CAPACITY UTILIZATION IN INDIAN INDUSTRIES
- A PROGRAMMING FRONTIER APPROACH
1960-61 - 1992-93

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CHAPTER 1

INTRODUCTION

1.1 The Context:

For capital scarce developing countries like India the utilization of capacity in the manufacturing or industrial sector is of crucial concern. Yet the overall framework of planning in India has been one which has placed too much emphasis on capital accumulation and far too little on the efficiency with which capital is utilized. In the context of the resources constraint in the economy, the utilization of capacity already installed in the industrial sector assumes great significance.

Capacity utilization is a key determinant of corporate profitability and a major indicator of macro economic performance. In deciding whether to expand their manufacturing facilities, firms rely heavily on observed rates of utilization at the firm and industry level. In capital intensive industries such expansion decisions can have huge financial implications.

Excess capacity indicates that the economy is failing to make the best use of its scarce resources. The existence of large unutilized or underutilized capacity implies a high cost both to the producer and to society at large which an economy like India can ill afford. The existence and persistence of large underutilized capacity in various sectors of the economy is thus a major problem which necessitates the serious attention of researchers so as to enable policy makers **to** take timely corrective actions and measures.

1.2 The Notion of'Capacity:

The importance of having correct estimates of industrial productive capacity and the extent of underutilization is obvious. But the concept of 'capacity' and thus capacity utilization do not lend themselves to any simple and unambigous definition and measuring it in practice also presents difficulties. An important reason for the considerable neglect of empirical research devoted to the estimation of capacity utilization arises from the ambiguity in the term 'capacity'. The term 'capacity' while appearing seemingly simple is dangerously deceptive. Any estimate of capacity utilization is based on the rather elusive concept of potential output for which various definitions and methods of measurement have been proposed. The principal difficulty arises from the fact that potential output is not directly observable; estimation methods must thus either adopt theoretical/statistical constructs to infer potential output from officially published data or rely on information provided by business surveys. Thus, from the various alternative interpretations emerge alternative measures of capacity utilization (CU) which typically measure different things.

A review of the alternative measures **of capacity utilization** (CU) shows that while some of these measures are purely adhoc, some new measures of CU have explicit theoretical and analytical framework. The different measures also differ with respect to the role of economic variables in defining full capacity output. The extent of underutilization depends on the choice of the concept of capacity. The interpretation of the estimates and trends of CU would thus depend on the notion of potential output used and the analytical framework in which CU has been estimated.

Capacity utilization (CU) is usually defined as the ratio of actual output to some measure of potential output. Till recently, most of the measures obtained were traditional measures, based on technical constructs to obtain capacity output. These measures were not based on explicit economic theory of the firm.

However in recent years, two different approaches based on an economic notion of capacity output have been used to obtain measures of CU. In these approaches the notion of capacity output is derived from the cost minimization or output maximization framework.

In the first approach, following Cassels (1937), Klein (1960) and Hickman (1964), a number of studies have employed the economic theory of cost in defining capacity output. In these studies, two different definitions of potential output have been put forth. The first suggested by Cassels (1937) and Hickman (1964) corresponds to the output at which the short run average total cost curve reaches its minimum. The second advocated by Klein (1960) corresponds to the output at which the long run and short run average total cost curves are tangent. Corresponding to these definitions of capacity output, two economic measures of CU can be estimated. The framework for deriving economic measures of capacity utilization has been developed by Berndt (1980), Berndt and Morrison (1981), Morrison (1985,1986) and used by others. In this approach the optimal capacity output is obtained by an econometric estimation of the cost function.

In the second approach Fare (1984), Fare Grosskopf and Kokkelenberg (1989), used linear programming techniques to fit a nonparametric production frontier about input-output observations rather than using the econometric technique which fits a stochastic parametric cost function between cost - output observations. The calculated production frontier reveals the relationships between efficient production and inputs and provides information on plant capacity and utilization as well. The notion of plant capacity used here is that given by Johansen (1968): "The maximum output that can be produced with existing plant and equipment provided that the availability of variable factors of production is not restricted."

In India, a number of studies give estimates of capacity utilization based on the traditional measures of estimating potential output. These estimates are available for limited years and for a limited number of industries. The measures reveal a substantial amount of under utilization of capacity, yet these estimates of capacity utilization are not based on the framework of costs or production.

