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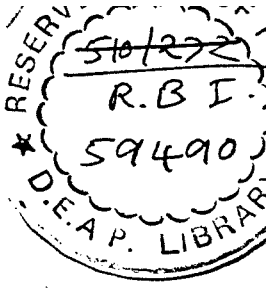

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Growth and Productivity in the Indian Economy

Deepak Mohanty*

That the rate of capital accumulation and growth of labour force can not by themselves ensure a desired level of economic growth is amply evident in India's growth experience. Economic growth, it is well known, emanates as much from the growth of labour and capital as from the growth of total factor productivity (TFP). The growth in TFP can be measured either by the growth accounting approach developed by Kendrick or by the aggregate production function model. This paper differs from the earlier studies in that, it attempts to measure TFP growth for fourteen major economic activities, besides aggregate net domestic product for the period 1970-71 to 1988-89. The empirical evidence suggests that the accelerated growth of the eighties has not been accompanied by any statistically significant improvement in TFP growth.

The level and growth of per capita national income is by far the most easily quantifiable and widely accepted indicator of economic development. Historical evidence suggests that high and sustained economic growth rate is needed for countries to improve their per capita income levels. Economic growth, it is well known, emanates as much from the growth of labour and capital as from the growth of 'total factor productivity'[1]. The rapid growth of Japan and the newly industrialising countries of South East Asia has often been attributed to an increase in the growth of 'total factor productivity' (TFP, hereafter).

That the rate of capital accumulation and growth of labour force can not by themselves ensure a desired level of economic growth is amply evident in India's growth experience. For a developing country, post independent India experienced a fairly long period of rapid capital accumlation. The rate of gross domestic saving rose from 10.4 per cent of GDP in 1950-51 to 15.7 per cent in 1970-71 and then to 21.2 per cent in 1980-81, except for the 1980s when it showed a tendency of stagnation. On the other hand, real GDP registered a high growth rate of 5.1 per cent in the 1980s. Consequently, the annual average growth rate worked out to 3.7 per cent for the period 1950-51 to 1988-89.

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1 In the discussion we provide the definition of 'total factor productivity'.

Hypotheses abound towards an explanation of the somewhat sluggish long-term growth of the Indian economy. One often encounters studies which attribute the slowdown in long-term growth to an increase in the capital output ratio, or sluggishness in the growth of output per labour employed. But these partial productivity ratios reflect both changes in factor substitution as well as changes in productive effeciency. In other words, while measuring the productivity of labour the contribution of capital is not controlled for and *vice varsa.* Changes in TFP ratio indicate the net savings achieved in the use of basic factors per unit of net output and thus the increase in productive efficiency[2]. Studies on TFP growth for the Indian economy are few and far between. Earlier studies by Goldar (1983), Brahmananda (1982) and Ahluwalia (1985 & 1991) have provided estimates of TFP growth in the manufacturing industries.

This paper differes from the earlier studies in that it attempts to measure TFP growth in net domestic product (NDP) by industry of origin (as per the national accounts classification) for almost all the major economic activities. To be specific, it measures the following fourteen major economic activities, besides aggregate NDP for the period 1970-71 to 1988-89: i) Agriculture, ii) Forestry and Logging, iii) Fishing, iv) Mining and Quarrying, v) Registered Manufacturing, vi) Unregistered Manufacturing, vii) Electricity, Gas and Water supply, viii) Construction, ix) Trade, Hotels and Restaurants, x) Transport, Storage and Communication, xi) Banking and insurance, xii) Real Estate, Ownership of dwellings and Business services, xiii) Public adiministration and Defence, and xiv) Other services.

The paper is organised thus: Section II provides a brief discussion on the methodological issues and sets up the model for estimation. Section III outlines the data base used as the input for estimation. Section IV analyses growth trends and our *a priori* conjectures. Finally, Section V presents the TFP growth estiamtes and our conclusions.

II

Productivity can be defined as the relationship between output and the associated inputs used in the production process. When the same amount of input produces larger quantities of goods and services than before, or the same amount of output is produced with smaller quantities of inputs, productivity has increased. Notwithstanding the definition, the measurement of productivity is tenuous and wrapped in controversy.

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2 See Kendrick and Grossman (1980), p.4.

The measure of productivity growth is closely associated with the concept of aggregate production function developed by Paul H. Douglas and his associates. This concept is one of those masterful simplifications that makes it possible to summarise a welter of detailed information within a single overreaching framework. It is also the concept that seems tailor-made for the interpretation of data on output, input and productivity of the type compiled in the national product accounts.[3].

Following the pioneering work of Jan Tinbergen (1942), Robert Solow (1957), George J. Stigler (1947), Kendrick (1956) and the research effort of the National Bureau of Economic Research, the epoch making monograph by John W. Kendrick, "Productivity trend in the United States" was published in 1961[4]. These have helped to improve the version of aggregate production function as originally envisaged.

Let us consider an aggregate production function,

$$Q = Q\ (K,\ L,\ I)\ (A)$$

Where Q denotes the potential or actual physical volume of output; L and K are the series of basic factors of production, labour and capital inputs, respectively. I is the set of intermediate inputs, the output of all other industries used in the output of Q. Then A can be defined as a parameter that influences output in addition to changes in tangible factor inputs. The variable A is sometimes loosely called technology. It is less misleading to refer to A as productive efficiency of tangible factors, or "total (tangible) factor productivity" (TFP).

In the context of estimation of output at the level of the economy the inclusion of intermediate input involves double counting. Hence, the Value Added by each industry (Q-I), which is gross output net of intermediate inputs, translates into a function of K, L and A. Thus, the estimates of Value Added can be taken as a measure of output. However, the exclusion of intermediate inputs from the production relations could possibly lead to a positive bias in the estimates of returns to scale which affects elasticity of substitution between labour and capital[5]. The homogeneity of labour and capital is assumed. However, it can be argued that labour and capital are aggregates of elements that are basically heterogeneous with divergent characteristics; they differ in their longevity, impermanence, productive qualities, mobility etc. The definition of factor inputs

3 Jorgenson (1990).

4 For a detailed discussion see Jorgenson (1990).

5 See Nadiri (1970).

could be extended to include intangibles such as that the stock of productive knowledge as embodied in labour and capital or disembodied in the organisation of production. The existing capital stock may represent disembodied technological change, the new investment can be considered to embody quality improvements. Further, not all technological change is embodied in capital goods; part of it must be transmitted through changes in characteristics of labour force such as skill and education.

While, *a priori*, the influence of intangible factors on labour and capital can not be assumed away, their quantification poses a major problem. Nevertheless, measures of labour inputs allowing for heterogeneity was developed by Denison (1961). The methodology for incorporating quality changes for capital goods and relative efficiency of capital goods of different vintage was developed by Hall (1971), who generalized the "hedonic technique" for measuring quality changes employed by Griliches (1961)[6].

On the other hand, the approach developed by Kendrick includes only tangible factor inputs unadjusted for changes in knowledge and other factors affecting efficiency[7]. It is this convenient two factor growth accounting approach that we use for the purpose of this study. With a consistent time series on value added, capital stock and labour inputs, the TFP growth over a time period can be estimated from the Cobb-Douglas production function. Assuming differentiability of the production function, profit maximization, factor price taking on the part of the industry and disembodied technological progress we have,

$$Q = Q\ (K^{\alpha},\ L^{\beta})\ (A)$$

Takind natural log of both sides and differentiating with respect to time,

$$\ln Q = \alpha \ln K + \beta \ln L + \ln A$$

$$\frac{\partial \ln Q}{\partial t} = \alpha \frac{\partial \ln K}{\partial t} + \beta \frac{\partial \ln L}{\partial t} + \frac{\partial \ln A}{\partial t}$$

$$\frac{1}{Q}\frac{\partial Q}{\partial t} = \alpha\left(\frac{1}{K}\frac{\partial K}{\partial t}\right) + \beta\left(\frac{1}{L}\frac{\partial L}{\partial t}\right) + \frac{1}{A}\frac{\partial A}{\partial t}$$

6. See Jorgenson (1990) and also Nelson (1981).

7 See Kendrick (1973).

Let,

$$\frac{1}{Q}\frac{\partial Q}{\partial t} = g_q ,$$

$$\frac{1}{K}\frac{\partial K}{\partial t} = g_k ,$$

$$\frac{1}{L}\frac{\partial L}{\partial t} = g_l ,$$

and $$\frac{1}{A}\frac{\partial A}{\partial t} = g_{Tfp} .$$

Where, g_q, g_k, g_l, and g_{Tfp} are growth in output, growth in capital, growth in labour and growth in total factor productivity, respectively.

Rewriting,

$$g_q = (\alpha g_k + \beta g_l) + g_{Tfp}$$

Where α and β are elasticities of output with respect to the two factor inputs. The expression in the parentheses takes the form of Divisia Index Number. Under constant returns to scale, the rate of growth of total factor inputs can be expressed as a weighted combination of the growth rates of individual factor inputs[8].

Transposing, we have the final expression for the rate of growth of total factor productivity,

$$g_{Tfp} = g_q - (\alpha g_k + \beta g_l)$$

Thus, the growth of total factor productivity is measured as the difference between the rate of growth of value added and the rate of growth of total factor inputs.

It may be noted that the Cobb-Douglas production function is linear in the logarithms of outputs and inputs and assumes unitary elasticity of substitution between the factor inputs. Hence, one could use the more generalised form of the Cobb-Douglas model, the translog model[9], which relaxes the Cobb-Douglas model's assumption of unitary elasticity of substitution. Since the elasticity of output with respect to each factor input is allowed to vary with the level of input, competitive equilibrium

8 See Gallop and Jogerson (1980)

9 Introducted by Berndt and Christensen in 1972.

does not imply constancy of factor shares as in the Cobb-Douglas model. The translog model can be written as,

$$\ln Q = \beta_1 + \beta_2 \ln K + \beta_3 \ln L + \beta_4 \frac{\ln K^2}{2} + \beta_5 \frac{\ln L^2}{2} + \beta_6 \ln K \ln L$$

The Cobb-Douglas model is obtained by the restirction,

$$\beta_4 = \beta_5 = \beta_6 = 0$$

In the expanded model the capital elasticity of output is given by,

$$\frac{\partial \ln Q}{\partial \ln K} = \beta_2 + \beta_4 \ln K + \beta_6 \ln L$$

Similarly, the labour elasticity of output is given by

$$\frac{\partial \ln Q}{\partial \ln L} = \beta_3 + \beta_5 \ln L + \beta_6 \ln K$$

The elasticities can be estimated for different values of K and L. One way is to evaluate the elasticities at the mean values for lnK and lnL. The TFP growth estimation using translog functional form could be made more complex by adding in a time variable which allows for a discreet time analysis. Further, the advantage of translog measure is that TFP growth can be measured for each successive year[10]. The period to period rate of change in the scalar, or productivity, may be obtained as the difference in the rate of change in output and the rate of change in labour and tangible capital inputs, each weighted by its share of income as derived from the statistical production function or directly from the national income estimates[11]. In order to generate the annual estimates of TFP growth of the US economy, Kendrick relies on the estimated share of each factor income in gross domestic product originating in various industry groups to combine the index number of labour and capital inputs.

Annual estimates of TFP growth in the context of a developing economy such as India could however be misleading because year to year fluctuations in the growth rates of the economy may not be strictly related to productivity changes. As Dale W. Jorgenson[12] observed in

10 See Ahluwalia (1985).

11 Nelson (1964), "Aggregate production function", The AER, September, p. 528.

12 See Jorgenson (1990).

an extensive review of the mainstream research in productivity changes, "My conclusion ..... is that the aggregate production model used in analysing economic growth by Dension, Kendrick, Kuznets, Maddison, Solow, Tinbergen and a long list of others is appropriate for studying long term growth trends. However this model is highly inappropriate for analysing the sources of growth over shorter periods" (p. 26). In the case of India, though the share of agriculture in national income has declined over time,[13] the peaks and throughs of the growth of aggregate national income is closely associated with agricultural performance which in turn largely depends on weather conditions[14]. Further, due to perdominantly unorganised character of the economy, bulk of the income in the economy originates as mixed income of the self employed. For example, national accounts of India classified 39.7 per cent of NDP for the year 1984-85 as mixed income of the self employed, the apportionment of which between capital and labour could be arbitrary. Hence, we rely on the estimated factor shares from the statistical aggregate prouction function rather than national accounts to combine the labour and capital inputs.

