real value-added in the wage-goods sector, P is determined by Y and M, money supply (consisting of currency and demand deposits). The model is set out below:

$$Y = a_{10} + b_{11} K + c_{12} Y_w + u_1 \quad (1)$$

$$P = a_{20} + b_{21} \hat{Y} + c_{21} M + u_2 \quad (2)$$

The model it may be noted is recursive.

The results are given below:

$$Y = 2759.15 + 0.08 K + 1.98 Y_w$$

(2.31)\*    (4.13)\*\*    (7.00)\*\*

$\bar{R}^2$  (Adjusted  $R^2$ ) = .99 SEE (Standard error of the estimate) = 346.10  
(2.25% rate of SEE to the mean); DW (Durbin Watson Value) = 0.89

(Elasticity of) Y = 0.25; of  $Y_w$  = 0.93

Both real capital and wage-goods value-added are highly significant.

$$P = 38.51 - \text{neg } Y + 0.02 M$$

(1.50)    (0.07)    (7.60)\*\*

$\bar{R}^2$  0.96; SEE = 12.68 (9.13%); DW = 1.02 e of M = 0.74.

The negative effect of real output upon P is not prominent.

7. We now go for a 4 equations version. We bring in an equation for determining money. Money is deemed to be determined by real capital stock, income-velocity of money, B bank loans to commercial sector, and i, geometric mean of short and long rates of interest. A velocity equation has also been entered. V, velocity, is determined by  $P_x$ , expected rate of price level change, i, interest rate, and w/y, the share of wages in national income. We modify the price level equation by entering in also velocity (national income divided by money).

The second (M), third (V), and fourth (P) equations are set out below (The equation of Y remains the same).

$$(2) M = a_{20} + b_{21} \hat{V} + c_{21} K + B_{22} + c_{23} i + u_2$$

$$(3) V = a_{30} + b_{31} \hat{P}_x + c_{32} i + c_{33} W/y + u_3$$

$$(4) P = a_{40} + b_{41} \hat{Y} + b_{42} \hat{M} + b_{43} + u_4$$

The results are given below:

$$(2) M = 1783.94 - 350.58 \hat{V} + 0.07 K + 0.70 B_L - 92.07 i$$

$$(2.16)^* \quad (-1.93) \quad (5.92)^{**} \quad (15.11)^{**} \quad (-0.98)$$

$$\bar{R}^2 = 0.998; \text{SEE} = 164.04 (3.37\%); \text{D.W.} = 1.42$$

$$e \text{ of } K = 0.64; \text{ of } B_L = 0.51$$

As expected, the real capital stock and bank loans are significant determinants of M.

$$(3) V = 4.58 + 0.11 P_x + 0.09 \hat{i} + 0.02 w/y$$

$$(2.42)^* \quad (4.83)^{**} \quad (1.62) \quad (0.55)$$

$$\bar{R}^2 = 0.876; \text{SEE} = 0.17 (2.98\%); \text{D.W.} = 2.07 \text{ e of } P_x - 0.09$$

The price expectational variable alone is significant

$$(4) P = -108.30 - .006 \hat{Y} + 0.02 \hat{M} + 38.00 \hat{V}$$

$$(-2.45)^* \quad (2.62) \quad (11.20)^{**} \quad (3.88)^{**}$$

$$\bar{R}^2 = 0.989; \text{SEE} = 9.28 (6.6\%); \text{D.W.} = 1.17$$

$$e \text{ of } y = -0.65; \text{ of } M = 0.87; \text{ of } V = 1.56$$

All three are significant though the negative effect of Y has improved with the induction of the velocity variable.

8. The 3 blocks together yield 2 basic sets of informations (with variants in each set). Care has to be taken to see that the models do not suffer from under-identification. Since both the Keynesian and the Classical systems deal with real magnitudes proper deflators will have to be used for income, investment, savings, capital stock etc. One must specify whether narrow or broad money is

used. In classical models it would be helpful if the real rate of interest can be used but where this is difficult to obtain values for these variables, nominal rate of interest and the expected rate of inflation can both be used.