1.3 Review of Estimates of Capacity Utilization:

The review of the estimates of capacity utilization for Indian industry shows that the problem of under utilization of capacity has not attracted adequate attention. Existing estimates of CU for India are based on the traditional mechanical measures of capacity utilization. Most of the studies pertain to the measurement of idle capacity either in specific industries or in the aggregate manufacturing sector and cover a limited period. Some of these studies while giving the traditional estimates of CU also focus on the major factors responsible for underutilization of capacity.

Many of the studies on capacity utilization are based on data on installed capacity and actual output from the official publication, Monthly Statistics of Production of Selected Industries (MSP) in India (e.g. Paul, 1974; Goldar and Renganathan, 1991; Burange, 1992 and 1993; Ajit, 1993). However, the MSP data on installed capacity and production are subject to a number of limitations. In addition, the official Index of Industrial Production has also been used (RBI, 1974) to construct mechanical measures of capacity utilization using trend-through-peaks method.

Economic measures of capacity utilization have been obtained in the study by Padma Suresh (1991) and are obtained in a cost minimization framework using econometric techniques. The study covers four two digit industries of the Annual Survey of Industries corresponding to the capital goods sector of India and covers the period from 1960-61 to 1982-83.

In recent years, two studies which give a longer time series of estimates of capacity utilization and cover a wide range of industries are those by Ajit (1993) and Burange (1992,1993). Both studies however use MSP data on installed capacity and actual production to construct traditional measures of capacity utilization.

1.4 Objectives of the Study:

The present study thus aims to fill a major research gap in the area of underutilization of capacity. Linear programming techniques are used to construct a production frontier from which a measure of potential output is obtained. The estimates of capacity utilization are thus derived in an economically meaningful manner and are not merely technical constructs. This study is based on the nonparametric linear programming frontier production framework used by Fare (1984), Fare, Grosskopf and Kokkenlenberg (1982) and others. The study is comprehensive and covers eighteen industry groups corresponding to the two digit Annual Survey of Industries (ASI) classification. The period of study is for thirtythree years from 1960-61 to 1992-93.

The basic objectives of the study are:

(1) To obtain trends in capacity utilization rates (CAPUT) obtained as the ratio of actual output to maximum plant capacity output. Plant capacity output is based on Johansen's (1968) definition and is defined as the maximum output that can be obtained from given plant and equipment and assuming the availability of variable factors of production poses no constraint. The maximum potential plant capacity output is obtained as linear programming solutions from the frontier production framework with the assumption of constant returns to scale.

(2) Trends in another measure of capacity utilization – plant capacity utilization (PCU) defined as the ratio of maximum output that can be obtained from given factors of production to maximum

plant capacity output have also been obtained with the assumption of constant returns to scale.

(3) In addition, trends in PCU rates have also been computed under an alternative technology i.e. with the assumption of variable returns to scale. This measure is denoted by PCUVRS.

(4) The linear programming solutions also reveal interesting insights on input utilization (INUT) rates for the variable inputs. These rates are obtained as the ratio of actual input used to the input required to produce optimal plant capacity output. Thus, an INUT rate greater than or less than unity implies respectively that the input is either overutilized or underutilized relative to that of optimal output.

(5) The present study also gives trends in a measure of productive efficiency (PE) or technical efficiency. Technical efficiency is defined as the ratio of actual output to maximum potential output that can be obtained from the available factors of production. These measures of efficiency are similar to those obtained by Farrell (1957). The second measure of CU, denoted by PCU adjusts for efficiency and estimates of PCU can thus be related to TE estimates. The trends in efficiency are obtained for the eighteen industry groups under consideration for the period of thirtythree years.

(6) Finally, the study also obtains measures of scale efficiency. By comparing the measures of technical or productive efficiency and scale efficiency the study determines whether inefficiency is due to suboptimal scale. In addition a three step procedure outlined in Chapter 4 enables the determination of the nature of returns to scale

(RTS) i.e. whether constant, decreasing or increasing returns to scale prevail in the various industries in each year.