III

The importance of data base in an empirical study of this nature can hardly be exaggerated. The reliability of TFP growth rates, *inter alia,* depends on consistent time series on value added, capital stock and estimates of labour employed. In the following paragraphs we outline the sources and methods used to generate the data set for the purpose of this study.

Output: As mentioned earlier, we choose value added in each industry as a measure of output. The national accounts statistics, published annually by the Central Statistical Organisation (CSO), Government of India, presents both the gross and net value added data by industry of origin at factor cost. The consensus among national income specialists is that NNP rather than GNP is the preferred measure from a welfare standpoint.[15] The consumption of fixed capital which differentiates GNP/GDP from NNP/NDP, reflects the incremental capital goods production required to maintain the productive capacity of the economy intact.

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13 The share of agriculture in NDP declined from 41.5 per cent in 1970-71 to 32.4 per cent in 1988-89.

14 The gross irrigated area as per cent of cropped area worked out to only 32.8 per cent in 1987-88.

15 See Kendrick (1973).

For the purpose of this study, we use the NDP estimates by industry of origin at factor cost in real terms (at 1980-81 prices) as available in the national accounts statistics. The real industry product estimates in relation to the real factor cost alone indicate the changes in the efficiency with which the basic factor resident in the industry are used to add value to the intermediate products purchased from other industries.[16] It can be seen from table 1 that the real NDP of India, in 1980-81 rupees, increased by about 33.0 per cent from Rs. 831.7 billion in 1970-71 to Rs. 1,103.4 billion in 1980-81 and further by about 53.0 percent to Rs. 1,683.8 billion in 1988-89.

Capital Stock: The capital stock of an economy includes both reproducible tangible networth - such as structure, machinery and equipments, and inventories - and non-reproducible tangible wealth such as land. The capital stock could be measured on gross basis or on net basis after providing for wear and tear of assets. The estimates of capital consumption could be derived on the basis of book value of the assets, or economic depreciation which reflects the true productive capacity of the capital stock.

Until very recently, there was no official series of capital stock estimates consistent with GDP/NDP estimates in national accounts statistics. Hence, all the earlier studies on TFP growth - Goldar (1983) and Ahluwalia (1985) - relied on different estimates of capital stock for the manufacturing sector. For example, the Ahluwalia study generated capital stock at constant prices by perpetual inventory accumulation method, using gross fixed capital stock data at repalcement cost for 1960 from Dadi and Hashim. Both Ahulwalia and Goldar preferred to work with gross capital stock.

Since our output series is on net basis it is logical that we use net capital stock estimates. The 1990 national accounts statistics presented a series of net capital stock estimates by industry of origin for the years 1980-81 to 1988-89. These estimates are generated via the perpetual inventory method (PIM) on the basis of the expected life of an asset, and its current replacement value. As regards the earlier years, we generated an industry series on depreciation by substracting NDP estimates from the respective year's GDP estimates at 1980-81 prices. The depreciation figures are then subtracted from gross domestic capital formation estimates to obtain the industry-wise estimate of net capital formation. The 1980-81 estimate of net capital stock was then moved backwards by subtracting each year's net capital formation estimates. The capital stock

16 See Kendrick (1973).

estimates at three different time points is presented in table 2. It can be seen that the value of aggregate net capital stock in 1980-81 rupees increased by about 50.0 percent from Rs. 2,256.9 billion in 1970-71 to Rs. 3,380.9 billion in 1980-81 and went up further by about 48.0 per cent to Rs. 5,013.1 billion in 1988-89.

It may be added that these capital stock figures only include net reproducible tangible wealth; they do not include the value of land. However, the expenditure on improving the quality of land shows up in these estimates of capital stock. No attempt has been made to adjust the value of capital stock for under-utilisation of capacity as suggested by some researchers. Apart from the voluminous work required to do so, capital, as Kendrick felt, involves a real cost regardless of rate of utilisation. One of the major factors for the slow economic growth in developing countries, particularly in India, is the under-utilisation of capital for various reasons. To the textent capital is under-utilized, it would show up in TFP growth.

Labour: For the Indian economy there is no time series data on labour input for the different industries consistent with the national accounts statistics. The decennial population census provides the only comprehensive account of labour inputs. Though the National Sample Survey (NSS) collects data on employment in its various rounds, these data are not strictly comparable with the census estimates except perhaps the 38th round (for the year 1983). Annual data on employment in the public sector and organised private sector are available from the Director General of Employment and Training (DGE&T). But these data have varied in scope and coverage over the years.

For the purpose of this study, the annual estimates of labour inputs for the inter censal years have been worked out by linear interpolation of the 1970-71 and 1980-81 census working force data.[17] As regards the eighties, the latest 1991 decennial population census indicates that the rate of growth of population has slowed down just a little bit from 2.23 per cent per annum in the seventies to 2.13 per cent per annum. Though the detailed industry-wise estimate of working force for 1991 is not yet available, the 43rd round (for the year 1987-88) quinquennial NSS survey reveals a substantial drop in the rate of growth of employment. The rate of growth of employment has been estimated to have declined from 2.82 per cent per annum during 1973-78 to 2.22 per cent during 1978-83 and more recently to 1.55 percent during 1983-88.[18]

17 This procedure is consistent with the methodology currently followed by the CSO.
18 See Ghosh (1991).

Taking cognisance of all these statistics we have projected the working force estimates of 1980-81 for the subsequent years upto 1988-89. For the purpose of projecting working force in agriculture, forestry, and fishing, an annual growth rate of 0.925 per cent (represents the average of 38th and 43rd rounds of NSS employment growth rate for agriculture) has been applied. For mining and quarrying a growth rate of 6.005 per cent, for unregistered manufacturing 2.295 per cent, for electricity and gas 4.855 per cent, for construction 10.57 per cent, for transport and storage 4.51 percent (again the average of 38th and 43rd rounds) have been applied. As regards registered manufacturing, banking and insurance, trade and hotels, real estate, public administration, and other serivces, the annual average growth rates of 0.387 per cent, 4.66 per cent, 1.13 per cent, 4.66 per cent, 2.28 per cent and 1.98 per cent, respectively, obtained from DGE&T data for the period 1981 to 1989 have been used.

The industry-wise estimate of labour input for three different time points are given in table 3, which shows that the stock of labour input increased by 26.8 per cent from 178.26 million units in 1970-71 to 225.95 million units 1980-81 and went up again by 13.9 per cent to 257.30 million units in 1988-89. It is important to note that in various productivity studies, particularly for the US, the labour unit is expressed in terms of "hours worked". Persons engaged in production (comprising all classes of employees, plus proprietors, self-employed, and unpaid family workers) are multiplied by average hours worked per year by industry.[19] Our labour input data covers the number of people employed in a particular industry during the year. That too, by definition, labour units employed for more than 183 days during the year are considered fully employed.

Had the pattern of employment been uniform across industries, one could have made the simplifying assumption that hours worked is proportional to labour employed but there are considerable variations of employment intensity across industries. Sectoral labour quantity remains unchanged if all components of hours worked within a sector are growing at the same rate. Sectoral quality rises if components with higher flow of labour input per hour worked are growing more rapidly and falls if components with lower flows per hour worked are growing more rapidly.[20] No attempt has been made in our labour input data to adjust for changes in quality. Thus, compared to the quality of data on value added and capital stock, the labour data is not very firm.

19 Kendrick (1973), p. 29.

20 See Gollop and Jorgenson (1980) p. 53.

IV

An analysis of the growth rate of net value added (NDP), labour and capital is the first step towards the estimation of TFP growth. The long term trend growth rate of the economy was so stubbornly stuck at 3.5 per cent per annum that it has gained the notoriety of being labelled the "Hindu rate of growth". However, with a sustained high growth rate during the 1980s the economy seems to have moved onto a high growth trajectory.[21] In order to distinguish between two distinct phases of growth process we have divided our data for the period 1970-71 to 1988-89 into two sub periods: the seventies (1970-71 to 1979-80) and the eighties (1980-81 to 1988-89), the later period coinciding with the high growth phase.

The exponential growth rate has been calcualted by fitting a semilog equation of the form,

$$Y = e^{\beta 1 + \beta 2^x + \varepsilon}$$

Which is estimated as,

$$\ln Y = \beta_1 + \beta_2^x + \varepsilon$$

If x is "time", t, then

$$\frac{\partial \ln Y}{\partial t} = \beta_2$$

= average growth of Y.

Table 4 gives the exponential growth of NDP orginating in different sectors. The growth of aggregate NDP jumped from 3.2 per cent per annum during the seventies to 4.9 per cent during the eighties which pushed up the growth rate for the whole period 1970-71 to 1988-89. All the industries during both the periods showed positive growth rates except "forestry and logging". There was an across the board improvement in grwoth rates during the later period with the improvement in the growth rate of agriculture from 1.8 per cent to 2.8 percent, registered manufacturing from 5.0 per cent to 8.0 per cent in the commodity producing sector; "banking and insurance" from 7.5 per cent to 11.6 per cent, "public administration" from 4.7 per cent to 7.5 per cent in the services sector, being particularly noticeable.

21 For a detailed discussion see Mohanty (1990) and Nagaraj (1990).

The industry-wise growth rate of real capital stock (at 1980-81 prices) is presented in table 5. It can be seen that the growth rate of aggregate capital stock actually increased from 4.0 per cent during the seventies to 4.8 per cent during the eighties, a phenomenon not very apparent from the stagnating rate of domestic saving during the eighties. The upward thrust to capital stock has emanated from persistent current account deficit on the external payments accounts which complemented (substituted) domestic saving.[22] To quote from an earlier study, "Contrary to popular belief that the growth of the economy in recent period has been fuelled mainly by increasing consumption demand, we find that the rate of net domestic investment has increased ..... the 1980s has seen an increasing dependence of the economy on external sources of funds and slowly we are drifting into the painful situation of the 1960s when bulk of our investment was financed by foreign borrowings."[23]

However, the growth differential between NDP and capital stock has considerably narrowed down. In fact the growth rates are about the same (4.9 per cent) during the eighties as against a growth rate of 3.2 percent for NDP and 4.0 per cent for capital stock during the seventies. This would imply, other things being equal, that the capital stock has become more productive during the eighties. Interestingly, a disaggregated picture shows an inverse relationship between NDP growth and growth in capital stock in the commodity producing sector as one moves from the seventies to the eighties. Between the periods, the rate of growth of capital stock in agriculture fell from 2.7 per cent to 2.1 per cent and in registered manufacturing it declined from 6.2 per cent to 5.7 per cent; simialr trends can also be noticed for unregistered maufacturing. The direction of change, however, has been consistent for the services sector, with the banking sector showing the largest growth in capital intensity during the 1980s.

The exponential growth trends for the labour units are presented in table 6, which shows a drop in growth rate from 2.4 per cent during the seventies to 1.6 per cent during the eighties. At a disaggregated level the direction of change is in conformity with that of the capital stock. However, the fall in the rate of growth of labour units in agriculture[24] from 1.9 per cent in the seventies to 0.9 per cent in the

22 This phenomenon culminated in a balance of payments crisis during fiscal 1991-92 triggering off a major devaluation of the rupee and subsequent structural reforms. See Economic Survey, 1991-92, Part I, Government of India.

23 See Mohanty (1990),

24 The importance of agricultural labour force in total employment structure can be guaged from the fact that it accounted for 71.6 per cent of total labour units in 1970-71, 68.3 per cent in 1980-81 and our estimate show it to be 64.4 per cent in 1988-89.

eighties and that in registered manufacturing from 1.2 per cent to 0.39 per cent has been quite substantial.

Despite this fall, the NDP originating in both these sectors showed a marked improvement in growth rates during the eighties, paradoxically suggesting a negative relationship between output and employment growth. This could well be true if one subsrcibes to the hypothesis of "surplus labour" in agriculture and "uneconomic" level of employment (overemployment) in the organised manufacturing sector dominated by public sector enterprises.

On the basis of the step up in the growth rate of NDP which was accompanied by a fall in the growth rate of labour units it could be conjectured that TFP growth might have improved during the eighties. Yet, considering the fact that capital stock too has increased more rapidly during the eighties, the nature of improvement in TFP growth could be ambiguous. We address these aspects more formally in the following section.

