CHAPTER TWO

REVIEW OF MACRO-MODELS AND THE BACKGROUND

As a prelude to our study, we have reviewed in 2.1 of this chapter some selected macro-models constructed for the Indian economy over the past three decades. In 2.2, we have presented an overview of the Indian economy for the reference period of our study, i.e., from 1960-61 to 1981-82.

2.1 Review of Models of Indian Economy

The history of planning models for the Indian economy is as old as the planning itself. More than three scores of models have been constructed to analyse and/or to plan the economy during this period. These include planning models based on input-output and/or optimising techniques on the one hand, and macro-econometric models, on the other. It is very difficult to review each of these models in a study of this kind. Therefore, only some important macro-models relevant to our study have been reviewed here.

The models range from aggregative single and two-sector models used for the First Plan to highly disaggregated 89-sector model used in the Sixth Plan. For the intervening periods, we have a 4-sector Model for the Second Plan,

5 Details of the model being constructed for the Seventh Five Year Plan by the Planning Commission are not available.
Sandeep's Long Term Planning Model and Chakravarty's Model for the Third Plan. The Economic Division and the Perspective Planning Division (PPD) of the Planning Commission constructed a fairly disaggregated model for the Fourth Plan. The PPD constructed a 66-Sector Model for the Fifth Plan and an 89-Sector Model solved for its aggregated version having 14-sectors for the Sixth Plan.

In the single sector model, Mahalanobis depicts a very simplified picture of the economic process. This model is used to present economic growth as a first approximation. It, very closely, resembles the Harrod-Domar growth models except for distinction between average and marginal propensities to save. The capital-output ratio is assumed to be the same on the margin as on the average. The objective of the model is to chalk out a time path for income consistent with certain initial conditions.

Mahalanobis divides the economy in his two-sector model into investment and consumer goods industries. It resembles the Marxian scheme of reproduction except for the slight difference, Marx covering all raw material producing industries in "department 1". Feldman independently developed a two-sector model in the Soviet Union in the 1920's and

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Further details of Marx and Mahalanobis type of division are given in Tsuru (1962).
Domar revived it with improvement.

The concept of capital goods required for consumption does not clearly appear and the development of basic heavy industries is for manufacture of producer goods and not consumer goods (Mahalanobis, 1963). The model is based on the assumptions of constant prices, capital as the only limiting factor, closed economy, no lags, production independent of consumption, no distinction of Government expenditure for investment and consumption, no bottlenecks, complete division of economy into two categories - capital and consumption sectors - wherein no existing capital can be transferred from one sector to another whereas the total investment between two categories is completely flexible and no discounting taken into account.

In the 4-sector model, Mahalanobis divides the economy into four sectors by disaggregating consumer goods industries into three different sectors, viz., factory produced consumer goods, consumer goods produced in small and household industries and services such as health, education, etc. Fourth Sector is the investment goods sector. He assumes linear growth of national income, Cobb-Douglas type of production function with constant returns to scale, no

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relative price variation, income coefficients of capital independent of net investment required for employment during the plan, proportion of total investment allocated to production of capital goods varies over the plan period and the economy is a closed one. The model keeps the technology constant in all four sectors, though it has part to play in the output capital ratio.

The configuration of demand is almost neglected in this model which may turn a growth model into just a hypothetical construction under broad \textit{ceteris paribus} assumptions. A realistic model should consider demand as a function of population, income and prices. Moreover, the intermediate demand, that is, the demand for intra-industry or inter-industry inputs and changes in stocks did not receive any attention inside the equation system of the model. In the context of Third Five Year Plan, the two much talked about models are Professor Chakravarty’s Model (Chakravarty, 1964) and Professor Sandee’s 13-Sector Long Term Planning Model.

Sandee’s model (Sandee, 1969) appears to be mainly of experimental and illustrative nature and describes the development of the Indian economy in the decade of sixties, which roughly coincides with the Third and Fourth Plan periods. The model consists of 16 equations linking 30 variables, 14 binding constraints and an objective function. It uses an input-output table for 1953-54. The model is
essentially of Leontief static-open one, all helps to study the problems relating to comparative static situations. However, it has some dynamic elements also (Gupta, 1975).