1.5 Data Sources and Measurement of Variables:

In any empirical study the importance of the data base needs hardly be emphasized. For the nonparametric production framework used in the study data is required on output and the four inputs - namely, capital, labor, energy and intermediate materials. The primary data source for the present study for estimating trends in capacity utilization is the Annual Survey of Industries (ASI) of the Central Statistical Organization (CSO). The ASI provides detailed information on various industrial characteristics like value of output, employment, capital stock, fuels consumed, value of intermediate inputs used etc. The data from the ASI are available for the organized or registered manufacturing sector and covers the entire Factory Sector - including both the Census and Sample Sectors. The ASI data cover twentythree two digit major groups which are further subdivided into three digit groups. The current study covers eighteen of these two digit industries and covers the period from 1960-61 to 1992-93- the most recent year for which data are available.

In addition, for purposes of price adjustments the data on price indices from the various volumes of the Reserve Bank of India (RBI) are used. The official series on Index Number of Wholesale Prices (base 1970-71) have been used for this purpose. The construction of the capital stock series also requires data on unit value index of imports (UV1M) which was obtained from the RBI Bulletins. The price index of construction is the implicit price deflator obtained from the National Accounts Statistics (NAS) of CSO. A detailed description of the measurement of variables and the nature of the data sources used is given in Chapter 5.

1.6 Likely Contribution of the Study:

The importance of the present study lies in its contribution to two aspects- theoretical and empirical. In the present study, the analytical framework adopted is based on the use of linear programming techniques to construct a production frontier based on observed inputs and outputs. The notion of capacity is an economic notion. Capacity output is defined as the maximum output that can be obtained from given plant and equipment provided the availability of variable factors of production is not restricted. Thus unlike most empirical studies in India, the present study obtains trends in *CV* based on an economic notion of capacity and derived in a production frontier framework.

Empirically, the study is comprehensive in terms of coverage of industries as well as time period. In the study, eighteen industry groups of the Factory sector at the two digit classification of the ASI are included. These industry groups account for over 85% of net value added of the organized industrial sector in India. The two digit industry groups not included in the study are- electricity, gas, water works, cold storage and repair services. The period of study is for thirtythree years- from 1960-61 to 1992-93.

In the study, trends in three measures of capacity utilization are given and analyzed. In addition the analysis of CU estimates is also undertaken in terms of the performance of the industrial sector in India. The time periods corresponding to the debate on industrial retrogression and revival are chosen to analyse the trends in CU. Also, an industry analysis in trends in CU rates according to process and use based classification is given. Besides, trends in estimates of technical efficiency are obtained and a measure of scale efficiency is computed for the industry groups to enable the determination of scale economies. The analytical framework adopted in the present study also enables the estimation of input utilization rates for the variable factors of production- labor, energy and materials. Thus the present study enables the identification of the major input constraints limiting the use of productive capacity. This can enable policy makers to identify these constraints and to undertake appropriate actions to overcome these restrictions so that productive capacity installed in the industrial sector is fully utilized.

1.7 Organization of the Study:

The study is organized in the following manner: Chapter 2, begins with a discussion on the concept of 'capacity' and a review of the alternative approaches to the measurement of capacity utilization. Chapter 3 is a review of the determinants of utilization of capacity as given in the literature. In Chapter 4, the methodology used for deriving nonparametric measures of capacity utilization based on linear programming techniques to construct a best practice production frontier based on inputs and output is given. Chapter 5 presents the basic data sources and the measurement of variables required in the study. Chapter 6 is a review of the studies on capacity utilization in India. Chapter 7 presents the results on trends in capacity utilization based on the nonparametric linear programming approach for eighteen industry groups at the two digit level for the organized manufacturing sector in India for the thirty three year period from 1960-61 to 1992-93. This chapter includes results on three different measures of capacity utilization namely plant capacity utilization (PCU), capacity utilization unadjusted for inefficiency (CAPUT) and plant capacity utilization obtained under the assumption of variable returns to scale (PCUVRS). A detailed discussion on the trends, period wise comparison and a comparison according to use based and process based classification is included. Chapter 7 also includes trends in the estimates of productive or technical efficiency. The nonparametric linear programming approach used to obtain estimates of capacity utilization also enables the estimation of input utilization rates. These are given in Chapter 8.In addition, this chapter also attempts to determine if inefficiency is due to scale inefficiency and then find out the nature of scale economies. A brief summary and some policy implications are given in Chapter 9.

