CHAPTER - I

THE METHODOLOGY AND PLAN OF THE STUDY

1. The Background:

Almost since the days of Adam Smith, economists have been concerned with the theme of economic growth. It has only been in the last generation, however, that concern with the sources of economic growth has become widespread. This is probably attributable to three factors. One is the observed phenomenon of rapid and persistent economic growth whose meaning and implications have become increasingly clear during the post-war period, indicating thereby the necessity of undertaking a more detailed and a deeper analysis of the phenomenon than had hitherto been attempted. The second reason lies in the increase in general interest in economic growth witnessed by the post-war period, which was due, to a considerable extent, to a widespread and immense practical concern with growth after the Second World War, when the war-damaged economies were trying hard to reconstruct fast, and when the underdeveloped countries
had also become growth-conscious. Thus growth was everybody's concern and everyone was trying to concentrate on raising the long-term rate of growth. In such a situation and with such an immensely practical motivation, it was perhaps natural for growth economists to start thinking in terms of making a quantitative appraisal of various factors leading to economic growth. The third factor is, perhaps, the empirical evidence which, as some of the initial studies in this direction have revealed, sheds new light on the role of technological advance in the process of growth by assigning to it nearly half of the growth of national income and more than four-fifths of the growth of output per person employed in the United States.

These pioneering studies by Moses Abramovitz and Robert Solow have on the one hand dealt a severe blow to the classical beliefs regarding the role of technological progress in economic development and, on the other, re-dressed the neo-classical underemphasis on technology.

Classical economists described economic growth as the process whereby a nation transformed its economic surplus into capital accumulation. They believed that capital formation could not continue indefinitely and that stagnation would slowly strangle economic growth with a subsistence real wage, low profits and high economic rents. Their belief was based on three main assumptions, viz., the law of diminishing returns, the Malthusian theory of population and a more or less invariant state of technology. Obviously, the subsequent experience of many countries during the last century has shown that these gloomy predictions of the classical writers were not well founded. The reason probably lies in their failure to see the relative importance of labour and capital on the one hand and of the increase in productivity on the other as the sources of economic growth. Changes leading to a shift in the relationship between output per worker and capital per worker, for which Solow has devised the name of "technical change", were simply assumed away by the classical economists. Thus, "had Ricardo been asked whether increased productivity were possible, he would

2 In a frequently quoted description of the aggregate production function, Solow defines 'technical change' as "a short-hand expression for any kind of shift in the production function". "Thus slowdowns, speed-ups, improvements in the education of the labour force, and all sorts of things will appear as 'technical change'." Cf. R.M. Solow: "Technical Change and the Aggregate Production Function", Op.cit., p.312.
probably have answered that productivity would increase if capital per worker, including land per worker, were increased. The recent studies referred to above have, however, shown that the increase in capital per worker accounts for barely one-eighth of the observed increase in output per worker, the rest being accounted for by the so-called "technological change". The direct implication of the findings of these studies is therefore that the classical economists went wrong at least partly because they neglected seven-eighths of the increase in productivity which sprang from the mysterious source called "the technological change".

Technological progress is of course not a new phenomenon in human history. What is unique about the modern era, however, is the rapidity, depth and constancy of the flow of new technology. In the more distant past, the progress of technology, like past economic development in general, was sporadic, uneven and comparatively slow; and it was certainly not so systematic and dependable as it has actually turned out to be (at least in most of the developed countries) during the last few decades. It is perhaps not so surprising therefore to find that the classical economists writing in the late eighteenth and early nineteenth centuries regarded technological change as an exogenous influence on the rate

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of economic development of a nation. It goes without saying that the recent findings relating to the role of "technological progress", or of "productivity increase" to use a more general term, would have surprised the classical writers. What is interesting to note, however, is that these findings surprised their authors also. Thus, for instance, Moses Abramovitz has remarked: "This result is surprising in the lopsided importance which it appears to give to productivity increase...... Since we know little about the causes of productivity increase, the indicated importance of this element may be taken to be some sort of measure of our ignorance about the causes of economic growth in the United States and some sort of indication of where we need to concentrate our attention". 4