9. In constructing a 6 equation's classical macroeconomic model for the Indian economy for the income equation along with capital stock, the value added in the wage-goods sector which consists of predominantly agriculture and agricultural-derived consumption commodities is used as independent variable. For some of the other equations the expected rate of inflation has been proxied by 2 measures. One wherein an Almon log procedure is used to derive the expected rate of inflation ( $P_x^e$ ) and the other where a measure based on the regression results of the past six year's price indexes rises has been used ( $P_x^2$ ). As regards the interest rates the mean of the short-term and the long-term rates for each year is used. This is because the long-term rate is often determined as is well known in a captive market. The period chosen is from 1953-54 to 1973-74, a 20 years span lowering most of the period of the first four plans.

10. The model in 6 equations is set out below:

$$(1) Y = a_{10} + b_{11} \hat{M} + C_{11} K + C_{12} Y_w + u_1$$

$$(2) M = a_{20} + b_{21} \hat{V} + b_{22} \hat{i} + C_{21} K + C_{22} B_1 + c_{23} P_x + u_2$$

$$(3) V = a_{30} + b_{31} \hat{P} + b_{32} \hat{i} + C_{31} P_x + C_{32} W/y + u_3$$

$$(4) P = a_{40} + b_{41} \hat{Y} + b_{42} \hat{M} + b_{43} \hat{V} + u_4$$

$$(5) i = a_{50} + b_{51} \hat{M} + b_{52} \hat{P} + C_{51} \hat{S} + c_{52} P_x + c_{53} Y/K + u_5$$

$$(6) S = a_{60} + b_{61} \hat{Y} + b_{62} \hat{P} + b_{63} \hat{i} + c_{61} W/Y + u_6$$

In the above Y is real (deflated by 61-62 prices) national income, M is money 1, K is real capital stock,  $Y_w$  is value added in wage-goods, V is nominal income-velocity; i is the mean of the long and short nominal interest rates.

$B_1$  is bank loans to commercial sect, S is real (Savings deflated by 61-62 prices)  $P_x^e$  is the price-expectational Variable (We have taken alternatively Almon lagged Values and 6 year regression derived trend values)  $W/y$  is Wage-income ratio, and  $Y/k$  is the income-capital ratio. We have four model — variants, two for original values and two for double log (except for price expectational variable) values. Of the two, one is with Almon — lagged (original) values of  $P_x$  and the other with regression-derived values (original) of the same.

In the results  $\bar{R}^2$  = adjusted  $R^2$ , RMSE = Thiel's root mean square error, U is Thiel's u coefficient, DW = Durbin-Watson Value. t values are in brackets and e refers to elasticity. We have four model — variants.

11. (A) Model with regression demand price-expectations variables original values.

$$(1) Y = -2042.08 - 0.34\hat{M} + 0.18K + 1.49 Y_{wg}$$

$$(-1.92)^* \quad (-2.72)^{**} \quad (4.53)^{**} \quad (4.94)^{**}$$

$$\bar{R}^2 = 0.9919,$$

$$RMSE = 267.57, RMSE \text{ ratio} = 1.74\% \text{ Thiel's } U = 0.40,$$

$$D.W. = 1.05$$

Real capital and value added in wage-goods have highly significant positive effects on real national income. Money supply has a significant negative effect. The explained portion is very high, RMSE and its ratio are low for this magnitude as also the u coefficients. Auto-correlation is in uncertain range.

$$(2) M = 4153.35 - 295.30 \hat{i} - 698.16 \hat{V}$$

$$(0.89) \quad (-1.14) \quad (-0.92)$$

$$+ 0.08 K + 0.74 B_L + 55.82 P_x^2$$

$$(5.06)^{**} \quad (14.59)^{**} \quad (0.52)$$

$$\bar{R}^2 = 0.9969, RMSE = 164.0, RMSE \text{ ratio} = 3.37\% U = 0.28,$$

$$D.W. = 1.44$$

Bank loans and real capital stock have a highly significant effect on money. The explained portion is very high; RMSE and its ratio are low for this magnitude as also the u coefficient No auto-correlation;

$$(3) V = 4.27 - 0.0003 \hat{P} - 0.12 \hat{i} + 0.12 P_x + 0.02 W/Y$$

$$(1.46) \quad (-0.10) \quad (-0.81) \quad (4.36)^{**} \quad (0.58)$$

$$\bar{R}^2 = 0.7942, RMSE = 0.20;$$

$$RMSE \text{ ratio} = 3.58\% U = 0.70.$$

$$D.W. = 1.67$$

The expected rate of inflation alone is highly statistically significant, with a positive effect on velocity. The explained portion is high for this magnitude; RMSE and its ratio and u coefficients are relatively low for the magnitude. No auto-correlation.