CHAPTER 2

REVIEW OF LITERATURE: CONCEPT AND MEASURES OF CAPACITY UTILIZATION

2.1 Introduction:

The issues relating to the concept of '**capacity**', its measurement and the factors affecting capacity utilization are of obvious interest in a country like India. But the concept of '**capacity**' and '**capacity** utilization' do not lend themselves to any simple and unambiguous definition and measuring it in practice also presents a number of difficulties.

In this **chapter**, Section 2.1 below, begins with a review of the different interpretations of the concept of '**capacity**' as it has emerged in the literature. Section 2.2 is a review of the alternative measures of capacity utilization followed by some concluding remarks in Section 2.3.

2.2 The Notion of 'Capacity':

As Klein (1960) has pointed out: "Economic analysis is replete with use of the term *capacity,* yet comparatively little attention is devoted to a precise theoretical statement of the concept. It is often used as a self-defining term and it may be taken for granted that there is agreement about its meaning. If we were to set out upon the task of measuring capacity, however, whether for a firm, industry or national economy we would be sure to encounter many theoretical difficulties and a clear conceptual basis would be necessary as a starting point."

The concept of capacity utilization frequently occurs in the discussion of theoretical and applied problems at both micro and macro economic levels. For instance, the existence of excess capacity is often cited as evidence indicating the presence of monopolistic elements within individual industries. The notion of CU is also widely used in business cycle analysis to characterize the situation of individual industries or whole economies and to assess the appropriateness of economic policy. It also plays an important role in econometric models in estimation of the relative significance of the determinants in investment, imports etc.

The concept of 'capacity' relates to output. It is therefore different from concepts referring to a single factor of production such as the degree of utilization of capital. The study of capital utilization began with the pioneering work of Marris in 1964. Capital utilization measures are intended to tell how much of the time on an average the productive capital stock of a firm, sector or economy are operated and how much of the time they are idle. The central issue in the study of capital utilization has been to discover what it is that determines, how much of the time a firm desires to operate and how much of the time it wants to be idle. Thus theoretical models of capital utilization analyze and explain the cessation of productive activities at less than 100% of technical maximum productive capacity, caused by rhythmically varying factor prices. (Bosworth and Dawkins,1983)

On the other hand, the notion of capacity relates to potential output. Capacity utilization is then actual output expressed as a percentage of potential output. Since potential output is not directly observable it can refer to either maximum output or efficient output. Maximum output implies a technical definition of capacity, an engineering capacity. The engineering concept refers to the flows of potential output, per unit of time obtained from a capital stock as capacity output. In this concept thus, the centrality of fixed capital stock is a basic characteristic. This concept of capacity is analogous to the concepts like rated capacity or installed capacity. To an engineer, capacity may be associated with the nameplate rating on a generator or some analogous concept.

Klein (1960) uses the economist's concept of a production function to illustrate the notion of maximum output. According to him, capacity is an index combination of all fully utilized factors including capital stock as well as other factors. Capacity output is the production flow associated with the input of fully utilized manpower, capital and other relevant factors of production. Thus Klein has broadened the engineering concept of capacity since capacity is not purely a proxy for the capital stock but depends on all factors of production.

Klein's notion of maximum output is similar to the notion of plant capacity defined by Johansen (1968). According to Johansen: "Plant capacity is the maximum output that can be produced per unit of time with existing plant and equipment provided that the availability of variable factors of production is not restricted." In this notion too, like Klein's concept of capacity, the centrality of capital is still there but its productive capacity is adjusted with the availability of other inputs. In the recent literature, Fare (1984) and Fare, Grosskopf and Kokkenlenberg (1989) have obtained measures of plant capacity and utilization rates based on Johansen's definition and using frontier rather than 'average' production functions. A detailed discussion of this approach is given in chapter 4.