No wonder that these findings have led to an intense upsurge of interest in the questions regarding the major sources of economic growth and their relative significance. In the flood of massive reaction a number of studies both supporting as well as challenging these findings and using a variety of approaches, employing different bodies of data and covering different time periods have appeared during the

sixties. The main drift of their arguments has generally been that the rate of productivity increase is a sort of catch-all; it covers a wide range of different factors such as improvements in the quality of labour, non-constant returns of scale, non-neutral technical change, inter-industry shifts of resources, aggregation and measurement biases and so on, besides, of course, the effect of advances of knowledge. It is perhaps for this reason that the names given to this factor — the increase in output per worker which is not explained by increases in capital per worker — have ranged all the way from (a) "Technical Change" and (b) "Efficiency Index" to (c) "Total Factor Productivity" (d) "Output Per Unit of Input", (e) "The Residual", and (f) "Measure of Our Ignorance".

It is evident that a system of growth accounting which is based on only three or four conventionally measured variables such as labour, capital and land, and which leaves

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a large part of the observed growth unexplained by labelling it as "productivity increase" or "technological progress" is likely to provide a much less satisfactory explanation of observed economic growth as compared to the one which is more detailed and which tries to clarify at least the major components of the so-called "Residual". Particularly, the more detailed accounting of the growth rate is likely to provide a better approximation to the "true residual" (i.e. what remains after due allowance is made for increases in conventionally measured factor inputs, and factors like economies of scale and changes in (a) quality of labour, (b) degree of resource utilization, (c) resource allocation etc.) which may be taken as a rough and ready indicator of "the gradual growth of applied knowledge" and "which is, no doubt, the result of human activity, but not that kind of activity involving costly choice which we think of as economic input". As Moses Abramovitz has put it: "To identify the causes which explain not only the rate at which our opportunities to raise efficiency increase but also the pace at which we take advantage of those opportunities will, no doubt, remain the central problem in both the history and theory of our economic growth. The chief excuse for attempts

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to separate the measurable contributions of resources from those of productivity is to pose this problem as clearly as possible. 8

Of the several recent studies on this subject, the most comprehensive and far-reaching studies to date are those made by Edward F. Denison. 9 In these path-breaking studies which make a significant contribution to quantitative thinking in economic growth analysis, the author estimates the contributions made by a wide range of identifiable sources to the growth rates of the American and the Northwest European economies. In the process, he makes an ingenious attempt to clarify the main components of the residual (i.e. the contribution made by the increase in output per unit of conventional inputs) such as increased education of the labour force, 10 the shift of resources from low productivity sectors into the mainstream of the modern economy, economies of scale and

8. Ibid., pp.13-14.
10 It may, however, be noted that Denison treats increased education of the labour force as a factor leading to an improvement in the average quality of labour, and includes its contribution, like that of other factor inputs, in his estimates of the contribution made by total factor input to economic growth.
gains from advances of knowledge. All these scholarly studies have, however, been confined to the growth experience in some of the advanced western countries only, the most prominent among them being the United States. Little work seems to have been done in this direction for the majority of underdeveloped countries, which have, presumably, a greater concern for rapid economic development. In the case of India, in particular, such objective and quantitative appraisals of the factors which explain the growth experience of the last two decades have yet to be made, with the result that our knowledge about the subject of Indian economic growth lacks both the comprehensiveness and the quantitative character which have become the outstanding features of the analysis of economic growth in the Western countries. In fact, all that we know of the determinants of economic growth in India so far, is confined only to a list of factors such as capital investment, population growth and growth of working force, spread of education, technological advance and so on, all of which, we believe, have contributed to economic growth in the past and are expected to contribute to the future growth. Few attempts, if any, have been made to assess, on the basis of available empirical evidence, the quantitative importance of each single factor - or even the major factors such as labour and capital - in the growth
which has already occurred in the past and to estimate the amount of growth that might be expected in the future from any specified amount of activity in any specified direction.

The present study, which concentrates on the quantitative analysis of the sources of economic growth in India, is an initial and essentially experimental attempt in the direction of filling up this serious lacuna in our knowledge about the process of economic growth in India since independence. Following broadly the method adopted by E.F. Denison, it makes an attempt to quantify the importance of various sources of growth to India's economic development during the post-independence period.

