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Methods of Macro-Econometric Modelling in Developing Countries

Kishor Kumar Guru-Gharana *

NEED FOR MARCO-ECONOMETRIC MODELS

Macro-econometric models are of considerable importance because they can be used to shed light on several questions faced by development economists and planners of developing countries about development priorities and strategies: e.g. protectionist vs. free-trade policies: import-substitution vs. export-promotion strategies: public vs. private investment; internal resources mobilization vs. foreign-aid dependence; savings-investment gap; export-import gap; poverty alleviation through redistributive or growth-oriented programmes; internal and external stability; effects of various fiscal/monetary policy changes; and cost/benefits of increasing economic integration of a region such as SAARC.

To illustrate the above point, let us elaborate on the lack of economic integration in the SAARC region. It is argued that this is partly due to the lack of sufficient knowledge about the structure of South Asian Economies and their inter-linkages. Rigorous macro-econometric modelling of these economies is yet to be done (especially in case of Nepali). The available models are based on the adoption of assumptions about structure and parameter values on ad hoc basis from models developed for other economies and other regions. Even the macro-economic data used in the models are inadequate, inaccurate, manipulated, interpolated and extrapolated. The need for rigorous data compilation arises only when rigorous macro-econometric modelling exercise is done on regular basis. This has yet to happen.

Because of the above-mentioned ignorance the South Asian economies have so far largely followed inward-looking policies which have not only created non-competitive and inefficient industrial structure and sub-optimal resource allocation but also severely limited trade expansion in these countries. While the East Asian Economies have shown that foreign trade can play an important role in the development of an economy and that foreign capital and technology are the quickest instruments of rapid economic growth, these South Asian Economies have been hiding in their cocoons of inward-looking restrictive policies.

In addition to improving the present state of sub-optimal bilateral political relations in South Asia, there is urgent need to dispel the existing apprehensions about economic domination by India - the largest, relatively most industrialized and centrally located country in the region. In other words, there is urgent need for spelling out the

* *Dr. Guru-Gharana, is an Associate Professor at Central Department of Economics, Tribhuvan University, Kathmandu, Nepal.*

costs and benefits of the exiting and expanded regional economic co-operation among South Asian countries for each member of this region. It has to be convincingly established that economic co-operation and trade expansion within the region is a positive-sum game (in which all win) rather than a zero-sum game (in which one wins only when another loses). But this can be done only by rigorous macro-econometric modelling of each South Asian Economy as well as the region as a whole.

Another example of the need for macro-econometric models is provided by the analysis of impacts of fiscal/monetary policy changes. Suppose a government contemplates an increase in personal tax rate. This will change disposable income which will in turn change aggregate consumption. This will in turn affect national income because consumption is an important component of national income. Moreover, it will also affect imports (directly for consumption and indirectly for production of consumption goods).

All these direct and indirect affects on national income will in turn affect investment by accelerator process which will again affect exports and imports and so on. Even the monetary and financial sectors will not remain unaffected by these changes in the real sectors. Thus the simultaneous nature of macro-economic relationships will generate economy wide effects on every macro-variable, and the whole economy including its components will approach towards a new equilibrium position. The direction and magnitudes of these direct and indirect effects, in the short-run and the long-run cannot be ascertained by simple reasoning and rule-of-thumb methods. If a package of fiscal and monetary policy changes is contemplated by a Finance Minister, then the problem of evaluating the impacts on different sectors of the economy is almost impractical except by a macro-econometric model which realistically and adequately models the structure of the economy and has satisfactory forecasting/simulation power.

Although we could add other examples of the need for macro-econometric models, we conclude this sub-section with professor J.N. Bhagwati's remark in the foreword of a macro-econometric model. "The model is clearly of importance to serious analysis of inflation everywhere. But it is an absolute dividend for policy-makers in India. Official Indian policy making has been hamstrung by the lack of availability of 'realistic' marco-theoretic models that can capture the economic scene in its critical dimensions. Intuition and guesses are not enough; they must go in hand with analyses based on careful econometric work ... not substitute for the superb intuition, insights and expertise ... in the leading economists in the Indian government presently; it will rather interact with them to produce superior policy-making." (Ahluwalia; 1979.)