Thus, an engineer's notion of technical capacity is a straight-forward one and is in terms of rated capacity or installed capacity; while the economists notion of maximum output is based on either Klein's or Johansen's definition and can be estimated using a production function. The distinction between these two notions is that capacity can refer to the maximum output associated with fixed capital alone or it can refer to all factors of production. This distinction is the same as Cassel's (1937) distinction between shortrun and longrun capacity. In fact, Cassel (1937) recognizes that the term excess capacity is sometimes used with respect to the fixed factors of a firm, an industry or an economy while at other times it is used with reference to all the factors involved in the functioning of the economic unit concerned as in the context of short and longrun cost curves.

In the literature, capacity is also taken to refer to a most efficient level of output and this suggests an economic capacity, which is quite different from an engineering or technical maximum output. A technical maximum not based on cost considerations can seldom be attained. The economic capacity concept on the other hand, takes explicit account of economic factors like cost considerations.

Prof. Chamberlin is one of the first writers to have paid attention to the thereotical concept of capacity. According to him, imperfect competition causes inefficiency in economic organization and thus gives rise to excess capacity. The great advantage of Chamberlin's concept is that it brings in the economic considerations of cost in defining capacity.

The earliest work on the economic concept of capacity is that by Cassel (1937). Cassel makes a clear distinction between excess capacity of fixed factors (short run cost curves) and excess capacity of all factors (long run cost curves). In relation to short run excess capacity, he points out that since the absolute technical upper limit of the output obtainable from the fixed factors is likely to lie far beyond the realm of practical economic operations, capacity output should be taken as that at which the average ftill costs of production are their minimum. Cassel's interprets Chamberlin's analysis as applying to all factors and therefore longrun curves.

Klein (1960) and Hickman (1964) also point out that full capacity should be defined as the output level associated with full competitive equilibrium. For the individual firm, this point would occur at the minimum of the average cost curve. However, empirical implementation of the economic notion of capacity ran into problems partly because of the problem of the estimation of a cost function and partly because there were serious doubts that the longrun average cost curve actually curves up. Klein (1960) therefore suggested modifying Cassel's notion by specifying that capacity output be that output at which the shortrun average total cost curve (with capital being fixed in the short run) is tangent to the longrun average cost curve. If constant returns to scale prevailed in the longrun, then of course capacity output would correspond to the minimum point on the shortrun average total cost curve.

Thus two different definitions of potential output for the economic approach are available. The first, suggested by Cassel's (1937) and Hickman (1964) corresponds to the output at which the shortrun average total cost curve reaches its minimum. The second, suggested by Klein (1960) corresponds to the output at which the longrun and shortrun average total cost curves are tangent. Under the assumption of constant returns to scale, the two definitions are equivalent.

Thus, while the notion of capacity based on cost considerations has existed in the theoretical literature for a long time, its empirical implementation was not feasible as it (then) posed intractable problems of specifying and estimating the parameters of the cost function. It is only much later that with the thereotical contributions to duality theory by Shephard, Diewert, Lau, Fuss and McFadden the use of short run specifications of a firm's temporary equilibrium and the possibility of making a distinction between short and long run average cost curves that enable one to obtain econometric measure of capacity output and thus capacity utilization.

The framework for defining economic measures of capacity utilization has been developed by Berndt and Morrison (1981), Morrison (1985, 1986), Nelson (1985) and Berndt and Hesse (1986) and others.

Thus, to sum up the discussion so far, a distinction has been made between two notions of capacity output based on maximum output or efficient output. The technical or engineering concept of capacity refers to the maximum output that can be obtained by fixed capital stock alone. An economist's notion of maximum output refers to the maximum output that can be obtained from all factors of production including capital. The notion of capacity as it refers to efficient output on the other hand, explicitly brings in cost considerations and is efficient output corresponding to either the minimum point of short run average cost curve (Cassels, Hickman) or the point of tangency of short run average cost with long run average cost curve (Klein). We now make a comparison of the notions of potential output - maximum output and efficient output.

Technical Maximum Output and Efficient Capacity Output-A Comparison:

The following discussion makes clear the distinction between the engineering notion of capacity in which there is centrality of fixed capital and the economic notion of capacity which is based on cost considerations. Winston (1977) shows how the firms least cost level of output, its economic capacity, arises when its capital stock is idle much of the time, and economic capacity is therefore a level of output that is less than the engineering or technical maximum. The question that is frequently asked is how is it that firms capital is idle most of the time if capital stocks define output capacity? That idle capital is usually optimal is an insight that depends on a time specific or optimal utilization analysis of the firms production decisions, an analysis that is based on Marris's (1964) pioneering work.