In a developing country such as India where rapid economic growth has become a national goal, such a study analysing the sources of growth assumes special significance not only because it helps to find out what has and what has not been important in the growth which has already occurred but also because of the obvious implications it has for the crucial decisions and policies that affect the future growth - its rate as well as pattern. It hardly needs to be stressed in this connection that most actions which can raise the growth rate would also impose costs of one or the other sort, and that the increased future income resulting from the accelerated growth may or may not be worth the cost. Indeed,
it is precisely because the steps to increase the growth rate usually impose certain costs on the society as a whole, that a systematic study of growth in quantitative terms is necessary and rewarding. In addition to this, it may also be noted here that a study of the sources of economic growth in India would provide useful information on the process of economic growth in a typical underdeveloped overpopulated country as distinguished from the more developed industrialized countries of the West. Moreover, it would pave the way for an analytical comparison of the sources and rates of growth in India as against some of the Western countries contributing thereby to a more systematic explanation of the question so often raised, viz., why growth rates differ.

It should be fairly obvious, however, that in order to serve all these purpose adequately and satisfactorily, a well-directed sustained effort on a larger scale is required before any set of firmly established quantitative conclusions can be arrived at.

2. The Methodology:

It is customary in the current discussions on the quantitative appraisals of the factors affecting the rate of economic growth to define "the sources of economic growth" as "the
changes that cause national income to increase from one date to another." Broadly speaking, these may be divided between changes in the resources (or factor inputs) used to produce the national product and changes affecting output per composite unit of factor inputs. The factor inputs usually include the three classical factors of production, viz., labour, capital and land.

The broad method of evaluating the contributions made by each of these conventional inputs and also by the so-called "output per unit of input" to the growth rate of national income consists of the following steps:

(i) constructing a separate index for each of the factor inputs distinguished and deriving the average annual growth rates of various factor inputs from the indexes so constructed;

(ii) deriving an index of what is known as "total factor input" by combining the separate indexes for various factor inputs in the same proportion as their relative shares in national income;

(iii) Calculating the contribution made by each factor input to the growth rate of national income as the product of the growth rate of each factor input on the one hand and

its relative share in national income on the other; and finally

(iv) deriving the index of output per unit of input as a ratio of the index of national income (numerator) and the index of total factor input (denominator), and calculating the average annual growth rate implicit in the index so derived which indicates — after a trivial adjustment if necessary for "the interaction factor" — the contribution made by the increase in output per unit of (measured) input.

Broadly speaking, this method of analysis, which was introduced by Jacob Schmookler and by various economists at the National Bureau of Economic Research in the United States (NBER), underlies Denison's approach to the problem of quantifying the importance of various sources of economic growth. It is easy to see that this method of analysis is


based on the so-called "factor share approach", which has been widely used in economic literature especially on growth economics and which derives directly from the marginal productivity analysis. "It provides an accurate estimate if the earnings (prices) of the various factors of production are proportional to the value of their marginal products." \(^{14}\)

In particular, under the special case of a constant-returns competitive equilibrium, the method simply boils down to the direct use of the well known neo-classical distribution postulates which equate factor price to marginal productivity and, in turn, the relative share of a factor to the elasticity of output with respect to that factor at the point of equilibrium. \(^{15}\)

In order to estimate the contribution of each input to the growth rate of national income, we must answer the question: "What fraction of the increase in real national income that would result from a 1 per cent increase in all factors of production is obtained from a 1 per cent increase


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16 E.F. Denison: Why Growth Rates Differ, op.cit.,pp.33-34. The question, as Denison has made it explicit, "refers to conditions in which available resources are utilized at the same rate and rather fully". Thus, it does not refer to short-term "cyclical" changes resulting from fluctuations in aggregate demand.

17 ibid., p.34.

18 ibid., p.34.
While the above conditions necessary for a tendency towards proportionality to exist are often assumed to be more or less satisfactorily fulfilled by the advanced industrialized economies of the West at least during periods of almost full utilization of available resources, there exists enough room for doubt regarding the validity of such an assumption when we have to consider the case of an underdeveloped economy with a large unorganized subsistence sector, such as the Indian economy. It is widely believed that in the face of a tremendous pressure of population on land and relative abundance of unskilled labour, especially in the farm sector, the average earnings of workers do not reflect the "true" marginal product of labour in agriculture, which is supposed to be very low and sometimes even zero implying the presence of the so-called "disguised unemployment".  