SIZE OF MODERN MACRO-ECONOMETRIC MODELS

This section is is based on Intrilligator, 1978. One important characteristic of macro-econometric models is their size which varies from about a dozen equations (e.g. Klein's initial models, Morishima-Saito Model and Guru-Gharana - Agrawal Model) to several hundred equations (e.g. the Bookings Models, The MPS Model, and the DRI Model). Jan Tinbergen, in his Nobel Lecture (1969) remark, said, "... sometimes indeed some of our followers overdo model building." Yet, there has been tremendous

acceleration in size and complexity, principally arising from lengthy equations with numerous nonlinear elements. The main reasons for this trend are the following:

- The Perception that in reality there are many different models of behaviour. This coupled with an awareness of 'aggregation bias' led to substantial disaggregation.

- Model clients (policy-makers) have an insatiable and understandable desire for detailed information about the structure of the economy. Moreover, policy options cannot be understood unless there are numerous policy instruments represented.

- Costs of computations have been falling dramatically both for statistical estimation and simulations including computer-intensive application such as Monte-carlo simulations and optimal control. On the other hand, economic theory is often regrettably vague about critical aspects of behaviour institutions, dynamics and expectations.

Most modelers usually build their enlarged model with minimal theoretical underpinnings and with data whose properties are unfavorable for sharp tests of hypotheses - many alternatives fit the data about equally well.

Thus, since model building is dominated by forecasters and their pragmatic response to clients needs, the prevailing situation is one in which large models that have minimal theoretical justification but much empiricism are in fashion. Many aspects of these models are often superficial because of pressures to respond quickly to urgent questions of the day.

Therefore, while adding to our knowledge in some circumstances and perhaps improving our forecasting ability (a seriously debated issue) growth in size and complexity has been largely accompanied by a substantial dilution in disciplinary context and intuitive understanding.

However, large macro-econometric models have recently been facing a rising stream of criticism. Coming partly from the followers of rational expectations, partly from the advocates of time-series models, and partly from those model practitioners who are frustrated by the predictive failures of these huge models during an unquiet period of supply or policy shocks (that is when accurate prediction is urgently needed).

Then, there is also a growing interest in small but efficient models (Agrawal and Gurugharana; 1988). Such models can be used to test the robustness with respect to policy changes (Lucas; 1976). They can also test the appropriateness of specification of expectations process and indicate the possibility of using more appropriate estimation techniques. The small models are often seen as fast-food-substitutes for the large models in the Keynesian tradition. They are also more cost-effective in their roles as 'black-boxes' for foretelling the future.

The costs of specification, testing and using large modes are high, so they are preferable any if they produce more useful information or significantly better results.

At the macro-economic level, and especially at the international level, policy makers are interested in relatively few variables. In these case the need for disaggregation depends on whether the feedbacks and distributional effects are significant and not able to be captured by small models.

In conclusion, we can say that, for a poor developing country like Nepal, a small or medium-sized macro-econometric model (say with 20 equations) is appropriate for most practical purposes considering the enormous time and budget requirements for specifications, data compilation, estimation, and simulation of larger models.

TYPES OF MACRO-ECONOMETRIC MODELS

Keynes Type Models

A large number of Keynesian type national income determination models have recently been constructed and utilized for the developing economies which are adopted from stabilization models of developed economies with little or no adjustments for the special conditions of developing economies. These models have following limitations. (Behrman; 1977)

- These models focus on aggregate demand and its components (consumption, investment, export, import, government expenditure, etc.) and inadequate specification of the supply constraints in the economy, while supply constraints are relatively more important in reality in the case of developing countries. Due attention has to be paid to the low capacity utilization, capital and (skilled) labour shortage and constraint of foreign exchange in developing countries- but these are either completely ignored or just added loosely without integrating into the rest of the model.
- The role of human capital is ignored. Underemployment or surplus labour problem is also not incorporated. Similarly, human development aspects such as education, health, nutrition, access to resources etc. are also forgotten. These issues may not be that important for developed countries, but are of vital importance in developing countries like Nepal.
- The role of foreign sector as a source of non-competitive intermediate imports and of capital goods, as well as of a significant proportion of government revenues, is not well represented. For Nepal, these issues are of great significance.
- The importance due to fragmented and poorly functioning capital markets - of direct flows and of retained earnings in the real investment process is not explored.
- The possible impacts of quantitative restrictions, which are widely applied in many developing countries, is not examined.
- The degree of endogeneity of fiscal and monetary variables is ignored, with the result that policy options are overstated.