V

The OLS regression estimates of the Cobb-Douglas model for three periods - 1970-71 to 1979-80 (table 7A), 1980-81 to 1988-89 (table 7B) and 1970-71 to 1988-89 (table 7C) - are presented in table 7. The coefficient estimates are found to be statistically jointly significant at the conventional 5.0 per cent level, except for agriculture, forestry and construction during the earlier period (seventies). The standard errors associated with the coefficient estimates are generally found to be high due to auto correlated disturbances.[25] The standard errors, however, improved as the number of observations increased.[26]

We could not proceed with the direct estimation of the translog function due to presence of multicollinearity since we had only nineteen observations with five variables, three of which were second order terms involving squares or cross products.[27] Further, for most of the industries the coefficients from the Cobb-Douglas function added upto a number greater than one suggesting increasing returns to scale. Using the elasticities from the Cobb-Douglas model we, computed the TFP growth rates by industry which are presented in table 8.

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25 This may be partly because of our manipulation of data, particularly the labour input data, which were generated by linear interpolation of point estimates.

26 For example the estimates for 1970-71 to 1988-89.

27 An indirect method of parameter estimation by Koltz et. al. (1980, p. 255) suggests that assuming profit maximisation behaviour and competitive markets the marginal productivity function could be set equal to their respective factor prices.

The estimates indicate that there has been no contribution of TFP growth to the growth of the economy during the period 1970-71 to 1988-89. This pattern has been consistent across industries and there has not been any perceptible variation over time. Though the number of industries showing negative TFP growth declined from seven during the seventies to five during the eighties, their magnititude has been too small to give rise to any strong conclusions. Our estimate of TFP growth rate of .009 per cent per annum for the manufacturing sector falls somewhere between Goldar's estiamte of 0.3 per cent per annum for the period 1960-70 and Ahluwalia's estimate of -0.6 per cent per annum for the period 1959-79. Although a recent study of organised manufacturing sector by Ahluwalia (1991, pp. 153-161), following the search procedure with the help of a series of multiplicative dummy variables on time, finds a statistical evidence of an upward shift in total productivity growth after the year 1982-83, the time series data for the period 1959-60 to 1985-86 based on Cobb-Douglas production function, nevertheless, yielded a negligible and statistically insignificant growth in total factor productivity. Since similar estimates for other industries are not available we are not able to compare our results.

The output, input, and productivity indexes are not "precision tools" but they do indicate the general order of magnitude of change, given the theoretical and conceptual framework within which they have been constructed and in terms of which they must be interpreted (Kendrick, 1973). Our labour input data tend to be on the higher side since we have uniformly added up labour units working for varying durations during a year. This would normally tend to depress the TFP growth rates. At the same time, the capital stock figures are likely to be under estimates because the oddity of the Perpetual Inventory Method (PIM) is that capital assets which have outlived their economic life and which should have been discarded on the basis of their life table tend to be operational, producing incremental output. This would impart an upward bias to TFP growth rates. To what extent these opposing effects cancel out, however, is difficult to fathom.

Further, for an economy characterised by "economic dualism". There are wide intra industry varaitions in technology and productivity. For example, within the manufacturing sector, at the disaggregated two-digit industry level, both Goldar's and Ahluwalia's estimates showed wide vairations.[28] As such, our highly aggregative model tends to subsume wide variations of opposing directions.

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28 See table 1 (Goldar, 1986, p. 146).

The neoclassical formulation (of growth) has progressed from treating technological advances as an unexplained residual, to consideration of technological advances as a result of accumulating R&D capital stock. In turn R&D investment by firms has been treated as subject to the same profit maximising calculation as other investments (Nelson, 1981, p. 1046). Though there has been substantial investment in R&D over the years, the nature of technological development did not take into account the resource endowment of the economy (Mohanty, 1992). With an emphasis on institutional R&D though India could achieve technological diversity, the underlying profit maximising calculation was missing. Without competitive market conditions, the inducements to commercialisation of technology was lacking. Hence, the R&D capital stock failed to secure technological excellence so vital for productivity growth.

In conclusion it can be said that the accelerated economic growth of the 1980s has not been accompanied by any improvement in TFP growth. The slow growth of employment in agriculture and industry, in a way, may indicate that the economy undergoing the process of readjustment of its factor endowments is yet to translate it into any appreciable productivity gains.

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Table 1 : Net Domestic Product by Industry of Origin

(Rs. Crores)

Industry/Year	1970-71	1980-81	1988-89
1. Agriculture	34,545	40,056	54,477
2. Forestry & logging	3,547	3,229	3,026
3. Fishing	619	806	1,138
4. Mining & quarrying	1,027	1,474	2,077
5. Manufacturing (Registered)	6,946	10,050	19,466
6. Manufacturing (Unregistered)	5,817	8,648	13,540
7. Electricity, gas & water supply	567	912	1,838
8. Construction	4,271	5,771	7,509
9. Trade, hotels & restaurants	9,556	14,322	23,248
10. Transport, storage & communication	1,946	3,724	6,545
11. Banking & insurance	1,783	3,344	8,366
12. Real estate & business services	4,313	5,920	8,047
13. Public administration & defence	3,179	5,370	9,392
14. Others	5,056	6,777	9,713
Total	83,172	110,340	168,382

Note : One Crore = 10 Million

Table 2 : Net Domestic Capital Stock by Industry of use

(Rs. Crores)

Industry/Year	1970-71	1980-81	1988-89
1. Agriculture	49,539	66,563	78,857
2. Forestry & logging	728	923	1,559
3. Fishing	433	558	936
4. Mining & quarrying	3,108	6,921	19,263
5. Manufacturing (Registered)	27,268	51,248	82,465
6. Manufacturing (Unregistered)	6,765	16,612	27,299
7. Electricity, gas & water supply	14,341	25,672	49,282
8. Construction	1,828	3,300	6,084
9. Trade, hotels & restaurants	5,719	20,144	42,058
10. Transport, storage & communication	21,485	28,714	40,632
11. Banking & insurance	800	1,254	4,259
12. Real estate & business services	68,291	77,955	91,864
13. Public administration & defence	20,542	31,768	47,146
14. Others	4,844	6,461	9,610
Total	225,691	338,093	501,314

Table 3 : Labour Units by Industry

(in thousands)

Industry/Year	1970-71	1980-81	1988-89
1. Agriculture	127,569	154,307	166,102
2. Forestry & logging	147	232	250
3. Fishing	583	958	1,031
4. Mining & quarrying	915	1,446	2,306
5. Manufacturing (Registered)	5,045	5,672	5,850
6. Manufacturing (Unregistered)	11,789	19,350	24,370
7. Electricity, gas & water supply	514	1,017	1,486
8. Construction	2,444	4,172	9,321
9. Trade, hotels & restaurants	8,941	12,584	13,768
10. Transport, storage & communication	4,306	6,181	8,797
11. Banking & insurance	539	1,067	1,536
12. Real estate & business services	294	491	707
13. Public administration & defence	4,874	5,854	7,011
14. Others	10,301	12,621	14,764
Total	178,251	225,952	257,298

Table 4 : Growth Rates of Net Domestic Product by Industry of Origin

(Per cent per annum)

Industry/Period	1970-71 to 1979-80	1980-81 to 1988-89	1970-71 to 1988-89
1. Agriculture	1.8	2.8	2.6
2. Forestry & logging	-0.6	-1.3	-1.4
3. Fishing	2.8	4.8	3.2
4. Mining & quarrying	3.2	3.2	3.9
5. Manufacturing (Registered)	5	8.1	5.9
6. Manufacturing (Unregistered)	4.5	5.4	4.4
7. Electricity, gas & water supply	6	8.5	6.1
8. Construction	3.1	3.3	3.4
9. Trade, hotels & restaurants	4.7	5.8	5
10. Transport, storage & communication	7	7.2	6.7
11. Banking & insurance	7.5	11.6	8.3
12. Real estate & business services	3.2	3.9	3.4
13. Public administration & defence	4.7	7.5	5.9
14. Others	2.8	4.3	3.6
Total	3.2	4.9	3.9

Table 5 : Growth Rates of Net Domestic Capital Stock by Industry of Origin

(per cent per annum)

Industry/Period	1970-71 to 1979-80	1980-81 to 1988-89	1970-71 to 1988-89
1. Agriculture	2.7	2.1	2.7
2. Forestry & logging	1.9	6.7	4.6
3. Fishing	2.2	6.7	4.2
4. Mining & quarrying	8.2	12.9	11.2
5. Manufacturing (Registered)	6.2	5.7	6.2
6. Manufacturing (Unregistered)	9.4	6	7.6
7. Electricity, gas & water supply	5.5	8.1	6.8
8. Construction	5.1	6.6	7.7
9. Trade, hotels & restaurants	13.6	8.6	11.6
10. Transport, storage & communication	3.2	4.4	3.4
11. Banking & insurance	4.5	14.8	8.3
12. Real estate & business services	1.3	2	1.7
13. Public administration & defence	4.6	5	4.6
14. Others	2.7	4.9	3.8
Total	4	4.8	4.5

Table 6 : Growth Rates of Labour Units by Industry

(per cent per annum)

Industry/Period	1970-71 to 1979-80	1980-81 to 1988-89	1970-71 to 1988-89
1. Agriculture	1.9	0.9	1.5
2. Forestry & logging	4.6	0.9	3
3. Fishing	5	0.9	3.3
4. Mining & quarrying	4.6	5.8	5.1
5. Manufacturing (Registered)	1.2	0.4	0.8
6. Manufacturing (Unregistered)	5	2.9	4
7. Electricity, gas & water supply	6.8	4.7	5.9
8. Construction	5.2	10	7.4
9. Trade, hotels & restaurants	3.4	1.1	2.5
10. Transport, storage & communication	3.6	4.4	3.9
11. Banking & insurance	6.8	4.5	5.9
12. Real estate & business services	5.1	4.5	4.9
13. Public administration & defence	1.8	2.3	2
14. Others	2	2	2
Total	2.4	1.6	2

Table 7A : Output Elasticities by Industry (1970-71 to 1979-80)

Industry	Capital (Ke)	Labour (Le)	R-Square F-Values
1. Agriculture	-5.578	8.837	0.336
	(5.284)	(7.508)	3.278
2. Forestry & logging	-2.188	0.758	0.307
	(1.497)	(.627)	1.55
3. Fishing	-0.706	0.874	0.92
	(.250)	(.130)	40.48
4. Mining & quarrying	-0.266	1.179	0.93
	(.136)	(.255)	49.76
5. Manufacturing	1.247	-2.352	0.92
(Registered)	(.955)	(5.063)	42.34
6. Manufacturing	-0.315	1.507	0.96
(Unregistered)	(.359)	(.682)	87.5
7. Electricity, gas & water supply	-4.314	4.372	0.96
	(1.143)	(.927)	90.5
8. Construction	0.294	0.272	0.56
	(.787)	(.804)	4.5
9. Trade, hotels & restaurants	0.457	-0.432	0.96
	(.255)	(1.022)	89.6
10. Transport, storage & communication	2.512	-0.265	0.99
	(.978)	(.855)	390.7
11. Banking & insurance	-2.861	2.981	0.88
	(2.865)	(1.89)	27.5
12. Real estate & business services	-0.483	0.734	0.99
	(.33)	(.082)	5018.2
13. Public administration & defence	-0.545	3.907	0.99
	(.201)	(.505)	711.6
14. Others	0.618	0.54	0.97
	(.580)	(.776)	153.6
Total	6.842	-10.152	0.94
	(2.485)	(4.183)	62.9

Note : Standard Errors are in parentheses.

Table 7B : Output Elasticities by Industry (1980-81 to 1988-89)

Industry	Capital (Ke)	Labour (Le)	R-Square F-Values
1. Agriculture	0.65	1.558	0.742
	(2.801)	(6.364)	8.65
2. Forestry & logging	-0.041	-1.05	0.81
	(.234)	(1.713)	12.5
3. Fishihg	-1.118	13.37	0.86
	(.817)	(5.98)	19.1
4. Mining & quarrying	-0.045	0.648	0.74
	(.361)	(.811)	8.84
5. Manufacturing	2.08	-9.819	0.98
(Registered)	(1.227)	(18.14)	146.9
6. Manufacturing	0.464	0.891	0.96
(Unregistered)	(1.48)	(3.09)	84.2
7. Electricity, gas & water supply	-2.01	5.2	0.98
	(1.57)	(2.67)	151.9
8. Construction	-0.241	0.489	0.95
	(.112)	(.08)	65.4
9. Trade, hotels & restaurants	0.051	4.814	0.99
	(.118)	(0.912)	560.8
10. Transport, storage & communication	2.533	-0.86	0.99
	(1.07)	(1.05)	522.6
11. Banking & insurance	0.176	1.96	0.99
	(.099)	(.32)	133.7
12. Real estat ervices	-2.393	1.927	0.99
	(.671)	(.299)	78.90
13. Pub defence	-2.281	8.373	0.98
	(1.616)	(3.568)	279.6
14. Cl.	0.167	1.793	0.99
	(.585)	(1.46)	806.6
Total	0.088	2.736	0.98
	(.982)	(2.91)	178.1

Note : Standard Errors are in parentheses.