Marris (1964) showed that firms in British industry planned ex ante and intentionally to leave capital idle most of the time as a rational investment decision. His study focussed on the wage rate changes between day and night shifts and week days and week ends – a view that has been broadened to include rhythmic changes in input prices in general. The theory of capital utilization has been extended in a series of papers by Winston (1971, 1974,1982), Winston and McCoy (1974), Betancourt and Clague (1975,1978) with particular reference to the less developed countries.

Thus, in a situation of rhythmic input prices, the most efficient least cost level of utilization (and output) for a firm will often be a good deal less than the maximum level of utilization (and output) at which technically it could operate. The typical firm could always produce a good deal more output per year simply by utilizing its capital stock more of the time, but to do so would increase its costs of production. So the firms least cost level of output, its economic capacity comes when its capital stock is idle much of the time and economic capacity is therefore a level of output that is less than the engineering or technical maximum. Idle plants and maximum efficient output coincide because it is efficient for firms not to use their capital all the time.

In the figure below, MN corresponds to 8760 hours, that is the total number of hours in a year that capital stock can be operated. The output that could be produced if the firm/industry worked for MN hours per year would be the technical maximum output. But bringing in cost considerations reduces the economic desired level of utilization to say MH_d. Suppose this is 2000 hrs per year. The output produced when the firm operates 2000 hrs/year is the firms capacity output, the output that coincides with its optimal capital utilization. If the firm actually produces output by operating only 1800 hrs in a year, the firms capacity utilization then is 90% (=1800*100/2000). Its capita] utilization is 21% (=1800*100/8760) of the time. Thus, the firm has 10% excess capacity when it operates 21% of the time. If the firm operates at "100 % of capacity" (i.e. 2000 hrs a year), it operates its plant 23% of time and under utilization of capital is still 77%.

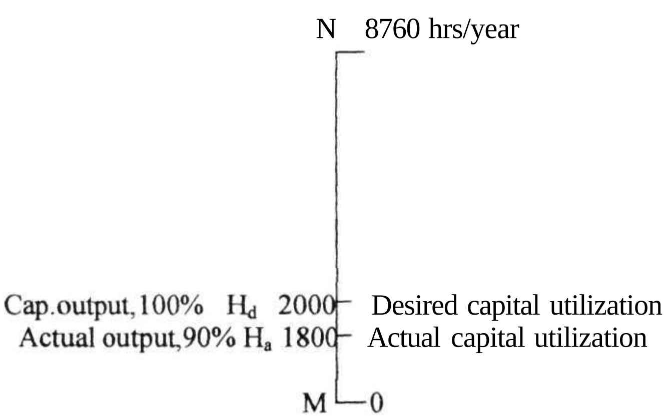


Figure 1: Capacity utilization and capital utilization of a firm

The notions of capacity given above however are not comprehensive and can in no way be said to complete the discussion on the notion of 'capacity.' In an individual firm for example, the perceptions and decisions of managers and owners, influence of management capabilities, qualitative differences in inputs, demand conditions etc., influence the capacity output. According to Panic (1978): "It can be argued for instance that managers of a firm are the best judges of what its 'capacity' is ...." Thus, according to the operational concepts, capacity output is largely related to the fixed stocks of capital but is significantly influenced by the availability of variable inputs, costs of inputs as well as such qualitative factors as managerial quality and objectives etc. Thus, capacity is an instrument variable with management because management can alter the rate of utilization of capacity depending upon several factors. Thus, at the individual firm level, managers might interpret capacity to mean 'practical' capacity or 'preferred' capacity (See Christiano, 1981). The 'practical capacity' concept is defined as the maximum output that is possible given a fixed plant and equipment and 'realistic operating conditions'. The latter are related to such things as machine maintenance requirements, number of shifts assumed and 'reasonable ' expectations of productivity from the work force. The concept of 'preferred capacity' is defined as the level of output that firms wish to produce given current market demand conditions and thus treat capacity as a function of the level of demand.