On the other hand, there are some macro-models adopted from growth models (e.g. Harrod-Domar), labour-surplus models (e.g. lewis - Fei - Ranis), input-output models (e.g. Leontif fixed-coefficient), linear-programming models, or two-gap models (e.g. Chenery and Strout), which are focussed on real phenomena and supply bottlenecks, especially due to foreign exchange and capital constraints. The major problem with such long-run supply-oriented models is that they ignore the entire fiscal-monetary income - international policy - inflation nexus, as well as the role of aggregate demand and its components.

BASIC ELEMENTS OF MACRO-ECONOMETRIC MODELS

A Keynesian type macro-econometric models begins with the national income identity,

$$Y = C + I + G + X - IM$$

Where,
- Y = National Income
- C = Consumption Expenditure
- I = Investment Expenditure
- G = Government Expenditure
- X = Exports
- IM = Imports

The Various components of aggregate demand are expressed as functions of other macro variables (sometimes G and X are treated as exogenously determined). These components can further be desegregated (e.g. I into fixed investment and changes in inventory) and other sectors can also be added to the basic model (e.g. money demand function, price equation and labour demand equations etc.).

Thus, a simple text-book style IS – LM type Keynesian macro-econometric model would look as follows:

$$C = C(YD)$$
$$I = I(r, Y)$$
$$IM = IM(Y, P)$$
$$YD = YD(Y, t)$$
$$N = N(Y)$$
$$W/P = F(Y, N)$$
$$MS/P = MD(Y, r)$$
$$Y = C+I+G+X-M,$$

Where,
- YD = Disposable Personal Income
- t = Tax Rate
- r = Rate of Interest
- P = Price Level (usually measured by GDP deflator)
- N = Employment
- W = Money wage Rate
- MS = Money Supply
- MD = Money Demand

Note that the functional form of the above functions is not specified yet. This specification would depend on the nature of the data and what is called "data mining" in which the researcher estimates a variety of different equations forms until one is found with acceptable error variance, sign of coefficients, and t, F and R^2 statistics, etc.

An alternative, and perhaps more fashionable method of model building is to start with a set of broad and exhaustive sectors or blocks and to do further, disaggregation according to the need and purpose of the researcher.

The usually selected blocks or broad sectors and their disaggregation are discussed below.

Real Expenditure Sector

The real expenditure sector is usually desegregated into Consumption sub-sector and Investment sub-sector.

Consumption Sub-sector

Consumption is further sub-divided into private consumption (PC) and government (or public) consumption (GC). Consumption function is usually expressed in real terms assuming that consumers do not suffer (inaggregate) from "money illusion". It is also argued that consumption function is better expressed in per capital terms, especially when positive saving exists and is responsive to household size. By working with per capita quantities, an element of reality is added an, as a bonus, some of the common trends from the variables is remove (which reduces multicollinearity problem).

(a) The most common consumption function found in the literature is of linear type with lagged value of consumption expenditure and disposable income. The lagged endogenous variable reflects partial adjustment assumption, or a simple version of Friendman's Permanent Income Hypothesis or Duesenberry's Ratchet Effects. Some authors also include real interest rate to capture the wealth effect on consumption.

Thus, a popular equation of private consumption would be,
$PC = a_1 + b_1\ YD + c_1\ PC_{-1} + d_1\ r + \text{error}$,
Where, PC_{-1} is lagged consumption.