Table 7C : Output Elasticities by Industry (1970-71 to 1988-89)

Industry	Capital (Ke)	Labour (Le)	R-Square F-Values
1. Agriculture	1.799	-1.562	0.86
	(.744)	(1.35)	49.3
2. Forestry & logging	-0.246	-0.103	0.78
	(.076)	(.116)	28.8
3. Fishing	0.534	0.274	0.88
	(.119)	(.153)	63.8
4. Mining & quarrying	-0.058	0.892	0.95
	(.157)	(.352)	162.1
5. Manufacturing	1.598	-4.729	0.98
(Registered)	(.149)	(1.07)	468.1
6. Manufacturing	0.567	0.005	0.95
(Unregistered)	(.499)	(.923)	182.9
7. Electricity, gas & water supply	0.765	0.134	0.95
	(.255)	(.294)	182.9
8. Construction	0.161	0.288	0.9
	(.166)	(.177)	73.3
9. Trade, hotels & restaurants	0.836	-1.948	0.98
	(.101)	(.474)	478.9
10. Transport, storage & communication	0.69	1.086	0.99
	(.61)	(.531)	1255.8
11. Banking & insurance	0.528	0.672	0.97
	(0.089)	(.132)	376.1
12. Real estate & business services	1.104	0.325	0.99
	(.122)	(.042)	6589.8
13. Public administration & defence	-1.112	5.474	0.99
	(.358)	(.817)	1620.6
14. Others	0.721	0.419	0.99
	(.077)	(.149)	3038.1
Total	1.208	-0.758	0.99
	(.189)	(.418)	544.4

Note : Standard Errors are in parenthe

Table 8 : Total Factor Production (TFP) Growth Rates by Industry

(per cent per annum)

Industry	1970-71 to 1979-80	1980-81 to 1988-89	1970-71 to 1988-89
1. Agriculture	0.003	0.002	0.024
2. Forestry & logging	0.0001	-0.02	0.013
3. Fishing	-0.0001	0.0042	0.062
4. Mining & quarrying	0.0015	0.0004	0.012
5. Manufacturing (Registered)	-0.003	-0.0065	0.0092
6. Manufacturing (Unregistered)	-0.0006	0.0003	0.085
7. Electricity, gas & water supply	0.0008	-0.0003	0.018
8. Construction	0.18	0.0003	0.075
9. Trade, hotels & restaurants	0.0008	0.0007	0.049
10. Transport, storage & communication	-0.0002	0.0015	0.019
11. Banking & insurance	-0.003	0.001	0.004
12. Real estate & business services	0.006	0.0005	0.0004
13. Public administration & defence	0.002	0.0026	-0.009
14. Others	-0.001	-0.0007	0.0036
Total	-0.0035	-0.0039	-0.0001

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The Structure of India's Imports : 1970-71 to 1988-89

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Substantial import liberalisation has taken place in recent years, mainly under the influence of a shift in the stance of policy from import substitution *per se* to *efficient* import substitution and export fortification. This requires adoption not merely of export promotion strategies but also of careful import management. An essential prerequisite to such an exercise is securing a proper understanding of the structure and behaviour of India's imports, disaggregated by commodity. This paper presents estimates of import demand functions for various categories of imports. Certain attendant methodological issues such as the choice of functional form and the errors of aggregation are also addressed. The empirical exercise is for 19 years, from 1970-71 to 1988-89. The results indicate significant differences in the principal elasticities (income and price) obtained from disaggregation and those estimated directly. The paper shows that there has been an inter temporal decline in income elasticity and some improvement in price elasticity of aggregate imports over time. Results of disaggregation of imports show that specific policy action could be taken to influence import behaviour over the medium term.

Substantial liberalisation has been effected in commercial policy in India in recent years to provide for an augmented access to imports, particularly with a view to fortifying the quality of export production and maximising net foreign exchange earnings. This is essentially a reflection of the change in the stance of policy from that of rigid import substitution to one of efficient import substitution. While the overriding priority would continue to be attached to export promotion in keeping with the evolving degree of openness of the economy and consistent with the achievement of comparative advantage, the importance of careful import planning needs to be emphasised, especially to ensure a viable balance of payments over the medium term. The content of import management policies would essentially be determined by a proper understanding of the structure and behaviour of imports. The main purpose of the paper

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is to promote such an understanding. The paper estimates import demand functions for various categories of imports in order to determine responsiveness of each individual import group as well as total imports to macro-economic fundamentals. As part of this exercise, certain methodological issues are addressed. They relate to the choice of the appropriate functional form for estimation of import elasticities, the choice of variables and the errors of aggregation which, as Barker (1970) pointed out, estimates of import elasticities derived from total import functions would be subject to. A systematic analysis of the behaviour of various categories of imports would help to identify the sources of import growth and provide a firm basis for formulation and evaluation of policy measures in respect of imports.

The paper is organised on the following lines : Section I presents a review of certain salient contributions to the literature on the estimation of elasticities of India's imports. Section II deals with the period of study, the choice of variables and the sources of data. Section III sets out the methodology adopted in this study, and as stated earlier, addressed related issues. In Section IV, the results obtained are presented. In the concluding Section certain objective inferences are drawn from the analysis of the results obtained which address the overall policy question of efficient import management.

Section I : Review of Literature

In this section, a review of select studies, their methodological framework and the prevailing attitude as regards the structural determinants of import behaviour is presented. A major criterion in the selection of studies is the estimation of disaggregated import functions. The underlying objective is therefore to present a continuum wherein empirical analysis has been evolving over time.

Murti and Sastri (1951) present empirical exercises on the pre-Independence period (1927-28 to 1937-38). Characteristic of studies undertaken for this period, the methodology was nascent and data availability was a major constraint necessitating drastic approximations. Aggregate imports were found to be elastic with respect to domestic industrial production (used in the absence of national income estimates) and inelastic with respect to import price. Disaggregate import functions were estimated in respect of cotton piece goods, raw cotton, vehicles, chemicals, hardware, tobacco and dyes and machinery. Demand for imports of vehicles, chemicals, hardware and tobacco was found to be price-elastic, both in the short and long run, while income elasticity of demand for

import was found to be low for all the commodities, directly vitiating the results obtained from the aggregate import function, perhaps pointing to errors of aggregation. The multiple correlation coefficient is the only statistic offered as a measure of the explanatory power of the equations. Moreover, the use of the time trend is open to question since by the authors' own admission, "it cannot explain anything about demand". This becomes evident in the case of cotton piece goods, where the introduction of the trend term alters price and income elasticities significantly.

Dutta (1964) estimated import demand functions as part of his prototype model of India's foreign sector during the early post-Independence period (1951-60). In keeping with his model, Dutta used private merchandise imports as reported in the balance of payments and expressed at constant prices. However, his preference for industrial production over national income as the activity variable is disputable. The demand for imports irrespective of the type of goods imported stems from almost every sector of the economy, directly or indirectly. The elasticity of imports with respect to the relative price variable was found to be insignificant and therefore was not reported. These results were found to hold also for disaggregate import functions estimated in respect of raw cotton, iron and steel, chemicals and machinery. Dutta adopted the linear form of estimation and also used a time trend term. Hence the reservations expressed about the usefulness of the study of Murti and Sastri apply here too. Broadly, however, Dutta's results are comparable to conventional wisdom that imports are more or less determined by overall economic activity and are insensitive to price movements.

Jayaraman (1976) recognised the need to eliminate the bias arising out of amalgamating commodities with high and low elasticities as in a typical aggregate import function. He provided estimates of import demand functions for disaggregated imports categorised into sections according to the Standard International Trade Classification (SITC) of the UN for the period 1961-72. His methodology conformed to the standard formulation of the import demand function. He preferred the double log functional form in view of its obvious merit in circumventing the difference in base years of the various indices used and the property of direct estimates of elasticity. Net foreign exchange assets at constant prices were used as a proxy for import control. A dummy was employed to capture the structural break effected by the devaluation of 1966. A time trend was also used presumably to obtain good results in a statistical sense. Only imports of food and live animals had both high price and income elasticity. Imports of machinery and transport equipment showed an elastic response to variations in income. Overall imports were found

to be both price and income inelastic with the coefficient of income elasticity being insignificant. These findings are at odds with the general understanding as regards import behaviour and are not easily explained. Net foreign exchange assets was found to have relatively low explanatory power.

Kannan (1985) attempted to quantity factors influencing the demand for imports as part of his model on India's foreign sector for the period 1956-57 to 1979-80 broken into two sub-periods 1956-57 to 1965-66 and 1966-67 to 1979-80. Import functions were estimated in respect of five categories of imports, i.e., foodgrains, raw materials, capital goods, mineral fuels, and others (beverages and tobacco, chemicals and miscellaneous manufactures) all in linear form. The explanatory power of the estimated functions declined in the second period suggesting perhaps the need for a different functional form in this period. The positive association between domestic foodgrains prices and import thereof cannot be explained in the absence of knowledge regarding the behaviour of import prices. As regards imports of raw materials, the significant influence of non-agricultural income conforms to *a priori* reasoning as also low and insignificant price elasticities. However, a relative price variable is used only in the second period. Gross domestic capital formation at constant prices is found to have a significant influence of capital goods. A point meriting consideration is that gross domestic capital formation would include imports of capital goods.

All the studies reviewed here do not address the issue of errors arising out of estimating the aggregate import function without taking into account the differential response of individual categories of imports to macro-economic determinants. They either limited themselves to estimating disaggregate import functions or estimated the aggregate import function without reference to the results of disaggregation. Nevetheless, the results of these studies have a crucial bearing on the theme of this paper.

Section II : Period of Study, Choice of Variables and Sources of Data

The period chosen for study is one of nineteen years from 1970-71 to 1988-89. The choice of the period, apart from being governed by the purpose of providing more recent estimates of import elasticities, was determined by the clear change introduced into overall economic policy on the eve of the 'Seventies. In the years preceding the 'Seventies, the Plan strategies placed emphasis on import-substitution. By the end of the 'Sixties, several weaknesses of the import-replacing path of indus-

trialisation became evident. Creation of capacity in various sectors of the economy led to the manifestation of sluggish tendencies and deceleration in outputs of various industries by the mid-'Sixties. These units continued to survive under protection and in the absence of cost-reducing tendencies, together resulted increasingly in a high-cost economy. In retrospect, it is clear that the policy makers not only underestimated the export possibilities but also the import-intensity of the import-substitution process itself.[1]

In the later half of the 'Sixties a distinct change set in. Import-substitution and export expansion became concomitant in the process of industrialisation. The correction of the overvaluation of the rupee in 1966 brought in its wake several measures of decontrol and liberalisation. Several incentives - fiscal and others - were put in place to directly promote exports.

Thus, while in the 'Fifties and the 'Sixties import behaviour was largely determined by the stance of import substitution, in the 'Seventies, the dependence on imports was influenced greatly by the goal of reaping efficiency gains in the domestic economy, particularly in the export sector, through liberal access to imported inputs. Furthermore, during the 'Seventies, issues relating to import management assumed crucial importance as the external sector was subjected to several shocks, the full effects of which spilled over to the 'Eighties. Indeed, going by the relatively large dependence on imports, it is debatable whether the adjustment to these shocks is as yet complete. Moreover, whereas the primary impact on the terms of trade came from the escalations in crude oil prices, the secondary effects were in terms of non-oil commodity price increases which more than counterbalanced the rise in export unit values. During the 'Eighties, therefore, while the outgo on account of petroleum, oil and lubricants (POL) remained sizeable, although it declined as a proportion to total imports compared to the period of the second oil shock, it is the heterogenous category of non-oil imports which became a cause for policy concern. The category of non-oil bulk imports and export-related imports have come to assume a non-compressible character, given the needs of the developmental process and of supply management and the gathering momentum of trade liberalisation.