For a detailed account of the concept of disguised unemployment and its theoretical foundation, see

While the concept of disguised unemployment as well as the radical arguments based on it have been subjected to severe criticism, the general hypothesis regarding the divergence between the average earnings and the marginal product of labour in the subsistence sector seems to have survived most of the attacks, though perhaps with much reduced force.

Even in the more organised sectors of the economy (especially in the non-agricultural sector), significant departures from proportionality (between average earnings of factors of production and the value of their marginal products) may be caused by a number of factors such as (i) ignorance on the part of entrepreneurs regarding the actual least-cost combinations, (ii) poor foresight, (iii) failure to keep pace with the constantly changing economic system in which the most efficient factor combination may itself be undergoing changes with the introduction of new techniques of production, (iv) lack of sufficiently strong

competitive pressure which is necessary in order to eliminate the inefficient enterprises which fail to arrive at the best factor combination, (v) the changing pattern of final demand, (vi) legal and institutional restrictions on the freedom of entrepreneurs to arrive at the best factor combinations, and so on.

Granting that the basic postulate of proportionality between earnings and marginal products is valid, the method of using income shares to assess the contribution of various factors to economic growth yields results that can be given precise significance only to the degree to which another far-reaching assumption is valid. This assumption involves specification of the relationship between marginal rates of substitution between factors (i.e. the relative marginal products) and the factor proportions on the one hand and shifts in the relationship between inputs and output on the other. To be precise, it requires that "relative marginal productivities should not alter because the relative quantities of the factors vary or because shifts in the production function are not neutral,"21 or what comes to the same thing, that (i) the elasticity of substitution between factors of production is equal to unity within the limited ranges involved, and (ii) technical progress is neutral towards all factors.

of production in the sense that it simply raises the total output obtained from a given combination of factors without altering the related marginal rates of substitution. The bias resulting from errors in this assumption may be minimized (as it has actually been done by Denison), first, by dividing the longer period under consideration into a number of sub-periods (each of about five years or so) and, then, by using income share weights within each of these shorter periods that reflect average income distribution during that period.


It is easy to see that the first step in this procedure aims at reducing the extent of shifts in factor proportions during each period for which a given set of income share weights is to be used, while the second step aims at eliminating as far as possible the effect of short-term cyclical fluctuations in income shares on the weights to be used. This procedure has the advantage of restricting the assumption of unit elasticity of substitution only to the range of factor proportions observed during each time period distinguished. "If this assumption is not correct the error in an estimate of the effect of a change in inputs upon output is greater (1) the more the growth rates of different factor inputs differ (if they do not differ, there is no error); (2) the larger the income shares of the more rapidly growing factors; and (3) the more elasticities of substitution in fact differ from unity" Cf. E.F. Denison: Why Growth Rates Differ, Op. cit., p. 36.
Finally, we may note a practical difficulty, which one encounters while using this method, arising mainly from the inability to isolate the element of "pure" profits (including monopoly profits) from what are essentially the returns to capital and land. "This probably leads to an underestimate of the effect on output of a change in labour input, and an overestimate of the effect of a change in land or capital input". 24

If, despite all these limitations, the factor share approach is found to have been frequently used in empirical studies dealing with the quantitative aspects of the problem of identifying the sources of economic growth, the reason perhaps lies in its utmost simplicity coupled with the belief that it yields results which, although somewhat crude, provide reasonably good approximations of the underlying reality. It could therefore be a working hypothesis of the present study that the income shares estimates for the Indian economy provide an adequate basis for an analysis of the absolute and relative contributions made by various factors to India's economic growth.