The approach of Chakravarty's model is similar to that of Sandee's model. It provides us with five yearly totals of a few important variables and growth rates of some plan magnitudes. The Perspective Planning Division of the Planning Commission carried out an exercise using a model resembling Manne and Rudra Model (Manne and Rudra, 1965). The Manne-Rudra Model was of open-static type and was related to the consistency of the terminal year of the Fourth Plan. It did not specify a complete time phased course of action and had no financial counterpart. Like Sandee (1960), it tried to give a rationale for investment activity in the terminal year. They assumed exponential rise in investment over the intervening years of the Plan. The Perspective Planning Division exercise differs in the matter and the phasing of investment and capital formation in the final year is done rather arbitrarily and loosely integrated with the total investment requirements over the plan period. The sectoral classification and the time horizon also differs in the two models.

The Perspective Planning Division Model is based on a macro-model, a 77-sector Inter-Industry Consistency Model, a Material Balance Part and a Financial Resource part.

The Macro-model is, by and large, based on "guesstimates" or in other words on mechanical extrapolation and value judgement, made by various agencies. The estimates of gross capital formation are based upon a separate calculation of the requirements of net investment and replacement investment. Replacement investment itself is derived by the perpetual inventory method, whereas the net investment is assumed to be 17.5 per cent of national income.

The inter-industry model determines a consistent set of gross output within the boundary conditions set by the macro-model. The whole of the final demand is treated as exogenous in this open-static model of Leontief type.

The Fifth Plan Model is again an exercise carried out by the Perspective Planning Division. It is an open-ended static input-output type of model. It provides a consistent set of sectoral targets of gross output, given the set of input-output coefficient and sectoral levels of final demand for the target year. It consists of three parts. Part one is a macro-model which includes equations for gross-domestic

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product, gross savings, gross investment, net imports, pri-

vate consumption and public consumption along with various
tax identities. Part two is an open-static input-output
model based upon 66-Sector classification. This part of the
model determines changes in stocks, imports, total indirect
taxes on inputs along with a consistent set of sectoral
gross output. It uses private consumption estimated in the
consumption sub-model which is the third part of the overall
exercise. The third part is based upon a 66-Sector classifi-
cation and 27 consumption expenditure categories separately
for rural and urban population. The consumption expenditure
is assumed to be log-normally distributed across the expend-
diture classes and has been fitted on the basis of lowest
30 per cent of the population. The aggregate sectoral private
consumption estimates are fed into the input-output model
as a component of final demand. The overall model is solved
for various alternatives of exogenously given sectoral
export targets. 10

The Sixth Plan Model constructed, again by the Perspec-
tive Planning Division 11 attempts to integrate both the Harrod-
Domar and input-output approaches of earlier plan models.
An additional feature of this model is an investment planning

10 For details of the model and that of endogenous and
exogenous variables, see Technical Note for Fifth Plan:

model integrated to the input-output framework. Moreover, it attempts to consider not only the commodity and services markets but also markets dealing with inputs like non-renewable resources of the country, labour and capital.

The core model is composed of seven blocks which are inter-dependent and have five major sub-models linked to it. The structure of the model is a typical non-linear programming one. However, due to high non-linearity of the model, it has not been solved through non-linear procedures. Instead, it has been solved by giving alternative values to key policy variables such that the system is reduced to a state with only one degree of freedom.\(^\text{12}\)

In the models mentioned so far, we can see an improvement over-time, obviously due to availability of better data base and sophisticated computational facilities. However, these models do not treat endogenously the rise in prices, which is inevitable in an economy like ours. Moreover, none of these models tries to capture the consequences of the plan activities, particularly that of government consumption and government investment, on the prices during the plan period itself. An unexpected and unplanned rise in the prices during the plan period may not only create hardship for a

\(^{12}\) The details of the structure of the model are too lengthy to be presented here. See Technical Note for the Sixth Plan, Planning Commission (1981).
large portion of population but may also jeopardise the entire development plan by reducing the real value of development inducing forces like investment, thereby leading to a lower level of economic activity in real terms. The problem may be aggravated if attempt is made by the government to revise its nominal investment targets, in view of changing price situation, such that real level of investment remains the planned one. Such an attempt may give an upward push to the prices if the investment is in the non-consumer goods producing sectors and if the additional investment is met through deficit financing.