$$(4) P = -105.53 + -0.007 \hat{Y} + 0.03 \hat{M} + 40.09 \hat{V}$$

$$(-2.91)** \quad (-3.93)** \quad (14.64)** \quad (4.81)**$$

$$\bar{R}^2 = 0.9828, \text{ RMSE} = 7.28, \text{ RMSE ratio} = 5.24\% \text{ U} = 0.40, \\ \text{D.W.} = 0.97$$

D - 4. Real national income has a highly significant negative effect on prices, money and velocity have highly significant positive effects. The explained portion is high. RMSE and its ratio are relatively low for this magnitude as also the u coefficient. Auto-correlation is in an uncertain range.

$$(5) i = 6.31 - 0.0008 \hat{M} + 0.04 \hat{P} + 0.001 \hat{P}$$

$$(1.83) \quad (-1.24) \quad (1.51) \quad (1.45)$$

$$-0.07 P_x^2 - 0.10 K/Y$$

$$(-0.62) \quad (-1.39)$$

$$\bar{R}^2 = 0.9022, \text{ RMSE} = 0.34, \text{ RMSE ratio} = 6.21\% \text{ U} = 0.75, \\ \text{D.W.} = 1.15$$

No variable in the equation has a significant effect on interest. Explained portion is high. RMSE and its ratio are low for this magnitude as also the u coefficient. Uncertainty exists regarding auto-correlation.

$$(6) S = 923.16 + 0.19 \hat{Y} + 5.37 \hat{P} - 75.75 \hat{i} - 32.23 W/Y$$

$$(0.31) \quad (3.87)** \quad (1.78) \quad (-0.40) \quad (-0.73)$$

$$\bar{R}^2 = 0.9316, \text{ RMSE} = 227.86, \text{ RMSE ratio} = 12.16\% \text{ U} = 0.91 \\ \text{D.W.} = 1.50.$$

Real income has a significant positive effect on real savings: The explained portion is high. No auto-correlation.

12. (B) Model with Almon-lagged price expectational variable with original values



$$(1) Y = -2005.51 - 0.35 \hat{M} = 0.19 K + 1.47 Y/w$$

$$(-1.92)^* (-2.91)^{**} (2.74) (4.95)^{**}$$

$$\bar{R}^2 = 0.9922, \text{RMSE} = 268.18, \text{RMSE ratio} = 1.75, U = 0.40,$$

$$\text{D.W.} = 1.10$$

Real capital stock and the value in the wage-goods sector have highly significant, positive effect on real national income. Estimated money has a highly significant but negative effect. The explained portion is high. RMSE and its ratio are relatively low, as also the u coefficient; the D.W. statistic for auto-correlation is in the uncertain range.

$$(2) M = 2788.69 - 371.57 \hat{i} - 473.40 \hat{V} + 0.099 K$$

$$(1.94)^{**} (-1.80) (-1.75) (3.94)^{**}$$

$$+ 0.67 B_L + 22.48 P_x$$

$$(9.12)^{**} (1.94)^*$$

$$\bar{R}^2 = 0.9965,$$

$$\text{RMSE} = 196.57, \text{RMSE ratio} = 4.04, U = 0.34,$$

$$\text{D.W.} = 1.78$$

Bank loans and real capital stock have highly significant positive effect on money. The Almon lag measure of expected rate of inflation has some effect in the positive direction on money. The explained portion is very high; RMSE and its ratio are low for this variable as also u coefficient. There is no auto-correlation.