Note that we could add population as explanatory variable or could, alternatively, regress per capita consumption on per capita disposable income. Also note that the inclusion of lagged endogenous variable makes the model dynamic introducing the questions of dynamic multipliers and dynamic stability.

b) Government consumption (GC) is sometimes assumed to be policy determined. In the experience of developing countries, however, governments do not have much short run discretionary power over many expenditures because of existing commitments (e.g. to government

employees) which can be changed quickly often only at large political cost. If GC is taken as endogenous, then the major determinant of real GC and government savings (GS) is real government revenues. There is also some evidence of significant effect of foreign assistance on GC.

Thus, an equation for real government consumption expenditure could be,

$$GC = a_2 = b_2 GR + c_2 GC_{-1} + d_2 FA + \text{error},$$

Where, GR = Government Revenue
FA = Foreign Assistance (borrowing).

The inclusion of lagged endogenous variable here reflects 'ratchet effect'. Some authors also include GDP as an explanatory variable.

Investment Sub-sector

Investment is also divided into private investment (PI) and government investment (GI)

(a) Decision to invest in capital assets depends on expectations about the future. The inherent complexity of expectations mechanism and the dynamic properties of investment make it one of the most difficult sector for model specification.

There are two popular principles underlying investment functions. These are the acceleartor relation between output and capital stocks and the cost of capital (generally real interest rate). The accelerator principle can be captured by using lagged value of aggregate output of income.

Lags of different types are also associated with investment decisions. One important lag occurs between changes in the determinant of optimal capital stock and business decisions to purchase capital stock. The second important lag is the time between the decision to invest and actual investment spending - log between orders and deliveries of investment goods.

Bank credit to the private sector (BCR) is also found to affect private investment. This variable provides a link between the real and the monetary sectors.

Thus, a plausible private investment (PI) equation would be,

$$PI = a_3 + b_3 GDP_{-1} + d_3 r + e_3 ECR + \text{error}$$

Note that two period log is included to capture the lags mentioned - above and to incorporate the modelling of trade-cycle phenomena following Hicks/Samuelson Multiplier - Accelerator Model. Some authors also include foreign Direct Investment and Public Investment to analyses their effects on private investment (as complementary or substitutes).

(b) Government Investment (GI) is much more under government discretionary control than is government consumption at least in nominal terms. Revenues provide only a loose constraint on these expenditures because the central bank is required to provide credit to the government if necessary. However, it is frequently found in the literature that government revenue (GR) is used as an explanatory variable. In a country like Nepal it is also true that foreign capital (usually on the form of foreign assistance FA) is a major determinant of public investment (a major component of development expenditure). thus, a plausible equation for public investment is,

$$GI = a_4 = b_4\ GR + c_4\ FA + d_4\ GDP + e_4\ GI_{-1} + error$$

Here GDP is also added to capture the accelerator principle. previous year's public investment is also included to denote the influence of on-going projects for which commitments have already been made.

Monetary/Fiscal Sector

Supply of Money

In macro economics text-books, money supply (MS) is treated as policy determined or exogenous. Of Course, by changing volume of bank credit, budget deficit, and foreign exchange reserves, the central bank and the government together can significantly affect money supply. In developing countries, foreign exchange reserve (FER) movements and credit to be given to the government make the size of monetary base at least partially outside the control of the central bank. Even for a given monetary base, the behaviour of commercial banks and on non-banking public limits the extent to which the central bank can precisely determine the money supply through its reserve, interest, discount rates, open market operations and other policies.

A simple model of money supply function is,

$$MS = a_5 + b_5\ PDC + c_5\ GDC + d_5\ ED + e_5\ FER + error$$

Where PDC = Domestic Credit to Private Sector
GDC = Domestic Credit to Government Sector
ED = Budget Deficit
FER = Foreign Exchange Reserve.