The categories of imports chosen for the purpose of this study were again decided by the availability of disaggregated indices. These categories taken together account for 80 to 90 per cent of total imports, on an average. For each category, imports in real terms, i.e., quantum indices were considered. Given the character of the dependence on imports,

explanatory variables were chosen so as to identify demand effects only. There is always a trade-off between analytical niceties and feasible computation. So, for each category of imports, a specification of demand function was attempted involving explanatory variables which lend themselves to macro-economic treatment. Thus, Gross Domestic Product (GDP) at factor cost was selected as a measure of real activity in the economy.[2] The real activity variable isolated that portion of demand for imports which is induced by domestic activity. Price effects were sought to be captured by a relative price variable given by a ratio of import prices to domestic prices. Import prices were proxied by unit value indices disaggregated by commodity, while domestic prices were represented by commodity-wise wholesale price indices. The price variable, at once, reflects domestic demand responses to exogenous developments as well as the degree of substitutability between domestic production and imports. In a broad sense, just as the activity variable represents internal influences, the price variable reflects the gamut of external factors that account for variations in import demand. As the process of import-substitution led to a step-up in indigenous availability of various importables, domestic production was added as an explanatory variable in some cases as proxy for capacity utilisation. In such cases, the problem of multicollinearity cannot be ruled out. Thus the income and price variables identify pure demand effects and the capacity utilisation variable identifies any excess demand effects.[3]

For a capital-deficient developing economy, inadequate availability of foreign exchange operates as a constraint on import purchasing power. In times of resource crunch, imports are subjected to a measure of prioritisation and the available foreign exchange is rationed in the case of essential imports. The volume of foreign exchange reserves exclusive of gold holdings (i.e., foreign currency assets of the RBI and Special Drawing Rights (SDRs) holdings of the Government of India with a one-period lag, deflated by current import prices) was employed as the policy control variable.

Other than these explanatory vairables, a dummy variables has been used as a proxy for import liberalisation since 1978-79, the value of which was taken as zero for the years prior to it and one for the rest of the period since 1978-79. Furthermore, lagged import quantities entered into the equations to capture the speed of adjustment of actual imports to desired levels.

Quantum and unit value indices of imports are available from the Directorate General of Commercial Intelligence and Statistics (DGCI&S)

and are taken from various issues of the Report on Currency and Finance of the RBI. Data on GDP at factor cost are taken from National Accounts Statistics, published by the Central Statistical Organisation. Other data are taken from various issues of Report on Currency and Finance and the Economic Survey (All the data series were converted into a common base with 1978-79 = 100 using linking factors.)

Section III : Methodology

The basic import demand function of the individual commodities and total imports is specified as :

$$QM = f(GDPFC, PM, PD, DP, FAP) \quad \ldots (1)$$

Where, QM = Quantum of Imports,
GDPFC = Gross Domestic Product at Factor Cost
PM = Unit Value of Imports
PD = Domestic Wholesale Price
DP = Domestic Production
FAP = Real Foreign Assets

The trade literature offers no consensus on the choice of the functional form of the import demand function. Earlier empirical exercises typically employed a linear or a double log functional form for estimation of import functions. The use of one form or the other has implications that are either highly restrictive or inconsistent with theoretical considerations or actual experience.[4] A double log functional form assumes that elasticities of import demand are constant at any level of income and price which avoids the problem of drastic falls in the elasticity as imports rise. However, if the variations in income and price are relatively large, such as assumption would be unduly restrictive. Nevertheless, the double log functional form has been widely used as it allows imports to react in proportion to a rise and fall in the explanatory variables and in view of its attractive computational properties, i.e., it is independent of differences in base periods and that it yields direct estimates of the relevant elasticities.[5] For the purpose of this paper, the import demand function specified at (1) was estimated in both the linear and double log forms and the estimates obtained from the functional form with the better fit in the statistical sense are presented in the following section. The equations were estimated by means of ordinary least squares.

There is usually a time-lag involved in the adjustment of actual imports to desired levels due *inter alia* to inventory drawdown, transportation costs and transportation time. In order to allow for the adjustment

of actual imports to import demand over time, a partial adjustment process of the Nerlovian type was specified in some cases. If (1) is specified in a double log form, then change in imports in period t would imply the difference between the demand for imports in that period and the actual imports in the preceding period as given below.

$\Delta \log QMt = \lambda (\log QM_t^d - \log QM_{t-1})$, $0 \leq \lambda \leq 1$, and the superscript d indicating the desired level of imports ..... (2)

In double-log form, (1) can be expressed as

$$\log QM_t = \lambda a_1 + \lambda a_2 \log GDP_t + \lambda a_3 \log \left(\frac{PM}{PD}\right)_t + \lambda a_4 \log DP$$

$$+\lambda a_5 \log FAP + (1 - \lambda) \log QM_{t-1} + \lambda e_t \quad (3)$$

Various studies have shown that estimation of import elasticities with the dependant variable being the sum of all imports leads to serious errors of aggregation.[6] These errors arise as a result of changing shares of particular categories of imports in total imports and the fact that different categories of imports have widely differing income and price elasticities. Even in the short period, fluctuations bring about significant changes in the shares of import categories depending on their responsiveness to income changes. Thus an aggregate import function which implicitly assumes fixed weights for each import categories would either overestimate or underestimate the relevant elasticities.

In order to examine the nature and extent of the bias involved in estimates of elasticities based on aggregate imports only, overall import elasticities were derived as weighted averages of the distribution elasticities estimated in respect of disaggregated imports.[7]

The total relative variation in imports can be written as

$$\frac{dQMi}{QMi} = a_{1i} \frac{dPi}{Pi} + a_{2i} \frac{dY,}{Y} \quad i = 1,2, \ldots\ldots\ldots\ldots n$$

Where Pi = Import price of i^{th} category of imports
Y = Gross Domestic Product at factor cost.

Since $\Sigma QMi = QM$ (total imports), variation in total imports is:

$$\frac{dQM}{QM} = \Sigma a_{1i} \frac{dPi}{Pi} \frac{QMi}{QM} + \frac{dY}{Y} \Sigma a_{2i} \frac{QMi}{QM}$$

The aggregate price elasticity a_1

$$= \frac{\partial QM}{\partial P} \cdot \frac{P}{QM} = \Sigma a_{1i} \left(\frac{QMi}{QM}\right) \cdot \left(\frac{dPi \cdot P}{Pi \cdot dP}\right) \quad \ldots\ldots \qquad (4)$$

a_1 is thus dependent on the share of each category of imports in total imports (QMi/QM) and the distribution elasticities i.e. the variation in the ratio of relative price of individual categories of imports to the relative price of total imports, (dPi/dP) (P/Pi). Thus, the aggregate price elasticity of imports is obtained as the weighted sum of distribution elasticities of various import categories. Distribution elasticities were computed from the following equation:

$$\Delta \log P = b \, \Delta \log Pi + ei \quad \ldots\ldots\ldots\ldots \qquad (5)$$

where Pi is the ratio of import price of each category of imports and its domestic price and P is the ratio of unit value index of total imports to the wholesale price index.

The distribution elasticity is obtained as the inverse of the estimated coefficient "b" in the above equation. The shares of individual import categories in total imports were calculated as 14-year geometric averages (1975-76 to 1988-89). For deriving the aggregate income elasticity, however, individual income elasticities were weighted with the shares only (and not with distribution elasticities). This was done since the distribution elasticity would turn out to be unity as the same income variable (GDP at factor cost) had been employed in each case. Also, the aggregation to arrive at the suggested measure of price and income elasticities was done at the section level in order to avoid double counting.[8]

Section IV - Results

Table 4 presents the estimates of elasticities of import demand for various commodities with respect to the selected explanatory variables. By and large, the double log functional form was found to have a better fit than the linear form except in the case of dyeing, tanning and colouring materials and transport equipment where a linear formulation of the import function yielded better results. The Durbin-Watson/h statistics show the absence of auto correlation in most cases; and the F-statistics testify to the overall stability of the estimated equations (Table 5).

Except in the case of edible oils, fruits and vegetables, iron and steel and paper, paper board and manufactures thereof, all categories

of imports had income elasticities which were significant and positive. Negative income elasticity was obtained in respect of iron and steel, fruits and vegetables and paper, paper board and manufactures; however, it was found to be insignificant. Imports of beverages and tobacco, fruits and vegetables, pulp and waste papers, dyeing, tanning and colouring materials, textile yarn, fabric etc., iron and steel and electrical machinery were found to be significantly price elastic. Except iron and steel, these commodities are also significantly income elastic. Commodities like paper, paper board and manufactures, transport equipment and professional and scientific instruments have inelastic price elasticity. All price elasticies have the expected negative sign.

The policy control variable embodied in real net foreign exchange reserves was found to be significant, though low, mainly at the section levels. However, in the case of edible oils, paper, paper board and manufactures thereof, and capital goods, it was a significant factor in explaining the behaviour of import demand.

The domestic production variables intended to capture excess demand met by import substitution efforts was significant only in respect of beverages and tobacco, petroleum crude and electrical machinery. In the case of electrical machinery, the coefficient of domestic production had a positive sign.

The dummy variable used as a proxy for import liberalisation was found to be significant only in respect of iron and steel, transport equipment and professional and scientific instruments as well as in aggregate imports.

Lagged import quantities entered into the equations to capture the speed of adjustment of actual imports to desired levels were significant only in respect of beverages and tobacco, chemicals and related products and textiles yarns, fabrics, etc.

The overall aggregate price and income elasticity of demand for imports were found to be -0.42 and 1.57 respectively. After correcting for bias involved in estimates based on aggregate imports only, aggregate weighted price[9] and income[10] elasticities of demand for imports calculated on the basis of the method outlined in Section III, turned out to be -0.60 and 1.44 respectively.

Table 1 : Estimates of Distribution Elasticities

Food and food articles	1.0189
Edible oil	0.9785
Crude material, inedibles except fuels	1.2234
Petroleum crude	1.0463
Chemical and related products	1.0226
Manufactured goods	0.9758
Machinery and transport equipment	1.0328
Professional and scientific instruments	1.3090

It can be seen that the aggregate weighted elasticities derived from the results of the disaggregated import equations are different from the aggregate price and income elasticities obtained by estimating an aggregate import equation directly (Table 2).

Table 2 : Comparision between Aggregate and Aggregate Weighted Elasticities

	Aggregate elasticity	Aggregate Weighted elasticity
Price Elasticity	-0.42	-0.60
Income Elasticity	1.57	1.44

The results of this study compare well with some of the earlier studies on import demand functions relating to India (Table 3).

Table 3 : A Comparison of Significant Elasticity Coefficients for Aggregate Imports of India

Study	Period of study	Price elasticity	Income elasticity
Murti and Sastri	1927-37	- 0.38	2.01
Narasimhan	1919-52	--	2.07
Dutta	1951-60	--	2.72
Jayaraman	1961-72	- 0.63	--
Present Study	1970-71 to 1988-89		
Aggregate Elasticity		- 0.42	1.57
Aggregate Weighted Elasticity		- 0.60	1.44

Table 4 : Estimates of Elasticity of Demand for Indian Imports

	Commodity	Income Elasticity	Price Elasticity	Domestic Production Elasticity	Foreign Exchange Assets Elasticity
I.	Food and food articles	2.78	--	-	-1.36
	i) Beverages and tobacco	6.53	-1.43	-4.54	--
	ii) Fruits and vegetables	--	-1.70	--	--
II.	Edible oil	--	--	--	--
III.	Crude materials, inedible except fuels	3.07	-1.03	--	1.48
	i) Crude fertilizer	1.57	--	--	0.29
	ii) Pulp and waste paper	3.80	-2.58	--	--
IV.	Petroleum crude	1.09	--	-0.30	--
V.	Chemical and related products	1.03	--	--	--
	i) Dyeing, tanning and colouring materials	1.85	-1.75	--	--
VI.	Manufactured goods classified chiefly by materials	1.28	-1.10	--	0.29
	i) Textile yarns, fabrics etc.	2.90	-2.22	--	--
	ii) Iron and steel	--	-1.45	--	--
	iii) Paper, paper board and maufactures	--	-0.73	--	0.49
VII.	Machinery and transport equipment	2.10	-1.03	--	--
	i) Electrical machinery	1.57	-1.27	0.96	-0.35
	ii) Transport equipment	1.78	-0.61	--	0.56
VIII.	Professional and scientific instruments	2.74	-0.60	--	0.27
	Aggregate imports	1.57	-0.42	--	--

Note: Only significant elasticities are reported.