$$(3) V = -6.73 - 0.01 \hat{P} + 0.30 \hat{i} + 0.02 P_x^2 + 0.17 W/Y$$

$$(-2.42)^{**} (-2.55)^{**} (2.00)^{**} (1.6) (4.18)^{**}$$

$$\bar{R}^2 = 0.5842, \text{RMSE} = 0.24, \text{RMSE ratio} = 4.22, U = 0.88$$

$$\text{D.W.} = 1.33$$

Estimated price index has a highly significant negative effect on Velocity. Estimated interest has a significant positive effect as also the wage-income ratio whose effect is positive and highly significant. The explained portion is high for this variable. RMSE and its ratio are relatively low as also the u coefficient. There is no auto-correlation.

$$(4) P = -87.65 - 0.01 \hat{Y} + 0.03 \hat{M} + 35.65 \hat{V}$$

$$(-1.91) (-3.21)^{**} (13.33)^{**} (3.36)^{**}$$

$$\bar{R}^2 = 0.9801, \text{RMSE} = 8.68, \text{RMSE Ratio} = 6.25, U = 0.47 \\ \text{D.W.} = 1.11.$$

Estimated real national income has a highly significant negative effect on the price index; estimated money supply and Velocity both have highly significant positive effects. The explained portion is high, RMSE and its ratio are also high version, the u coefficient is moderately D.W. shows uncertainty regarding correlation.

$$(5) \ i = 13.56 + 0.0004 \hat{M} - 0.01 \hat{P} - 0.0003 \hat{S} \\ (1.96)^* \quad (0.53) \quad (-0.42) \quad (-0.29) \\ + 0.041 P_x^1 - 0.20 Y/K \\ (1.29) \quad (-1.73)$$

$$\bar{R}^2 = 0.8963, \text{RMSE} = 0.40, \text{RMSE ratio} = 7.36, U = 0.89, \\ \text{D.W.} = 1.53$$

No variables seem to have significant effect on the rate of interest. The explained portion is high. The F-ratio is highly significant; RMSE and its ratio are high as also u coefficient but there is no auto-correlation.

$$(6) \ S = 642.17 + 0.17 \hat{Y} + 5.12 \hat{P} - 37.37 \hat{i} - 28.34 W/Y \\ (0.21) \quad (3.48)** \quad (1.66) \quad (-0.18) \quad (-0.63)$$

$$\bar{R}^2 = 0.9317, \text{RMSE} = 226.07, \text{RMSE ratio} = 12.06, U = 0.91, \\ \text{D.W.} = 1.51$$

Real national income has a highly significant and positive effect on real saving. The explained portion is high; RMSE and its ratio are low for this variable as also the u coefficient. There is no auto-correlation.

13. (C) Model with regression derived price expectational variable. double-log form.

$$(1) \ \log Y = -1.39 - 0.07 \log \hat{M} + 0.41 \log K + 0.77 \log \\ (-1.92)^* \quad (-.94) \quad (2.47)** \quad (4.77)**$$

$$\bar{R}^2 = 0.9922, \\ \text{RMSE} = 0.19, \text{RMSE ratio} = 0.20\%; U = 0.42, \\ \text{D.W.} = 1.12$$

Real capital stock and the value added in wage-goods have highly significant positive effects on real national income. The explained portion is very high. RMSE and its ratio are low as also the u coefficient. The D.W. statistic is in the uncertain range.

$$(2) \log M \quad 4.73 \quad -0.87 \hat{i} \quad -0.17 \log \hat{V} \quad +0.20 \log K$$

$$(1.34) \quad (-0.88) \quad (-0.70) \quad (0.24)$$

$$+0.70 \log B_L \quad +0.17 \log P^2_x$$

$$(4.16)** \quad (0.70)$$

$$\bar{R}^2 \quad 0.9950,$$

$$\text{RMSE} \quad 0.03, \text{ ratio} \quad 0.35\% \text{ U} \quad -0.32,$$

$$\text{D.W.} \quad 1.22$$

Only bank loans have a highly significant positive effect on money supply. The explained portion is very high. RMSE and its ratio are rather low as also the u coefficient. There is uncertainty about the auto-correlation.