Average V/S Total Changes Approach: Viewed from the angle of what it actually attempts to measure (especially in the temporal context), Denison's approach may be termed "the

average annual changes approach" since it defines the importance of a source of growth during a given time period as "the percentage reduction that would have occurred in any one average year had the source of growth not changed in that year".25 As against this, there is an alternative approach - the so-called "total percentage changes approach" - which shows "the reduction that would have occurred in total growth or the average annual growth rate if the source of growth had not changed during the entire period under consideration".26

The total percentage changes approach may yield results which differ from those of the average annual changes approach for three reasons:

In the first place, the difference may be due to the effects of compounding. It can be easily seen that the ratio of total percentage change in an input to total percentage change in output varies directly (inversely) with the length of time period under consideration if the average annual growth rate of the input (s) is greater (less) than that of output (r); while in the case of the average annual changes approach, the ratio of the average annual input to average annual output (i.e. s/r) is constant regardless of the length of time period under consideration, provided that the growth

26 Ibid.
rates, s and r, continue unchanged.

The second source of difference lies in the effects of diminishing returns. "For substantial changes in the quantity of any one factor, consideration must be given to the principle of diminishing returns", which tells us that "as the quantity of any one factor of production is increased without increasing the others, the addition to output provided by the same addition to the varying factor will progressively decline". It can be readily seen that this problem becomes all the more important if we adopt the total percentage changes approach, because "the longer the period under consideration, the smaller the per unit output attributable solely to increases in the source of growth, in view of the above mentioned principle of diminishing returns. To a large extent the average annual changes approach avoids this problem, however, since the use of small changes in inputs make income shares a plausible approximation to the elasticity of output with respect to inputs - i.e., in the short run diminishing returns are unlikely to be significant".

29 ibid., p. 225.
Finally, the results yielded by the two approaches may differ because of the effects of interaction between various sources of growth. The causes of interaction are of course many and varied, and to some extent, one or the other kind of interaction is likely to take place among almost all inputs. Here again, it can be seen that the extent of interaction depends primarily upon the size of the changes in the sources of growth, and that the longer the period under consideration, the greater will be the importance of interaction. Under the average annual changes approach, however, interaction does not pose a serious problem because "annual changes tend to be small and when multiplied together almost inevitably results in minuscule quantities that, for all practical purposes can be ignored".

E.F. Denison has preferred to use the average annual changes approach rather than the total percentage changes approach because (i) the former yields interaction terms which are trifling and negligible, and (ii) by eliminating


the effects of compounding, it makes the results independent of the length of time period under consideration (if growth rates are assumed to be constant). While there may be a difference of opinion on the question of regarding these characteristics of the average annual changes approach as either advantageous (as E.F. Denison would argue) or limitations (as Ronald W. Comley would argue), from the practical point of view the average annual changes approach appears to be more attractive than the total percentage changes approach particularly in view of the empirical obstacles standing in the way of a precise and accurate estimation of the effects of different types of interaction as well as of diminishing returns over long periods of time.

For our present study, therefore, we have adopted the so-called "average annual changes approach", and, to be precise, we have followed more or less the same broad method of analysis which underlies E.F. Denison's studies. 33

33 A detailed account of the general methodology used by E. F. Denison is given in his earlier study The Sources of Economic Growth in the United States, op.cit. The same methodology has also been used in his more recent study Why Growth Rates Differ, op.cit.

In the second study, however, "a number of small improvements in methodology resulting from further reflection" have been introduced. Wherever possible, we have tried to incorporate such improvements in the methodology adopted for the present study.
3. **Purpose and Plan of the Study**

The present study centers mainly around the question of estimating the contributions made by various economic factors to India's economic growth during the post-independence period of twenty years following the year 1948-49, i.e. 1948-49 to 1968-69.

It therefore seeks to contribute in the following directions:

1. **Estimation of the long-term rate of growth of the Indian economy during the post-independence period on the basis of the time series of national income at constant 1960-61 prices covering the entire twenty-year period under consideration; and estimation of the functional distribution of national income in India during the same period;**

2. **Construction of a separate time series for each of the three broad factor inputs distinguished, viz., labour, capital and land, and estimation of the average rate of growth of each factor input over the twenty-year period under consideration;**

3. **Derivation of the Index of Total Factor Input from the separate indexes of factor inputs for the economy as a whole as well as for the agricultural and non-agricultural sectors of the economy;**
(4) Estimation of the contributions made by various sources of growth to the growth rate of national income, and thereby also of the rate of growth of output per unit of total factor input experienced by the Indian economy during the period 1948-49 to 1968-69;

(5) Projection of the factor inputs and national income over the period 1968-69 to 1980-81, and a quantitative appraisal of the sources of future growth.