Our results attest to the inter temporal decline in income elasticity of import demand which follows the theoretical expectations. As incomes rise in developing economies, efficiency gains reaped from the import substitution process would ensure a stable relationship between income and imports, with lesser and lesser proportions of the increment in the former being spent on the latter. The aggregate (weighted) price elasticity obtained by us from the results of disaggregation is comparable to that obtained by Jayaraman (ibid). The size of the coefficient of price elasticity dispels the conventional pessimism attached to the efficacy of price related policy measures in influencing import behaviour.

Section V : Conclusion

Knowledge of the structural determinants of import demand is essential for determining the content of import management policies. It is important to recognise that the heterogenous character of India's import need clearly suggests a disaggregate approach; otherwise, policies in this regard would carry errors of aggregation. The results of this study indicate significant differences in the principal elasticities obtained from the results of disaggregation and those estimated directly. In conjunction with earlier studies the results obtained here also provide evidence to the inter temporal decline in income elasticity and some, albeit marginal, improvement in price elasticity of imports over time, warranting critical evaluation of the conventional acceptance of the compulsory character of imports and their inflexibility with relation to price policies.

Domestic economic activity embodied in the income variable emerges as the basic determinant of demand for almost all categories of imports, notable exceptions being edible oil, paper, paper board and manufactures and iron and steel. The income linked character of the bulk of India's imports stems from the fact that imports consists largely of raw materials and intermediates which enter production processes at various stages, and of items for direct consumption. The import planner is thus confronted with a trade-off between import regulation and the needs of growth.

However, for various import categories such as beverages and tobacco, pulp and waste paper, dyeing, tanning and colouring materials, textile yarns, fabrics, etc., electrical machinery, transport equipment, professional and scientific instruments, high income elasticities are accompanied by high price elasticities. In influencing import demand, commercial policy measures operating through the price mechanism i.e., tariffs, tariff related measures such as margin requirements, surcharges, etc., and exchange

rates would be effective only when adopted in conjunction with the gamut of monetary and fiscal measures that address overall absorption. In a restrictive phase, for instance, the role of the tariff would lie in mopping up any spillover of aggregate demand into the external sector. The accompanying income elasticities for these import groups, however, place thresholds on the effective level of tariff rates. The structure of customs duties must therefore take into account differential responses of import groups to price signals ranging from the relatively low elasticity of transport equipment to iron and steel where price is the dominant variable affecting import demand.

By the same logic tariffs applied to commodities which exhibit little or no response to price behaviour would at best be neutral in their effects in terms of import regulation, and must be viewed as revenue raising measures only. This is true of food and food articles except beverages and tobacco and fruits and vegetables, crude fertiliser and crude petroleum. In the case of the latter two items, however, import prices are not directly translated into consumer prices, which are administered due to other considerations.

Two import groups, namely, crude petroleum and electrical machinery present contrasting responses to the domestic production variables. In the case of the former the low but significant coefficient of domestic production suggests room for manoeuvre. Development of alternative sources of energy, and inter fuel substitution, conservation and efficient utilisation are all measures which would strengthen domestic production and reduce the dependence on imports. Undoubtedly, such efforts would materialise only over a period of time. In the case of electrical machinery, however, the positive sign of the domestic production coefficient clearly points to the repetitive character of imports. Given the low level of investment in research and development towards product innovation, the attitude has been one of import and adapt. As a result, by the time indigenisation is complete, technology has moved ahead overseas, necessitating import merely in order to keep pace.

In the case of items such as edible oils, paper, paper board, etc., the variable foreign exchange availability has the overriding influence, suggesting rationing as the effective policy option. However, the case for physical control must be viewed with caution as these tend to grow inefficient over time and operate much in the same manner as structural bottlenecks.

Table 5 : Summary Table Showing Elasticities of Demand for Indian Imports, 1970-71 - 1988-89

	Commodity	Constant	GDPFC	RP	FAP	DP	DUM	QM(-1)	$\bar{R}^2$	DW/h@@ satatistics	F-statistics
	1	2	3	4	5	6	7	8	9	10	11
	Aggregate Imports	-0.25	1.57*	-0.42*	-0.05	--	0.11**	--	0.95	1.93	69.85
		(0.52)	(7.02)	(3.92)	(0.63)		(2.33)				
I.	Food and food articles	-1.84	2.78***	-0.37	-1.36*	--	--	--	0.74	2.5	11.24
		(1.16)	(1.91)	(1.01)	(5.99)						
	i) Beverages and tobacco	2.1	6.53*	-1.43**	--	-4.54**	--	0.48***	0.63	13.07	7.33
		(2.0)	(4.45)	(2.51)		(2.74)		(2.10)			
	ii) Fruits and vegetables	4.60**	-1.72	-1.70*	--	1.67	--	0.36	0.82	1.81	18.12
		(2.66)	(1.44)	(4.25)		(1.50)		(1.79)			
II.	Edible oil	-0.96	0.01	0.06	1.48*	--	--	--	0.86	1.92	30.48
		(0.33)	(.01)	(0.11)	(4.77)						
III.	Crude material, inedibles except fuels	-2.60*	3.07*	-1.03*	0.29*	--	--	--	0.91	2.5	48.70
		(4.27)	(6.16)	(5.07)	(3.48)						
	i) Crude fertilizer	-0.52	1.57*	0.33	0.05	--	--	--	0.75	1.97	15.64
		(0.90)	(4.72)	(1.32)	(0.49)						
	ii) Pulp and waste paper	-0.40	3.80*	-2.58*	-0.15	--	--	--	0.84	1.83	26.60
		(0.21)	(4.44)	(4.49)	(0.61)						
IV.	Petroleum crude	0.84	1.09*	0.04	--	-0.30**	--	--	0.65	1.57	12.10
		(0.79)	(2.97)	(1.24)		(2.25)					
V.	Chemicals and related products	-0.39	1.03**	-0.36	--	--	--	0.53*	0.88	1.17	35.66
		(0.50)	(2.31)	(1.59)				(2.61)			
	i) Dyeing, tanning and colouring materials@	0.89*	1.85*	-1.75*	--	--	--	--	0.71	1.2	19.38
		(3.33)	(6.15)	(4.9)							

Contd.....

	Commodity	Constant	GDPFC	RP	FAP	DP	DUM	QM(-1)	$\bar{R}^2$	DW/h@@ satatistics	F-statistics
	1	2	3	4	5	6	7	8	9	10	11
VI.	**Manufactured goods classified chiefly by materials**	1.08	1.28*	-1.10	0.29*	--	--	--	0.94	1.71	82.18
		(1.48)	(3.79)	(5.39)	(3.14)						
	i) Textile yarn, fabrics etc.	0.29	2.90**	-2.22**	--	--	--	0.45**	0.80	0.98	19.90
		(0.18)	(2.59)	(2.88)				(2.19)			
	ii) Iron and steel	7.49*	-1.37	-1.45*	--	-0.04	0.32*	--	0.87	1.98	25.85
		(4.26)	(1.27)	(3.74)		(0.049)	(4.13)				
	iii) Paper, paper board and manufactures	2.71*	-0.08	-0.73*	0.49*	--	--	--	0.91	1.71	50.33
		(3.98)	(0.24)	(3.65)	(4.66)						
VII.	**Machinery and transport equipments**	0.11	2.10*	-1.03*	--	--	--	--	0.94	1.85	59.84
		(0.17)	(6.62)	(6.99)							
	i) Electrical machinery	0.13	1.57***	-1.27*	-0.35**	0.96***	--	--	0.79	2.02	14.86
		(0.16)	(1.82)	(4.48)	(2.68)	(1.81)					
	ii) Transport equipments@	-0.397	1.79*	-0.61***	0.56*	--	-0.34**	--	0.78	1.94	14.18
		(0.68)	(3.18)	(2.11)	(3.29)		(2.59)				
VIII.	**Professional and scientific instruments**	-2.85*	2.74*	-0.60*	0.27**	--	0.15***	--	0.90	2.5	32.23
		(3.09)	(4.83)	(3.88)	(2.31)		(2.16)				

Notes: Figures in bracket represent t-values. All equations except those indicated by @ are estimated in double-log form.

@ Estimated in linear form.

@@ Durbin h-statistics are given for equations having lagged imports (QM-1) as independent variable.

* Significant at 1 per cent level

** Significant at 5 per cent level

*** Significant at 10 per cent level.

Definition of variables:

QM = Indices of quantity of imports, 1978-79 = 100

GDPFC = Gross domestic product at factor cost, 1978-79 = 100

RP = Ratio of import unit values to wholesale prices, 1978-79 = 100

FAP = Indices of ratio of foreign exchange assets in the current year to one year lagged import prices, 1978-79 = 100

DP = Indices of domestic production of importables, 1978-79 = 100

DUM = Dummy variable as a proxy for import liberalisation since 1978-79, assuming value of one since 1978-89 and zero before this period.

QM(-1) = Indices of lagged import quantities.

Thus, it emerges that imports are indeed amenable to policy action even over the medium term. In this, tariffs, exchange rates, and price related measures have a considerable role to play within the overall framework of macro-economic policy. It is essential that these measures are tailored to take into account unequal production cycles and the differential response of importables to fundamentals. For a large section of commodities, excessive import dependance reflects inefficiencies in domestic production. An improvement in the external payments position on a sustainable basis depends greatly on the performance of the economy. In the ultimate analysis, a rate of growth of output which outpaces the growth of consumption would ensure a containment of imports. This calls for better macro-economic management, elimination of infrastructural bottlenecks, an improvement in capacity utilisation and prioritisation of scarce investible resources.

Appendix - I : India's Import Demand Functions : 1970-71 to 1988-89

Equation No.	Commodity										$\bar{R}^2$	DW/h statistics	F. statistics
1	2										3	4	5
I.	**Aggregate Imports**												
	QM	= -0.2468	+1.57	GDPFC*	-0.424	RP*	-0.048	FAP	+0.106	DUM**	0.95	1.93	69.85
		(0.525)	(7.02)		(3.920)		(0.634)		(2.331)				
II.	**Food and food articles**												
	QM	= -1.8497	+2.783	GDPFC***	-0.37	RP	-1.364	FAP*			0.74	2.5	11.24
		(1.165)	(1.907)		(1.02)		(5.99)						
III.	**Fruits and vegetables**												
	QM	= 4.609**	-1.721	GDPFC	-1.706	RP*	+1.674	DP	+0.366	QM(-1)	0.82	1.81	18.12
		(2.661)	(1.446)		(4.246)		(1.497)		(1.792)				
IV.	**Beverages and tobacco**												
	QM	= 2.10	+6.5335	GDPFC*	-1.435	RP**	-4.543	DP**	-0.48***	QM (-1)	0.63	13.07	7.33
		(1.99)	(4.152)		(2.512)		(2.10)		(2.073)				
V.	**Edible oil**												
	QM	= -0.957	+0.011	GDPFC	+0.059	RP	+1.4783	FAP*			0.86	1.92	30.48
		(0.333)	(0.010)		(0.112)		(4.766)						
VI.	**Crude material, inedible except fuel**												
	QM	= -2.601*	+3.074	GDPFC*	-1.032	RP*	+0.29	FAP*			0.91	2.5	48.70
		(4.266)	(6.162)		(5.070)		(3.476)						
VII.	**Crude fertilizer**												
	QM	= -0.523	+1.575	GDPFC*	-0.328	RP	+0.051	FAP			0.75	1.97	15.64
		(0.899)	(4.726)		(1.323)		(0.493)						
VIII.	**Pulp and waste paper**												
	QM	= -0.409	+3.804	GDPFC*	-2.576	RP*	-0.154	FAP			0.84	1.83	26.60
		(0.216)	(4.437)		(4.489)		(0.615)						
IX.	**Petroleum crude**												
	QM	= 0.839	+1.091	GDPFC*	+0.036	RP	-0.305	DP**			0.65	1.56	12.10
		(0.791)	(2.979)		(1.249)		(2.252)						

Contd....