Demand for Money

Demand for money (MD) is assumed to be determined by GDP (Transactions and Precautionary Motive) and rate of interest (Speculative Motive or Cost of Holding Money). Express in real terms the money demand function and equilibrium condition of equating money supply and money demand can be shown as,

$$MS/P = MD\ GDP, r> = a_6 + b_6\ GDP + c_8 r + error$$

Government Revenues

Government Revenue (GR) depend not only on legal tax rates, but also on activity levels in the economy and the degree to compliance. The expectations concerning inflation, foreign exchange movements and transactions in the foreign sector also affect GR. In text-books total tax collections or effective tax rates are assumed to be policy determined. For most developing countries, however, this is unrealistic. The government simply does not have much control over toll tax collections. It can establish legal rates, but effective rates often are much different. A simple model of government revenue is,

$$GR = a7 + b7\ GDP + c7\ GR_{-1} + error$$

If the government implements major revenue administrative reform in some year (as proposed in the new Budget Speech of Nepal), then we could also add dumy variable to capture the consequent shift in the function.

Price Level

Price level (P) and inflation are determined by (a) demand pull factors like growth of MS (with appropriate log) and excess aggregate demand (savings, investment or inflationary gap), and (b) cost-push factors such as rising money wages (without accompanying increase in Productivity), higher prices charged by monopolistic and oligopolistic producers and sellers, rising costs of raw materials and other inputs (imported and domestic), and international inflation (especially in a country heavily importing consumers items, like Nepal). Apart from these factors, the expectation about future price levels is also an important determinant of inflation.

An eclectic theory incorporating some of these Monetarist/Keynesian (demand pull) factors, structuralist (cost-push or imbalances - in the economy) factors, and expectations hypothesis, is modelled in the following equation,

$$INF = a8 + b8\ MAM = d8\ U + e8\ PIM + f8\ \frac{IM}{GNP} = errors$$

Where, INF = Inflation $= \frac{P - P_{-1}}{P_{-1}} \times 100$

MAM = Moving Average growth Rate of Nominal Money Supply (say three-year moving average)

MAP = Moving Average growth Rate of Prices (Two or Three year Average).

U = Unemployment Rate

PIM = Import Price Index Inflation or Percentage annual change in Import Price Index. In case of Nepal Indian whole-sale Price Inflation may be a good substitute.

IM = Import to GNP ratio.

The above equation also incorporates elements of Phillips Curve which shows negative relation between wage inflation and unemployment rate. This relation translates into negative relation between general inflation and unemployment rate by wage-push mechanism. MAM reflects the monetarist view and the transmission from change in money supply to change in price level. MAP as a determinant of inflation reflects the common experience that inflationary process has inertia. Once in motion, inflation has a habit of perpetuating itself, especially by boosting up the expectation about future inflation. In this way, the above equation also incorporates expectation process.

The rate of change of import price Index (PIM) determines inflation in two ways- by directly increasing the prices of imported consumables, and by indirectly increasing the costs of production through imported inputs. This factor is quite dominant in case of Nepal. Finally, the share of imports in GNP is included as it determines the degree of sensitivity of overall price level with respect to imported inflation. Some authors have also found that in developing countries, the ratio of commodity producing sector (agriculture plus manufacturing) to the services sector affects inflation because it reflects the relative shortage of goods. Finally the degree of monopolistic or oligopolistic situation in case of major consumable items and raw material should also be incorporated to reflect the situation of a country like, Nepal. It is not done here to keep the model manageable.

Foreign Sector

Usually, small economy assumption is made for most developing countries which implies that foreign prices of the country's exports and imports are exogenously determined. Even the prices of non-tradables are affected by these foreign inputs (as reflected in the equation of inflation above). The authorities can, however, influence the prices of imports and exports in domestic currency terms by means of exchange rate adjustments.

Exports

The exports are usually assumed to depend on relative prices and foreign income. In case of a country like Nepal with limited supply capability, exports are also determined by own national output. Then, there are so many trade regimes, preferential treatments, treaties, restrictions, export promotion drives, and sometimes deadlocks, which affect exports and the whole foreign trade sector. These factors although quite important are difficult to model. Some authors use dummy variables for different periods with different trade regimes. In case of Nepal disaggregation at least in terms of India and rest of the world, is required.

Thus, a simple export model would be

$$x = a9 + b9 + c9\ FY + d9\ GDP + e9\ x\text{-}1 + error$$

Where, FP/P = relative price level or ration of foreign price (US dollar price of exports times exchange rate) to domestic price level. Alternatively relative price of tradables to non-tradables can also be used.