$$(3) \log V \quad -1.27 \quad -0.06 \log \hat{P} \quad +0.04 \log \hat{i}$$

$$(-0.47) \quad (-0.44) \quad (0.19)$$

$$+0.03 \log P^2_x \quad +0.77 \log W/Y$$

$$(3.91)** \quad (1.10)$$

$$\bar{R}^2 \quad 0.7840, \text{ RMSE} \quad 1.80, \text{ RMSE ratio} \quad -103.85\% \text{ U} \quad 35.89,$$

$$\text{D.W.} \quad 2.03$$

Only the expected rate of inflation has a highly significant positive effect on Velocity. The explained portion is high for this magnitude; the RMSE and its ratio are low for this magnitude; the u coefficient is low. No auto-correlation.

$$(4) \log P \quad 4.39 \quad -1.17 \log \hat{Y} \quad +1.06 \log \hat{M} \quad +1.39 \log \hat{V}$$

$$(2.58)** \quad (-3.61)** \quad (9.38)** \quad (3.72)**$$

$$\bar{R}^2 \quad 0.9792, \text{ RMSE} \quad 0.07, \text{ RMSE ratio} \quad 1.41\% \text{ U}$$

$$0.75, \text{ D.W.} \quad 1.56$$

Real national income has a highly significant, somewhat inversely proportionate, effect on the price level index. Money supply has a highly significant, proportionate, effect on the price index. Velocity as a highly significant mere

than proportionate effect on the price index. The explained portion is high; RMSE and its ratio are low as also the u coefficient. No auto-correlation.

$$(5) \log i = 3.92 + 1.03 \log \hat{M} - 0.98 \log \hat{P}$$

$$(1.30) \quad (1.55) \quad (-1.48)$$

$$- 0.36 \log \hat{S} + 0.11 \log P^2_x - 0.96 \log Y/K$$

$$(-1.04) \quad (2.38)^* \quad (-1.61)$$

$$\bar{R}^2 = 0.9178, \text{ RMSE} = 0.06, \text{ RMSE ratio} = 3.28\% \text{ U} = 0.79$$

$$\text{D.W.} = 1.13.$$

Only expected rate of inflation seem to have a mild, positive effect on interest. The explained portion is high; RMSE and its ratio are low for this magnitude, the u coefficient is low. Auto correlation is in uncertain range.

$$(6) \log S = -0.85 + 1.81 \log \hat{Y} + 0.50 \log \hat{P}$$

$$(-0.09) \quad (3.19)^{**} \quad (1.01)$$

$$- 0.48 \log \hat{i} - 2.53 \text{ W/Y}$$

$$(-0.54) \quad (-0.97)$$

$$\bar{R}^2 = 0.9544, \text{ RMSE} = 0.14, \text{ RMSE ratio} = 1.87, \text{ U} = 0.85,$$

$$\text{D.W.} = 1.32$$

Only real national income has a significant real savings. Explained portion is high; RMSE and its ratio are rather low as also the u coefficient for this variable. No auto-correlation.

#### 14. Model with Almon-Lagged price-expectational variable.

$$(1) \log Y = -1.42 - 0.08 \log \hat{M} + 0.46 \log K + 0.77 \log Y_w$$

$$(-1.96)^* \quad (-1.02) \quad (2.53)^{**} \quad (4.73)^{**}$$

$$\bar{R}^2 = 0.9923, \text{ RMSE} = 0.09, (\text{RMSE ratio } 0.20\%) \text{ u} = 0.43$$

$$\text{D.W.} = 1.14$$

Real capital stock and the value added in the wage-goods sector have a highly significant and strong positive effect on real national income. Estimated money does not seem to have any statistically significant effect on real national income. The explained portion is very highly significant. The RMSE ratio is low absolutely and relatively, so also the u coefficient.

$$(2) \log M = 4.11 - 0.29 \log \hat{i} - 0.13 \log \hat{V} - 0.12 \log K \\ (0.94) \quad (-1.02) \quad (-0.30) \quad (-0.29) \\ + 0.79 \log B_L + 0.014 \log P_x \\ (4.06)** \quad (1.04)$$

$$\bar{R}^2 = 0.9949, \text{ RMSE} = 0.033, \text{ RMSE ratio} = 0.39\% \text{ U} = 0.35 \\ \text{U} = 0.35, \text{ D.W.} = 0.73$$