Now let us have a look at a few econometric models. Since the pioneering work of Narsimham (1956) more than two scores of simultaneous equation macro-models of Tinbergen-Klein type have been constructed for the Indian economy. A large number of such models are the result of Ph.D. dissertations and are not published (Desai, 1973). After Desai, another survey of econometric models for the Indian economy has been conducted by Sinha (1973), which also covers later models. Some of these models are by Agarwala (1970), Ahluwalia (1979), Bhattacharya (1975, 1985), Choudhry (1963), Ghosh-Lahiri-Madhur-Roy (1983), Krishmurty (1964), Krishnamurty-Choudhury (1968), Mammen (1967), Krishnamurty-Saibaba-Kazmi (1984), Marwah (1964, 1979), Narsimham (1956), Pandit (1973, 1977, 1978, 1984), Pani (1977) and Econometric Division of
Reserve Bank of India (1983). These models differ widely from each other from the points of view of objective, coverage of time period, specification of equations, method of estimation etc., however, some of these have points of similarities also. These models cover the economy as a whole.

Some of the differences between the specification may be pointed out as follows: Krishnamurty, Marwah and Mammen specify their expenditure equations at constant prices (real terms) whereas Choudhry and Narasimham have them at current prices (nominal terms). Agarwala's system is based on the lines of W. A. Lewis's two sector growth model (Lewis, 1954) with feed-back from agriculture to industry and he uses price and expenditure equations only as means of closing the model. Krishnamurty's model is specified entirely in real terms and there is no explanation of price level in his model, but, perhaps this and Krishnamurty-Choudhry's models are only models which have an endogenous explanation of population growth. Mammen's system has the most explicit treatment of the monetary sector but all the other models except that of Narasimham have equations of interest rate structure and/or demand for money.

These models have their own merits and shortcomings which are pointed out by Desai (1977) and Sinha (1984) in details. However, an important drawback has somehow been overlooked by them while carrying out the surveys, that is, all these models concentrate on final demand and give little or no
attention to the intermediate demand. Thus, a substantial component of demand, i.e., intermediate demand or the input demand of production sectors, is ignored. The seriousness of this drawback of these earlier models may be realised from the fact, that the intermediate demand consists of about 45 and 47 per cent of the total demand in the year 1979-80 and 1983-84, respectively. (See Sixth Plan Technical Note).

Chenery and Watanabe (1958) in a cross country comparison of production structures of U.S.A., Japan, Norway and Italy, have found that 40-50 per cent of total domestic demand for goods and services comes from production sectors. This would justify an appeal to input-output methods. The intermediate demand as a percentage of total demand for India falls within the limits suggested by Chenery and Watanabe (45 and 47 per cent respectively for 1979-80 and 1984-85 at 1979-80 prices).

Klein’s Guidelines for Improved Modelling

As already mentioned, quite a large number of macro-models have been constructed for the Indian economy. On the one hand, there are behaviouristic models which successfully describe the behaviour of macro variables including the prices but ignore the intermediate demand. On the other hand, there are input-output and optimising models which give little importance to endogenising the behavioural
nature of variables and almost totally ignore the movements of prices though these models take into account the intermediate demand. However, input-output types of approaches, by and large, treat the final demand as fixed or exogenously determined. In other words, at least in the case of open models, the system does not determine the sectoral final demands and their components, namely, private consumption, government consumption, gross domestic fixed capital formation, changes in stocks, exports and imports. It may be possible to exogenously fix the final demand in a rigidly planned economy. Yet, the question whether the final demand can really be treated as exogenous remains unanswered since there are strong inter-relationships between the final demand, production activity and income generation. Therefore, while constructing a macro-model, consideration must be given to specify and incorporate the interactive nature of economic variables even if the final demand is to be fixed exogenously. In other words, some behaviouristic mechanism may be introduced in arriving at the final demand targets.

As an improvement to this, Klein (1965) suggests an integration between the input-output methods and behaviouristic models. He argues that "the input-output model, by itself is inadequate as is the final demand model, but the two together can form a complete model of the economic process."
Perhaps no attempt has been made to construct a model for the Indian economy on the lines suggested by Klein. The present study is a modest attempt in this direction.

2.2 Overview of the Indian Economy: 1960-61 to 1981-82

This section of the chapter presents some basic features of the Indian economy during our sample period i.e. 1960-61 to 1981-82.\(^\text{13}\)

Agricultural Sector remained the largest single sector in the economy from the point of view of economic activity. Its share in the real GDP was about half during the decade of sixties, which declined to about 40 per cent in the later period.\(^\text{14}\) The real gross value added rose at about 2.2 per cent during our sample period (table 2.1). A technological change took place in the agricultural sector in the late sixties with the introduction of improved varieties of seeds, better implements and chemical fertilisers - the phenomena popularly known as the 'Green-Revolution'. The agricultural real gross value added grew at a statistically insignificant growth rate of about one third of a per cent during the

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13 The period covers terminal years of the Second Plan, Third Plan, Three Annual Plans, the Fourth Plan, the Fifth Plan, a period of Rolling Plan and three years of the Sixth Plan.