Thus, the review of the notion of capacity shows the considerable problems in its interpretation. While an engineer's notion of capacity refers to a technical maximum from given plant and equipment, an economists notion is based on cost consideration and includes not only availability of capital stock but also input prices. To an economist, technical maximum output is not an economic feasible output. On the other hand, the concept of preferred capacity and practical capacity are often used by managers at the plant / firm level. The following section is a review of some of the measures of capacity utilization corresponding to various notions of capacity.

2.3 Measures of Capacity Utilization:

This section deals with several methods that have been developed to measure capacity utilization. A number of alternative measures of capacity utilization based on various notions of traditional, economic or operational capacities are available. A detailed survey of various measures is given in Christiano (1981).

Concepts of capacity utilization fall roughly into two categories - those that concern the degree of utilization of capital only (capacity utilization in the 'narrow' sense) and those that concern the degree of utilization of all resources, including capital (the 'wide' sense). The purely engineering concept of capacity refers to the maximum output that can be produced with a given plant and equipment. In this context, since the centrality of capital is important this section first begins with a discussion on two measures of utilization of capital that have employed published industrial data and are based on shift working data or electric power consumption data.

Shift working method: In a number of countries the data on the number of shifts worked for an industry or sector are often available.

These data describe the number of shifts worked in the typical day or in the typical week. From these data it is possible to obtain a measure of utilization of capital stock. For example if the typical plant in an industry works for two shifts in a day, then capital utilization for that day is roughly 67%.

Thus shift working data can be used to provide crude but useful measures of capital utilization. However, since the data report only shifts works per typical day, they do not reflect variations in capital utilization due to variations in days worked per week or in weeks worked per year. This measure has been used by Winston (1971) for Pakistan and Islam (1978) for Bangladesh. For India Paul (1974) uses a modified engineering approach based on data on installed capacity and actual production and re-computing installed capacity for number shifts actually worked.

Electricity consumption method: Alternative capital utilization measures have been derived using electric power consumption data. This measure was derived by Foss (1964) and later used by Jorgenson and Griliches (1967) for U.S., Heathfield (1972) for U.K. and Kim and Kwon (1977) for S.Korea. The basic premise of this measure is that since electric motors account for most of the mechanical work done in factories, the intensity of usage of the machinery can be established by finding the intensity of usage of electric motors which drive the machinery.

The utilization rate is defined as the ratio of the actual number of hours per period during which a given electric motor driven equipment is run to the total available number of hours during the same period. For purposes of computation, the utilization rate is defined by the ratio of actual consumption of electricity (kwh) to the maximum possible consumption by installed electric motors; where the maximum possible consumption is given under the assumption that all installed electric motors are operated continuously with out an interruption during a given period. Following the notation of Kim and Kwon(1977):

$$U_{it} = [E_{it}^{m} / (C_{it}^{m} * 8760/0.9)] * 100 \qquad \ldots\ldots 2.1$$

where

U_{it} = electric motor utilization rate (%) of sector i in year t,

E_{it}^{m} = actual consumption of electricity (kwh) by motors of sector i in year t,

C_{it}^{m} = 'rated capacity' of installed electric motors (kwh) of sector i in year t.

The denominator in 2.1 gives the maximum consumption of electricity (kwh) corresponding to 8760 hours in a year. The fraction 0.9 is used to allow for the fact that about 10 per cent of power input into motors is dissipated in the form of heat.

The main strength of the electricity-based measure is that from published data on total nameplate capacity and actual sales of electric power, a quick and simple measure of capital utilization can be constructed. The easy availability of such data has enabled construction of a long time series of capital utilization in the U.S (Foss, 1964) and S.Korea (Kim and Kwon, 1977).

As pointed out by Lim (1976) the electricity measure may underestimate the level of capital utilization in LDC's. This is because, in LDC's due to lack of electricity supply, plants may be operated by other prime movers such as steam engines and turbines. Also, in many industries some of the equipment may depend more on direct heat than mechanical energy. Use of electric power consumption data would then understate the extent of utilization.