Equation No.	Commodity											$\bar{R}^2$	DW/h statistics	F. statistics
1	2											3	4	5
X.	**Chemical and related products**													
	QM	=	-0.393	+1.032	GDPFC**	-0.360	RP	+0.532	QM (-1)**			0.88	1.17	35.66
			(0.506)	(2.312)		(1.595)		(2.614)						
XI.	**Dyeing tanning and colouring material@**													
	QM	=	86.69*	+1.781	GDPFC*	-1.862	RP*					0.71	1.14	19.38
			(3.327)	(6.150)		(4.908)								
	Elasticity		0.897	1.851		-1.749								
XII.	**Manufactured goods classified chiefly by material**													
	QM	=	1.082	+1.281	GDPFC*	-1.105	RP*	+0.287	FAP*			0.94	1.71	82.18
			(1.479)	(3.792)		(5.399)		(3.142)						
XIII.	**Textile yarn, fabrics etc**													
	QM	=	-0.294	+2.90	GDPFC*	-2.22	RP**	+0.458	QM (-1)**			0.80	0.90	19.90
			(0.180)	(2.585)		(2.88)		(2.195)						
XIV.	**Iron and steel**													
	QM	=	7.490*	-1.371	GDPFC	-1.455	RP*	-0.034	DP	+0.326	DUM*	0.87	1.98	25.85
			(4.269)	(1.269)		(3.738)		(0.049)		(4.133)				
XV.	**Paper, paper board and manufactures**													
	QM	=	2.715*	-0.077	GDPFC	-0.7315	RP*	+0.489	FAP*			0.91	1.71	50.33
			(3.976)	(0.235)		(3.652)		(4.660)						
XVI.	**Machinery and transport equipment**													
	QM	=	0.114	+2.104	GDPFC*	-1.035	RP*					0.94	1.84	59.84
			(0.170)	(6.62)		(6.99)								
XVII.	**Electrical machinery**													
	QM	=	0.131	+1.568	GDPFC***	-1.265	RP*	-0.349	FAP**	+0.967	DP***	0.79	2.0	14.86
			(0.156)	(1.818)		(4.479)		(2.677)		(1.805)				

Contd...

Equation No.	Commodity										$\bar{R}^2$	DW/h statistics	F. statistics
1	2										3	4	5
XVIII.	**Transport equipment@**												
	QM	= -40.74	+1.826	GDPFC*	-0.774	RP***	+0.997	FAP*	-62.348	DUM	0.78	1.94	14.18
			(3.185)		(2.11)		(3.297)		(2.594)				
	Elasticity	0.397	+1.789		-0.612		+0.056		-0.342				
XIX.	**Professional and scientific instruments**												
	QM	= -2.8510*	+2.74	GDPFC*	-0.601	RP*	+0.270	FAP**	+0.146	DUM***	0.90	2.6	32.23
		(3.091)	(4.833)		(3.88)		(2.311)		(2.160)				

Note : 1. Figures in bracket represents t-statistics.
2. The equations are double-log functions, hence the coefficient are elasticity.
3. @ The equations are of linear form.
4. * Significant at 1 per cent level.
** Significant at 5 per cent level.
*** Significant at 10 per cent level.
5. Durbins h-statistics are given for those equations where lagged imports (QM-1) is used as independent variable.
6. Definition of variables are given in page number 44.
7. Equation number XII was orginally estimated without imposing a foreign exchange constraints, On imposing this constraint the DW statistics improved significantly and the variable was found to be significant. The earlier equation was :

QM =	0.59	+ 2.09	GDPFC*	- 1.27	RP*,	$\bar{R}^2$	=0.91	DW = 0.95,	F Statistics =	88.10
	(0.33)	(9.77)		(4.80)						

Appendix - II : India's Imports - - Principal Commodities

(Rs. Crores)

	Commodity	1970-71	1975-76	1980-81	1984-85	1985-86	1986-87	1988-89 (PR)
	1	2	3	4	5	6	7	8
I.	Cereal & cereal preparation	213	1343	100	242	110	87	631
		(13.0)	(25.5)	(0.8)	(1.4)	(0.6)	(0.4)	(2.2)
	1. Beverages and tobacco	--	1	1	2	4	3	..
			(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	
II.	Edible oil	38	17	709	1008	770	656	727
		(2.33)	(0.3)	(5.7)	(5.9)	(3.9)	(3.3)	(2.6)
III.	Crude materials, inedibles except fuels	200	213	565	1123	1507	1625	..
		(12.2)	(4.0)	(4.5)	(6.6)	(7.6)	(8.1)	
	1. Crude fertilizers	..	83	208	414	466	421	316
			(1.6)	(1.7)	(2.4)	(2.4)	(2.1)	(1.1)
	2. Pulp & waste papers	..	..	..	176	245	244	253
					(1.0)	(1.2)	(1.2)	(0.9)
IV.	Petroleum oil, crude	106	1052	3349	3430	3687	2120	4374
		(6.5)	(20.0)	(26.7)	(20.0)	(18.8)	(10.5)	(15.5)
V.	Chemical & related products	192	760	1325	2431	2873	2637	3744
		(11.8)	(14.4)	(10.6)	(14.2)	(14.6)	(13.1)	(13.3)
	1. Dyeing, tanning & colouring material	9	12	21	41	56	66	95
		(0.6)	(0.2)	(0.2)	(0.2)	(0.3)	(0.8)	(0.3)

Contd....

	Commodity	1970-71	1975-76	1980-81	1984-85	1985-86	1986-87	1988-89 (PR)
	1	2	3	4	5	6	7	8
VI.	Manufactured goods, classified chiefly by materials	315	620	2242	2970	3781	4357	..
		(21.1)	(11.8)	(17.9)	(17.3)	(19.2)	(21.7)	
	1. Textile yarn, fabrics, etc.	8	13	59	113	153	151	287
		(0.5)	(0.2)	(0.5)	(0.7)	(0.8)	(0.7)	(1.0)
	2. Iron and steel	147	312	852	941	1395	1556	1937
		(9.0)	(5.9)	(6.8)	(5.5)	(7.1)	(7.7)	(6.9)
	3. Paper, paper board & manufactures	25	58	187	195	226	217	306
		(1.5)	(1.1)	1.5)	(1.1)	(1.1)	(1.1)	(1.1)
VII.	Machinery & transport equipment	395	935	1820	3027	4084	6279	6746
		(34.2)	(17.8)	(14.5)	(17.7)	(20.8)	(31.2)	(23.9)
	1. Electrical machinery	70	201	284	663	810	1212	1608
		(4.3)	(3.8)	(2.3)	(3.9)	(4.1)	(6.0)	(5.7)
	2. Transport equipments	67	157	472	369	569	804	767
		(4.1)	(3.0)	(3.8)	(2.2)	(2.9)	(4.0)	(2.7)
VIII.	Professional & scientific instrument	..	38	176	287	379	512	696
			(0.7)	(1.4)	(1.7)	(1.9)	(2.5)	(2.5)
IX.	Others		287	3238	5047	2472	1823	5707
			(5.4)	(25.9)	(29.4)	(12.6)	(9.1)	(20.2)
	Total Imports	1634	5265	12549	17134	19658	20096	28235

Note: Figures in brackets represents percentages to total imports. PR: Partially revised. ..: Not available, however these figures are available in the form of indices.

Notes

1. Rangarajan, C., (1990).

2. In certain cases, activity variables, such as indices of agricultural and industrial production embodying the demand appropriate to the commodity in question, were used in the place of real GDP. However, these yielded poor statistical results. Therefore, real GDP was chosen.

3. Humphrey, D.H., (1976).

4. Chang H. (1977). He used the maximum likelihood method suggested by Box and Cox to estimate parameters in a more general form, the functional character of which was determined by the value of the transformation parameters. However, the results obtained thereby did not show any material improvement over those obtained from the log-linear and linear forms.

5. Morris Goldstien and Mohsin Khan (1976) observe: "On the assumption of constant elasticities the logarithmic form avoids the problem of drastic changes in the elasticities as import quantities change."

6. See for instance, Barker, T.S., (1970) Humphrey, D.H., (1976).

7. The analysis here followed Mohsin Khan (1975) with some modification.

8. Food and food articles, edible oil, crude material, inedible except fuel, petroleum crude, chemical and related products, manufactured goods, machinery and transport equipment, professional and scientific instruments.

9. Weighted by shares and distribution elasticities.

10. Weighted by shares only, as distribution elasticities are equal to 1 for each commodity.

    Aggregate weighted income elasticity

$$a_2 = \sum_i a2i \left(\frac{QMi}{QM}\right) \left(\frac{dy}{Y} \cdot \frac{yi}{dy}\right)$$

    As Yi = Y since Yi = GDP at factor cost, which is used as the activity variable in aggregate imports also.

    Hence : $a_2 = \sum_i a2i \left(\frac{QMi}{QM}\right)$

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BOOK REVIEWS

North-South and South-South, Essays on International Economics, by Frances Stewart, Macmillan Academic and Professional Ltd., Hampshire and London, 1992.

This volume is a collection of fourteen essays, written mostly in the 'eighties. The emphasis in the essays is on highlighting the fact that international economic relations have been interpreted and fashioned by countries of the North from their own perspective, often giving little emphasis on the needs of the South. The book's main thrust is that international arrangements should be assessed for their impact on incomes and *basic needs* of the poor people, rather than for their relevance for such criteria as financial stability, economic growth and adjustment. The basic needs criterion should, in the view of the author, be built into both theoretical and policy formulation. The book also handles the potentiality of South-South relations in trade, finance, and technology transfer, and to an extent, in debt negotiations as well.

As a spokesperson for the South, there are very few scholars who can match Frances Stewart, in her commitment and work. Paradigms so commonly accepted in the West do not matter for her. She endeavours to find out the reasons why these paradigms do not work in LDCs. That is why, she holds the view that LDCs while concentrating on internal reforms, should negotiate changes by bargaining with the North. If need be, she would say, the South should give threats to specific interest of richer countries. This would be possible only if the LDCs hold out a collective action, at least in small sub-groups. This strategy can succeed since some countries of the South have many sources of negotiating power - the buyer power, the seller power of oil and critical materials, contracts, MNCs' investment and technology transfer, debtor power, and politically critical position. But this may not necessarily hold good for each and every LDC. Also, the positive gains may not be much for some countries which adopt negotiating powers strategies without identifying the areas of their strength. In Stewart's opinion, South-South links may provide positive gains, but this is an area where further research is warranted.

Frances Stewart's delineation of the Basic Needs Strategies, Human Rights and the Right to Development is truly a moving one. But there are very few enforcement mechanisms. Her account of trade theories and their relevance to LDCs provides many insights into the potentiality of South-South trade. Technology development and trade within the South could bring about conditions for developing appropriate, efficient technologies. She would, in certain cases, advocate even counter trade in South-South in manufactures, since it could be trade - creating. She finds justification for use of QRs in cases where countries have persistent BOP problems which cannot be addressed by devaluation.

Most of these views might appear familiar to most readers of international trade relations but the manner of presentation is refreshing in that the analytical reasoning is brought to bear on the arguments that are advanced. Stewart's own specialisation, this reviewer suspects, however lies in the field of international monetary system. Yet it is here disagreements are most possible. Stewart prefers to have international monetary arrangements in place to facilitate trade among Southern countries. There could be clearing arrangements, multilateral credit arrangements for BOP support, and monetary unions. Each of these schemes have certain advantages as well as disadvantages. In recent years, there were therefore, proposals for creating monetary and financial institutions for the South such as Payments Union, development of Commodity Reserves to act as foreign exchange reserves for the South; the institution of a Southern IMF; and a South-South Bank. Some overlap is possible between these proposals. Yet they can play, as Stewart would say, a vital role in promoting LDCs' trade and incomes. But one is not certain whether it would be feasible for the South to have its own Bretton Woods. Stewart seems to lay much emphasis on creation of a new currency - Rocnabs - by an institution like the IMF. But it is easy to argue that the proposal sounds so much like the SDR which has not worked in accordance with the wishes of the founding fathers of the SDR system.

On the international debt problem, Stewart's preference is for a large scale debt reduction that would affect the net present value of the debt rather than for default. But unlike the Brady approach, Stewart advocates a generalised debt reduction plan rather than a case by case approach, since it would prevent the recurrence of crisis, and help the process of negotiations with the combination of some conditionality and adjustment. The discussion here is relevant for borrowers in the international financial markets including banks. The debt problems however, of official borrowers, especially in Africa, are also important, though of a different class, and need to be focussed upon in a serious and innovative way

if the author's advocacy of Basic Needs approach to development should be paid heed to. That kind of integrative thought, one wishes, was injected into the volume while discussing the debt issue.