In all about a dozen sources of growth are considered in the present study. These are:

(1) the working force or the numbers employed;
(2) average quality of labour as determined by the increased education of the working force;
(3) average quality of labour as determined by changes in the broad age-sex composition of the working force;
(4) residential dwellings;
(5) non-residential structures and construction;
(6) machinery and equipment;
(7) inventories;
(8) international assets;
(9) land;
(10) changes in the broad resource allocation as measured by the contraction of agricultural inputs;
(11) economies of scale; and
(12) advances of knowledge, changes in the time lag in the application of knowledge and errors and omissions.

Of these, the first three taken together constitute the labour input and the next five (i.e. 4 to 8) constitute the capital input.

Similarly, the first nine factors when combined constitute the total factor input and the last three constitute the residual (i.e. growth of output per unit of total factor input).

In what follows, we present briefly the broad outline and scheme of the present study.

The study is divided into Seven Chapters including the present one, which being the First Chapter is mainly introductory in nature.

The Second Chapter is devoted to a study of the growth of national income and its functional distribution in India. To begin with, we examine critically the so-called Conventional Series which is the only available time series covering the entire twenty-year period under consideration, and also explore in some detail the broad statistical and methodological base of the other official series, viz., the so-called Revised
Series, which being issued only recently does not cover the period before 1954-55. Since the Revised Series is regarded as a better index of the movement of national income over time, we have adopted the existing official Revised Series (with a few minor changes) covering the period from 1954-55 onwards for our study. For the six years preceding 1954-55 (i.e. 1948-49 to 1953-54), however, we have made our own estimates of national income on the broad statistical and methodological base of the Revised Series with the help of whatever statistical information and data we could obtain from official sources. The Revised Series, so prepared to cover the entire twenty-year period under consideration, is then examined and analysed with a view to estimating the long-term rate of growth of national income in India during the post-independence period.

In the second part of the Chapter, an attempt is made to estimate the relative income shares on the basis of the available statistical source material.

The next three chapters are devoted to the estimation and analysis of the growth of various factor inputs in India. Since there does not exist any time series (covering the period 1948-49 to 1968-69) for any of the factor inputs under consideration, our main task here is to construct the required time series covering the entire twenty-year period.
Thus, Chapter III is devoted to the time series of Working Force, i.e. the labour input unadjusted for quality change. Chapter IV deals with the Quality Indexes measuring the effect of (i) increased education and (ii) changes in the broad age-sex composition of the working force on the average quality of labour and the time series of Labour Input Adjusted For Quality Change. Chapter V is then devoted to the time series of Capital Input and its components, viz., (a) non-residential structures and construction; (b) machinery and equipment; and (c) inventories. Appendix V-A deals with the index of Land Input.

The Sixth Chapter is devoted largely to the estimation of the absolute and the relative importance of various sources of economic growth in India during the period under consideration. Here we bring together the results of the previous chapters to estimate the contributions made by various sources of growth to the long-term growth rate of the Indian economy during the post-independence period. We also estimate in the process the size of "the Residual" or the rate at which output per unit of input is estimated to have increased during the period under consideration. The sources of growth of the two major sectors of the economy, viz., the agricultural sector and the non-agricultural sector, are also examined in a separate section. Then, in the concluding parts of the Chapter,
we have made an attempt, on the one hand, to construct the so-called "technical change index" by following the method suggested by Prof. R.M. Solow,\textsuperscript{34} and on the other, to present an aggregate production function for the non-agricultural sector of the Indian economy.

The seventh and the last Chapter makes an attempt to provide rough and ready answers to the questions relating to the sources of future growth. Here, in the first place, we have projected the factor inputs and national income over the twelve-year period following the year 1968-69 (i.e. the period 1968-69 to 1980-81, which covers the present Fourth and the coming Fifth Five Year Plans) on the basis of some simple assumptions about the future trends in these aggregates. We have also examined the sources of future growth implied by our projections. Then, in the concluding part of the Chapter, we have estimated the percentage points by which the projected growth rates of different factor inputs would have to be raised in order to raise the projected growth rate of national income during the period 1968-69 to 1980-81 by one-tenth of a percentage point.