14 The percentages and other figures used in this section are based on data from various issues of the National Accounts. The growth rates given in this section are based on semi-logarithmic trend equations and are statistically significant.
Table 2.1
Semi-logarithmic Growth Rates for Selected Variables

<table>
<thead>
<tr>
<th>Real Gross Value Added</th>
<th>Real Gross Domestic Capital Formation</th>
<th>Implicit Price Deflator for Gross Value Added</th>
<th>Implicit Price Deflator for Gross Domestic Capital Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1. Agriculture</td>
<td>2.2</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>2. Forestry and Logging</td>
<td>5</td>
<td>3.3</td>
<td>-2.0</td>
</tr>
<tr>
<td>3. Fishing</td>
<td>3.2</td>
<td>2.8</td>
<td>2.2</td>
</tr>
<tr>
<td>4. Mining and Quarrying</td>
<td>3.7</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>5. Manufacturing</td>
<td>4.1</td>
<td>4.8</td>
<td>4.6</td>
</tr>
<tr>
<td>6. Construction</td>
<td>3.7</td>
<td>4.7</td>
<td>2.7</td>
</tr>
<tr>
<td>7. Electricity, Gas &amp; Water Supply</td>
<td>8.6</td>
<td>11.4</td>
<td>6.9</td>
</tr>
<tr>
<td>8. Railways</td>
<td>3.4</td>
<td>3.9</td>
<td>4.0</td>
</tr>
<tr>
<td>9. Other Transport</td>
<td>6.8</td>
<td>5.9</td>
<td>7.3</td>
</tr>
<tr>
<td>10. Communications</td>
<td>6.4</td>
<td>6.8</td>
<td>6.8</td>
</tr>
<tr>
<td>11. Trade</td>
<td>4.2</td>
<td>4.6</td>
<td>4.9</td>
</tr>
<tr>
<td>12. Banking and Insurance</td>
<td>7.2</td>
<td>5.5</td>
<td>7.8</td>
</tr>
<tr>
<td>13. Real Estate &amp; Ownership Dwellings</td>
<td>4.0</td>
<td>3.5</td>
<td>2.9</td>
</tr>
<tr>
<td>14. Services</td>
<td>4.9</td>
<td>5.1</td>
<td>6.2</td>
</tr>
<tr>
<td>Total</td>
<td>3.5</td>
<td>3.3</td>
<td>3.7</td>
</tr>
</tbody>
</table>

All growth rates are significant at 1 percent level except those underlined.
pre-Green Revolution period (1960-61 to 1967-68). However, the post Green Revolution period (1967-68 to 1981-82) has a higher growth rate of about two and a quarter per cent for the real gross value added.

The share of agriculture in real gross domestic capital formation rose from about 15 per cent in the pre Green Revolution period to about 20 per cent in the later period. The growth rate of gross domestic capital formation in the agricultural sector was about 5.9 per cent during our sample period. The decade of sixties registered a growth rate of 6.9 per cent which reduced to 5.6 per cent in the later period. The growth rate for sixties almost coincides with the growth rate in the pre Green Revolution period and similarly that for 1970-71 to 1981-82 coincides with that for the post Green Revolution period.

The implicit price deflator for gross value added in the agricultural sector grew at 7.1 per cent during our sample period. The growth rate was higher during the decade of sixties; 8.7 per cent, whereas for the later period it was 6.3 per cent. In the pre Green Revolution period it remained at 11.4 per cent and declined to 6.1 per cent in the post Green Revolution period.

The implicit price deflator for gross domestic capital formation in the agricultural sector was 8.3 per cent during our sample period. It was 6.3 and 9.9 respectively during
the sixties and the later period. The growth rate was almost the same for the pre Green Revolution period as that for the sixties (6.4 per cent). Also, the growth rate for the post Green Revolution period was quite close to that for the seventies (9.4 per cent).

The second largest sector of the economy is the manufacturing sector, contributing about 15.5 per cent towards the real GDP on an average during the sixties which remained almost at the same level in the later period.