Bank loans have a highly significant and positive effect on money supply. The explained portion is very high. RMSE and its ratio to the mean are low as also the u coefficient. There seem to be auto-correlation.

$$(3) \log V = -9.74 - 0.42 \log \hat{P} + 0.64 \log \hat{i} \\ (-3.75)** \quad (-3.12)** \quad (3.10)** \\ + 0.014 \log P_x + 2.95 \log W/Y \\ (1.38) \quad (4.31)**$$

$$\bar{R}^2 = 0.64 \text{ RMSE ratio } 2.32\% \text{ U} = 0.84, \text{ D.W.} = 1.53$$

Estimated price level index has a highly significant negative effect on income-velocity; estimated interest rate has a highly significant positive effect on Velocity; so also the wage-income ratio. The explained portion is high in relation to what can be expected in regard to velocity. The RMSE and its ratio to the mean are rather high. There is no auto-correlation.

$$(4) \log P = 4.53 - 1.04 \log \hat{Y} + 1.03 \log \hat{M} - 1.01 \log \hat{V} \\ (2.06)** \quad (-2.94)** \quad (8.44)** \quad (2.43)**$$

$$\bar{R}^2 = 0.9748, \text{ RMSE} = 0.062, \text{ RMSE ratio} = 1.27\% \text{ U} = 0.68, \\ \text{D.W.} = 1.16$$

The results are highly important. Estimated real national income has a highly significant near inversely proportionate negative effect on the price level. Estimated money has a highly significant, and, proportionate, positive effect on the index of the price level. Such is the case also in regard to income Velocity. The explained portion is highly significant. Considering the variable. The RMSE and its ratio are low as also the u coefficient. The D.W. statistics is in the uncertain range.

$$\begin{aligned}
 (5) \log i = & 5.24 + 0.55 \log M - 0.54 \log P - 0.13 \log S \\
 & (1.45) \quad (0.80) \quad (-0.36) \quad (0.36) \\
 & + 0.044 \log P_x - 1.27 \log Y/K \\
 & (1.48) \quad (-1.77)^*
 \end{aligned}$$

$$\bar{R}^2 = 0.9364, \text{ FMSE} = \text{RMSE ratio} = 3.90\%, U = 1.43$$

Only the ratio of national income to capital seems to have a significant, positive effect on the rate of interest (the productivity effect). Other variables are not significant. The explained portion is high; RMSE and its ratio are high as also is the U coefficient. There is no auto-correlation.

$$\begin{aligned}
 (6) \log S = & 0.08 + 1.62 \log Y + 0.50 \log P \\
 & (0.07) \quad (3.07)^{**} \quad (1.00) \\
 & - 0.28 \log i - 2.39 \log W/Y \\
 & (-0.32) \quad (-0.92)
 \end{aligned}$$

$$\bar{R}^2 = 0.9050, \text{ RMSE} = 0.14, \text{ RMSE ratio} = 1.87\%, U = 0.85, \text{ D.W.} = 1.33$$

Only estimated real national income has highly significant and positive effect on real savings. The other variables do not seem to be important. The explained portion is high. The RMSE and its ratio to the mean are relatively low. The U coefficient is somewhat high. There is no auto-correlation.

## 15. General Results

The following broad results are generally common for all the models:

- (i) Real national income can be fully explained by real capital stock and the real value-added in the wage-goods sector.
- (ii) Money does not have a positive effect on output. Bank loans have a highly significant and positive effect on money supply which have been accounted by variables together in the equation.
- (iii) The wage-income ratio seems to have a significant positive effect on velocity. The effect of the measures of expected rate of inflation do not appear to be firm.

- (iv) The price level can be adequately explained by the augmented quantity theory version, which takes into account a velocity measure. Real national income has inversely proportionate effect on the price level. Money supply has almost a proportionate positive effect on the price level, as also velocity.
- (v) No variable seems to be having a decisive effect by itself on the nominal rate of interest. The price expectational measures certainly does not seem to have a significant positive effect on interest.
- (vi) Real savings are strongly positively affected by real national income.