FY = Foreign Income
GDP = Gross Domestic Products

The above mode 1 in case of Nepal would at least be broken into two equations - one for India and another for the rest of the world. The income of rest of the world can be proxied by those of OECD countries.

Imports

Imports of capital goods are dependent on the level of economic activity and development projects, prices and foreign aid (loans and grants). Other imports, too are determined by national income (reflecting economic activity as well as purchasing power) and relative price levels. Thus a simple model of imports would be,

$$IM = a_{10} + b_{10}\, GDP + c_{10} + d_{10}\, IM_{-1} + error$$

In the case of Nepal this model has to be sub-divided into two equations - one for imports from the rest of the world. Further disaggregation is possible according to types of import items, e.g. capital goods, consumption goods, and other goods and services.

Production and Labour Sector

In addition to the above three blocks or sectors found in most macro-econometric models, production sectors and labour sectors can also be included to complete the picture. Here we discuss the production sector.

The production sector is usually desegregated into three sub-sectors: Agriculture, Industry and Services. Two types of production functions are popular in the literature: Cobb-Douglas type and CES Type.

Agriculture Sector

Using the Cobb-Douglas Production function, the real value added in the Agriculture Sector can be modelled as,

$$\log VA\,G = a11 + b11 \log LAG + D11 \log Land + e11\, ILAND + error,$$

Where, VAG = Value added (in real terms) in Agriculture
LAG = labour employed in Agriculture
KAG = Capital stock in Agriculture Sector
LAND = Gross Cultivated Land
IRIALAND = Proportion of Irrigated land

The prefix log is used for logarithm of the above values.

If CES type production function is used, a simple model would be,

$$\log \frac{VAG}{LAG} = a_{11} + b_{11} \log \frac{VAG}{LAG}_{-1} + c_{11} \text{ Log } \frac{VAG}{LAG} + \text{error,}$$

Where, WAG = Wage Rate in Agriculture Sector
PAG = Price Level in Agriculture Sector
c11 = elasticity of substitution between capital and labour.

If capacity utilization is to be incorporated into the model, then capacity of real value added will be used which is defined by the trend-through-the-peaks method. (Behrman; 1977:113-156). Some authors also incorporate other complexities such as Koyck-Cagan-Nerlove process by which desired or potential value added adjusts towards actual value added.

Industrial Sector

In case of Industrial Production function factors like Cultivated or Irrigated Area are absent, while additional factor like total agricultural production is added in order to reflect the dependence of agro-based industries (which dominate the scene in Nepal) on agricultural inputs.

Thus a Cobb-Douglas type equation for Industrial Production would be
Log VI = a12 + b12 log LI + c12 log KI + d12 AGDP + error,

Where, VI = Value added in Industrial Sector
LI = Labour Force in Industrial Sector
AGDP = Agricultural GDP

The form of the CES type model would be similar to that in Agriculture Sector.

Service Sector

In the Service Sector, the specification includes capital stock, labour force and production of non-service sector (Agriculture plus Industry). Total population can also be added to reflect the demand for some categories of services. The production of non-service sectors is included because the activity in the service sector is directly affected by the activity level in other sectors. A Cobb-Douglas type model for the Services Sector would be,

$\text{LogVS} = a_{13} + b_{13} \log \text{LS} + c_{13} \log \text{KS} + d_{13} \text{ NSGDP} + \text{error,}$
where, NSGDP = GDP of non-service sector, and other variables are defined similar to above.

SOME TECHNICAL CONSIDERATIONS

- In addition to the above behavioral equations there will be identities (such as National Income Identity, Definition of Disposable Personal Income etc.). The

mathematical rules is that there should be as many equations plus identities as there are endogenous variables.