The real gross value added grew in the sector at 4.1 per cent during our sample period. The growth rate in the sixties (4.8 per cent) was slightly higher than that for the later period (4.6 per cent).

The growth rates for the real gross domestic capital formation were 5.6, 5.6 and 6.5 per cent respectively for the entire sample period, the sixties and the later period.

Implicit price deflator for the gross value added registered a growth rate of -7.5 per cent during our sample period. For the sixties, it registered a growth rate of 4.7 per cent whereas in the later period it was substantially higher (9.1 per cent).

Implicit price deflator for gross domestic capital formation rose at 5.6 per cent during the sixties but rose at much higher rate of 9.8 per cent in the later period. The overall growth rate was 8 per cent.
In the remaining twelve sectors, the highest growth rate of real gross value added during our sample period is observed in the electricity, gas and water supply sector (8.6 per cent) which is followed by the banking and insurance sector (7.2 per cent). 'Other Transport' and Communications sectors have quite close growth rates, 6.8 and 6.4 per cent respectively. All other sectors have growth rates between 3 and 5 per cent, the lowest being 3.2 per cent for the fishing sector.

The real gross domestic product in the economy as a whole has grown, on an average, at 3.5 per cent per annum. The rate was slightly lower for the decade of sixties (3.3 per cent) whereas for the post-sixties, it was around 3.7 per cent.

The year to year percentage changes in the real GDP show fluctuations, the change varying from -5.2 per cent for 1979-80 to 9.4 per cent for 1975-76. The annual percentage change over previous year was negative for 1965-66 (-5.2 per cent) and 1972-73 (-1.1 per cent) apart from 1979-80. Among the remaining 19 years of our sample period which show positive changes; 10 have more than 5 per cent change over the previous year.

15 Professor Raj Krishna used to refer to this growth rate as "the Hindu Rate of Growth".
The real gross domestic capital formation has grown at 5.2, 5.7 and 5.5 per cent respectively, during our sample period, the sixties and the post-sixties period. The rate of real gross capital formation on an average was 18.7 per cent during our reference period. It was slightly lower during the sixties (17.3 per cent) whereas that for the post-sixties it turned out to be 19.9 per cent. The highest rate of capital formation, 22.6 per cent, was recorded for 1978-79 and the lowest, 14.6 per cent for 1961-62.

The implicit price deflator for GDP rose at 7.4 per cent between 1960-61 and 1981-82. It rose faster during the post-sixties period (8 per cent) whereas the rise was relatively slower during the sixties (7.11 per cent). This indicator may be considered as reflecting the inflation in the country. The inflation rate, if measured by the wholesale price index (WPI), would indicate a similar situation. For our entire sample period, the inflation rate measured by the WPI averaged under 10 per cent per annum. Wide fluctuations are observed in the rate of inflation, ranging from negative values to as high as 20 per cent and more. The inflation rate was higher in the post-sixties period as compared to that of sixties. In the sixties, the rate of increase in the prices of food articles was the highest. However, in the later period it declined, but for all other commodity groups it registered a much higher value, which resulted in a higher rate of inflation for all commodities for this period.
Import prices also increased much faster in the later period as compared to the sixties. Among the import prices, fastest increase was observed in the prices of fuels and raw materials, particularly in petroleum and petro-based products.

The implicit price deflator for gross domestic capital formation increased at 7.9 per cent per annum. During the sixties, it shows an increase at 5.5 per cent per annum on an average, whereas for the post-sixties period, it is much higher (10 per cent). If this deflator is considered as proxy for the prices of capital goods (including construction), we may say that the prices of capital goods increased faster than the general prices (reflected by GDP deflator) and particularly during the post-sixties.

The wide fluctuations in year-to-year percentage changes in the values of various variables may be attributed to several internal and external reasons. Some of the major happenings which may be said to have bearing on the economy may be mentioned as follows:

The economy faced three wars (1962, 1965 and 1971), a major currency devaluation in 1966 and several bad years from the point of view of weather conditions. Rainfall was below normal in six years during the sixties, except 1962, 1968 and 1970. Extremely bad years were 1966, 1967 and 1969.
In the later period, 1973, 1977, 1980 and 1981 were the years when the rainfall was below normal. Internal emergency, followed by a period of political instability, may also be said to have some consequences for the economy. Steep rise in prices of petroleum and petro-based products in the international market and consequent rise in the prices of other imports can be expected to have influenced the economic scene in the country.