Reforming the IMF has been the most fascinating theme of many observers of the international economic scene. And it is here one is somewhat disappointed at the inclusion of only one essay and that too the one that focusses mainly on the aggregate effects of the conditionality programmes of the 1980s. The North-South problem in the IMF is manifest in the very structure of the Executive Board. The influences of the G-5/G-7/G-10 and of G-24 are felt by the members of the Executive Board, many of whom were associated with either of the Groups. A number of alternatives of SDR mechanism had emanated from the Board members, most notably that of Mr. Arjun Sengupta, a few years ago. This has unfortunately not been touched upon in the volume under review. Then there are a number of issues that were left out: financing and adjustment, sequencing of measures, frontloading of conditionality, the asymmetry of treatment of members, the relevance of devaluation, the nature of adjustment, the liquidity problem, the concessionality in lending, and the access question, to name a few. There is considerable amount of literature on each of these issues by the end of the first half of the 'eighties, requiring to be analytically unfolded.

The technology transfer issue has been most competently handled by Frances Stewart, but the issue itself has of late been complicated by intricacies as seen in the Uruguay Trade negotiation rounds. The awareness of policy makers on this issue in many developing countries is woefully inadequate. But there is no denying the truth in the assertion of Stewart that technologies should be adaptable to Southern conditions.

A perceptive reader is bound to see the total neglect in the book of G-24 efforts in the World Bank and the Fund. After all G-24 is more concerned with the 'economics' than the G-77. Why is it that there is also no reference to cross conditionality or the parallel or almost converging lines of functioning of the IMF and World Bank? Again the working of international capital markets and their impact, in the framework of the freeing of capital movements in developed countries and in some developing countries, on the South is an issue that will affect not only North-South relations but also South-South relations. This is an aspect on which the volume has nothing to offer.

Notwithstanding the above observations the book offers a rich and varied fare of reading on the subject, and a good handbook of reference.

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Productivity and Growth in Indian Manufacturing by Isher J. Ahluwalia, Delhi, Oxford University Press, 1991, pp. xvii + 242, Rs. 250.

Ms Ahluwalia's new book "Productivity and Growth in Indian Manufacturing" is an important contribution in this area. The main objective of the book is to find out the trend in growth of total factor productivity in the organised manufacturing sector as a whole in India and in the individual industries and to provide explanation for the presence or absence of it. The period covered in this book is from 1959-60 to 1985-86.

In order to find out the contributions of factors other than labour and capital to the growth of output, the author takes recourse to the use of the measurement of total factor productivity. This is because a partial productivity measure like the labour productivity could go up because of rise in capital intensity. While this is true, total factor productivity is essentially a residual measure and measures the contribution to output of all factors other than labour and capital. As Ms Ahluwalia says, "total factor productivity growth encompasses the effect not only of technical progress, but also of better utilisation of capital, learning by doing, improved skills of labour, etc." (p. 33). She considers that despite being a residual, the concept is useful, a point on which one could have difference of opinion. Ideally, it would be more useful to explain the growth of output in terms of specific factors like labour, machines, change in the composition of machines (say the ratio of new and old machines), R and D expenditure, increase in capacity utilisation, changes in the composition of various firms in an industry etc. This is essentially because determinants of these factors may not always be the same.

Ms. Ahluwalia concedes that "total factor productivity growth indices are based on a methodology which analyses equilibrium situations. The interpretation of these concepts in a disequilibrium situation becomes difficult". (p. 35) She also mentions the names of the economists who have criticised the growth accounting estimates of TFPG, like Griliches, Jorgenson and Nelson. As criticisms of these authors have not been given in the book., it would be useful to give in nutshell the important points made by them. First, studies on producitivity based on neo-classical framework assumes that aggregate production function exists. However, this assumes that different types of capital goods can be aggregated. But

this is not possible except under very stringent conditions. As Nadiri argued, the necessary and sufficient conditions for aggregating the variables are "(a) that the rate of substitution betgween capital goods of different types be independent of the quantity of labour used with them and (b) that the marginal rate of substitution between any two types of capital must be constant, i.e., the two types of capital are perfect substitutes". *(Journal of Economic Literature:* December, 1970). And if homogeneous capital goods exist and neo-classical production function exists for a production unit, aggregation of labour, capital and output over all the proudction units requires another set of stringent assumptions. Fisher has shown that in case of constant returns to scale and only two factors of production, the necessary condition for aggregation is that "all capital is perfectly substitutable and all technical changes are capital augmenting".

Moreover, there would be a problem if there exists a third factor of production. If the third factor is not a true "public good", this must be allocated optimally to all vintages and cohorts for the aggregate production function to exist". There is also, as Nadiri pointed out, a problem of complementarity between the third factor and inputs.

Finally, Ahluwalia considers only disembodied technical progress. But, as Arrow showed long ago, technical progress is typically embodied in new machines. This is a view shared by all the vintage models. The problem with the vintage model, however, is that, "each new vintage is superior to the older one by an amount that is assumed to be independent of the rate of investment". (Maurice Scott, A New View of Economic Growth - Clarendon Press, Oxford, 1989. p. 83.)

One could, develop a model, as was done by Scott, of economic growth in terms of the growth of the quality adjusted labour force, the rate of investment, and the efficiency of investment without a separate term for technical progress.

Once one argues that the efficiency of investment and the rate of investment are not unrelated variables, the growth of output is contributed by either labour or capital stock. In such a scheme of things, a concept like total factor productivity is just not applicable.

Alternatively, one could, as shown by Paul M. Romer in an article *(Journal of Political Economy, 1990)*, have a model in which growth is determined by human capital. In this model, technological change is defined as "improvement in the instructions for mixing together raw materials" (p. S 82) or to put it differently, technological change is equivalent

to the adoption of a new design. The introduction of a new design crucially depends on research output. And research output "depends on the amount of human capital devoted to research. It also depends on the stock of knowledge available to a person during research." (p. S 82) And in the balanced growth equilibrium, the growth of output would be equal to grwoth of stock of knowledge which is equal to amount of human capital devoted to research. The concept of human capital here is "years of education or training that are specific". (p. S 79). Thus human capital cannot be separated from the labour. Thus as per this model, it is just not possible to talk about total factor productivity. Notwithstanding these research writings, the use of total factor productivity has been very frequent, especially in empirical literature. This may be partly because of questions of measurement.

There are some other problems with the volume with which we shall briefly deal here. First, Ms. Ahluwalia writes that if we take a sufficiently long period of 30-35 years, the TFPG (total factor productivity growth) is unlikely to be influenced by short term changes like change in scale economies, sudden disruption in material supply etc. (p. 35) If this is true, one would feel uncomfortable with the statistical exercise that she has done while discussing the turnaround in the 1980s. This is because the period of turnaround is very short, emcompassing 1980-81 to 1985-86 (p. 74).

To get value added at constant prices, the author deflates the value added in industry X at current prices by the wholesale price of X. (pp. 215-232). This means that she is deflating the value added by the price of final product. This could lead to biased results except in certain situations. It seems to us, that to get value added at constant prices, value of output should be deflated by the WPI of final product and the value of inputs by the weighted average of WPI of the concerned inputs.

An important idea that comes out of the book is that growth of manufacturing in India is largely a function of investment in economic infrastructure. There are many historical parrallels in support of this viewpoint. More specifically the turnaround in 1980s, according to the author, is mainly on account of the rise in the share of infrastructure investment in total gross domestic capital formation at 1980-81 prices. Some interesting data were given in this connection, such as the following :-

Period	Share of infrastructure investment in total gross domestic capital formation at 1980-81 prices
1960-61 to 1965-66	39.8%
1965-66 to 1975-76	33.9%
1975-76 to 1979-80	34.3%
1979-80 to 1984-85	40.4%
1985-86	42.3%
1986-87	46.9%

The data definitely shows a rise in the share of infrastructure investment in 1979-80 to 1984-85 and thereafter compared to the period 1965-66 to 1975-76 and the period 1975-76 to 1979-80. (pp. 86-87). However, the share of infrastructural investment in the period 1979-80 to 1984-85 is not very different from what it was in the period 1960-61 to 1965-66.

It is therefore not possible to explain the marked difference in TFPG in the eightiers in terms of the share of infrasturctural investment to total investment which remained more or less the same in the first and fourth periods. This is all the more heightened by the fact that true acceleration in investment in infrastructure sub-sectors like electricity and railway during the eighties, as the author hereself concedes, was much less, because a large share of investment in infrastructure went to the petroleum sector.

The second explanation for a pick-up in TFPG in the eighties in terms of domestic deregulation - a shift away from physical control, significant rationalization and some liberalization in trade policy in the late seventies (p. 92) cannot be easily substantiated with the data on command. It is by now well recognised that major liberalization and de-regulation in the industry came about only in 1985-86. The author too has admitted that there was only 'some' liberalization in trade policy (p. 93). It is however possible that this explanation may come out as a valid one as deregulation increases in its range and content in future, surely not for the period that was studied.

Notwithstanding the above remarks, Ms. Ahluwalia's book should be studied because of its clarity of exposition, and simplicity of approach. Moreover, it shows that research in this area is a fertile ground for innovative thinking in the years to come as industrial policies shift in response to requirements of the economic space.

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C.R. Rao described econometrics as a 'New Technology' and is optimistic about its future. A.L. Nagar in his brief note appears to restrict econometrics to the systematic study of economic phenomenon using observed data. P.R. Brahamananda outlines the stages of development in the econometric theory covering Cowles Commission and contributions of Frisch, Tinbergen and Klein. He also provides brief comments on the lag structures in models and Bayesian estimation. According to him, Indian econometricians have kept pace with the developments in econometrics, and econometricians such as N.V.A. Narasimham, S. Chakarvarty, V.K. Chetty, K. Krishnamurthy, Kanta Marwah, V.N. Pandit, P.K. Pani, D.U. Sastry have done exceptionally qualified empirical work in their fields. Brahmananda opines that with the tremendous growth of information and expansion in the capabilities of computers and software, econometric testing for both private and public purposes will expand.

Prof. Iyengar gives a historical account of the Indian Econometric Society right from 1960, when the first Indian Econometric Conference was convened. Sukhamoy Chakravarty traces the development of econometrics in India from the point of veiw of empirical policy work done since the forties, when Mahalanobis began to utilise statistics as an essential aid to decision-making, visualising great possibilities in the area of planning which brought forth the fruitful connection between the three disciplines of economics, statistics and mathematics.

In part two, which contains an account of the proceedings of the Bangalore Conference, mention may be made of the illuminating address of C.R. Rao. Part three contains a review of the papers presented at the conference by Kaushik Basu and Ambirajan.

Part four includes four invited special papers highlighting the role of economic theory and econometrics in the selected areas of rent control, macro planning and poverty measurement. These represent a sample of modern econometric research in Indian problems. Kaushik Basu presents a case for regiorous application of economic theory in development economies. A succinct account of M.J.M. Rao's pioneering work in the application of optimal control theory is presented in the second paper. It enhances the role of econometrics in the framing of economic policies in the context of stabilization and attainment of higher growth paths in economic systems. Nanak Kakwani presents a survey of the literature on the measurement of under-nutrition in India. He proposes a procedure for ranking population according to the degree of nutrition without reference to any parametric assumptions about the distribution of calorie requirements. In the last technical paper, A.L. Nagar and Charu Chandrika deal

with the relative efficiencies of sampling distributions of competing estimates with a view to obtaining confidence bounds and testing statistical hypotheses for economic parameters. They find that exact sampling distribution for econometric parameters are intractable and too complicated in small sample situations and hence they advocate the use of limited distribution concept.

While going through this important publication which surveys major developments in the evolution of econometrics in India, two important factors strike the policy makers and the research scholars viz., (a) the need for toning up the quality of statistics generated at various levels, as for example at the Central Statistical Organisation (CSO) level, the State Statistical Bureaus and the District Statistical Offices; and (b) the need for establishing effective linkages between data, information and the decision making process, particularly at the policy formulation level.

Another crucial step that would give a push to the development of econometrics in India is that the econometricians should also vitally concern themselves and come up with short-term econometric models (besides the long-term econometric models) which would provide the policy makers with the requisite analytical frame work to unravel the undercurrents influencing the short-term economic scenario and help them in steering the economy in the set direction. The evolution and development of new econometric methods also go a long way in achieving this task.

The publication undoubtedly makes an interesting and absorbing reading. A critical reader, however, may wonder as to the omission of the names of some eminent econometricians in India like Prof. B.S. Minhas, Prof. T.N. Srinivasan, Prof. V.K. Ramaswamy who made notable contributions to the development of econometrics in India.

To sum up, the volume is a useful reference for research students on economic policy formulation, since it facilitates proper conceptualisation of economic problems under investigation.

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