It is found that most researchers in developing countries estimate each equation of the macro-econometric model system using Ordinary Least Squares (OLS) method, and in case of serial correlation by Cochrane - Orcutt (C-O) itemative method. In Simultaneous Equations System, however, direct application of OLS to structural equations gives biased, inconsistent, and inefficient estimates. OLS should only be applied, if at all, to reduced form equations, which is called Indirect Least Squares (ILS). However, even ILS is not efficient in over identified equations, which is generally the case. The most preferred method in practice is Three Stage Least Squares (3 SLS), which uses all available sample and a priori information. At least 2 SLS method should be used. Furthermore, the C-O method is inefficient in the case of lagged endogenous variables (as in the above equations) accompanied by serial correlation. In such cases Hatanaka's method provides an efficient two-step-residual adjusted-estimator. Even in equations without lagged endogenous variable but with serial correlation, Hildreth-Lu method is preferable because C-O may lead to local minimization only. Finally, in case of lagged variable Durbin-watson (DW) is not the appropriate test of serial correlation as it is biased toward two, thus reducing the power of the test. Other better tests are available, like Durbin's "h" test.

The three most common measures of predictive accuracy that have been used in the literature are Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Theil's inequality co-efficient U.
let that Yhat be the forecast of variable Y.

Then

$$RMSE = \sqrt{\frac{\Sigma(Y - Yhat)2}{T}}$$

$$MAE = \frac{\Sigma\left|Y - Yhat\right|}{T}$$

$$U = \sqrt{\frac{\Sigma \Delta Y - \Delta Yhat}{T} / \left(\frac{\Sigma \Delta Y}{T}\right)2}$$

Where Δ Denotes absolute or percentage change. The RMSE is also expressed as percentage of the actual values in which case it is called RMSE percentage.

Traditional economic theory sheds light on the equilibrium relationships among macro variables but provides much less information on the dynamic behaviour of the economy when the system is out of equilibrium. If a macro-model is to be plausible, its long-run equilibrium properties should be consistent with theory, whether or not equilibrium is ever reached. Then there is also the question of stability of the model. A stable model is highly desirable, and, although a model

need not necessarily be stable, a highly unstable model raises a question whether some feedback mechanisms are omitted from the system.

There are two types of forecasts: ex ante and ex post. Ex ante forecasts use predicted values of exogenous variables for simulation while ex post forecasts use actual or known values of exogenous variables. Ex ante forecasts are not very useful for examining the predictive accuracy of models because there is no way of separating a given error into the part caused by bad guesses of exogenous variable and the part caused by errors in the model. For ex post forecasting, available data for some periods are not used in estimation (outside the periods of fit). After estimating the model, the reserve data are used to check the forecasting power of the model. It is generally the case that forecasting accuracy deteriorates as the time period gets further and further away from the estimation period.

POLICY EXPERIMENTS

Policy simulation and evaluation of alternative fiscal and monetary policies is one of the major application of macro-econometric models. We give below a list of some popular policy variables incorporated into macro-econometric models.

Fiscal Policies

- Tax rate changes - personal tax, corporate tax, customs on imports and exports, etc.
- Expenditure Investment - subsidies (for domestic or export purposes), current government consumption, and public investment.

Monetary Policies

- Open Market Operations and other changes in unborrowed reserves.
- Changes in Reserve Requirements.
- Changes in Discount Rate.
- Changing nominal interest rate limits.

Income and Redistribution Policies

- Minimum wage, Price ceilings and floors, etc.
- Foreign Sector Policies to favour certain mass consumption items geographical regions or industries.
- Various subsidy Programmes.

Other Policies

- Exchange Rate Polices
- Industrial Policies
- Foreign Trade Policies
- Privatization or Nationalization
- Poverty Alleviation Programmes – which can be of income transfer, asset-transfer, subsidy, and income/employment-generating variety.

Thus, we see that macro-econometric models can be used for understanding the structure of the economy, forecasting the future trends, or for policy simulations. Plans and programmes and policy changes can, of course, be made, and are usually made, without the buttress of macro-econometric models; but a theoretically and technically sound, well-designed macro-econometric model with appropriate data, can be a valuable tool and guide for macro economic plans, programmes and policies. We need to work toward both developing suitable models for our country and compiling adequate and accurate data for all variables included in such models.

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