Survey Measures of Capital Utilization: The World Bank (Bautista et al, 1981) and ILO (Phan-Thuy et al, 1981) studies used survey data to obtain estimates of both capital and capacity utilization. In these surveys, individual production managers of a plant were the source of data on actual capital utilization: the number of hours of operation per day, the number of days per week and the number of weeks per year. Thus the data obtained gave the actual capital utilization i.e. hours of utilization of the plant and equipment per year out of 8760 hours in a year. Desired or optimal capital utilization estimates were then got from a manager's response to what he considered the "best" or "most efficient " schedule of operation for that plant and the number of hours per year that that estimate would imply. For each plant in the surveys the data collected enable the construction of a diagram (1) described in section 2.1. Thus the surveys yielded measures of actual and desired capital utilization as hours of capital services per year.

This measure of capital utilization based on survey data on hours worked was evolved by Winston (1974) and has been used in the World Bank country studies by Thoumi for Colombia, Lim for

Malaysia, Bautista for Phillipines and Morawetz for Israel. In the ILO study this measure was used by Winston for Nigeria, Betancourt for Sri Lanka and Phan-Thuy for Morrocco.

The main problem with such survey measures is that very often the size of the sample is too small, while extending the sample size could prove to be an expensive proposition.

The above discussion has been reviewing the alternative measures of capital utilization. Capacity utilization rates refer to the output gap between desired and actual output. Both the shift working method and survey data however reveal not only extent of capital utilization but also capacity utilization measures.

Again, the two basic approaches to measuring capacity utilization are based on either (a) survey data or (b) published data.

(a) Survey based measures: In surveys, firms typically report the rate of capacity utilization -they indicate whether they operate at full capacity, give an assessment of capacities (too large, sufficient or too small) and the like. As managers can be assumed to know best what their firms would be able to produce at full capacity, this direct source of information seems indeed very powerful. Some problems exist however the surveys are usually confined to manufacturing, the derived indicators are likely to involve reporting and sampling errors as it is usually left to the respondents how they want to define production capacity, the interpretation of the answers is not always clear. As pointed out by Stalder(1989), despite these limitations, survey based measures of capacity utilization have the undeniable advantage of reflecting tension as perceived by firms and this is the relevant concept in many contexts especially when it comes to explaining firm behaviour (e.g. investment and price-setting decisions)

Two different survey based measures are available. In the first type of survey measures of capacity utilization obtained by McGraw Hill Publishing Co. (MGH), US Department of commerce, Bureau of Economic Analysis (BEA) of US etc. firms are asked at what per cent of full capacity they are currently operating. In the other type of survey measures, firms are asked whether they are operating at full capacity or not. Examples of the use of this measure are the Confederation of Business Industries (CBI) of U.K, the National Institute of Statistics and Economic Studies of Paris, the Swedish Business Tendency Survey and in one variant of the BEA Survey of the U.S. Dewhurst (1989) uses survey data from CBI of the percent of firms reported to be working below capacity into a capacity utilization index for the U.K.

Survey based measures, being subjective in nature, are highly sensitive to the notion or definition of "capacity" the respondent uses. Since the definition is often left to the respondent, it may be interpreted in the sense of utilization of capital only or in the sense of the extent to which all resources are utilized. Any attempt to define capacity with complete precision *is* not really possible and troublesome ambiguities arise with regard to product mix, the relevant time period and the interpretation of "normal schedule of operation". In commenting on utilization rates computed from surveys, Perry (1973) states : "It appears that respondents 'find' capacity when output rises sharply and 'lose' it when output slackens." The reasons that have been offered to explain this include for example the fact that in periods of high demand, firms include marginal plant and equipment that they consider "normal" in calculating their capacity when demand is high; the opposite happens when demand low. Again, firms increase the number of shifts and amount of overtime that they consider "normal" in calculating their capacity when demand is high; the opposite happens when demand is low.

Despite the limitations of survey based measures, capacity utilization estimates based on these measures are regularly published in developed countries e.g. MGH and BEA in U.S, CBI in U.K etc. The World Bank (Bautista et al, 1981) and ILO (Phan-Thuy et al, 1981) studies also provide survey measures of capacity utilization.

(b) Published Data Based Measures: The alternative to asking firms about their capacity utilization is to infer it from published industrial data. Capacity utilization is obtained as the ratio of actual output to some measure of 'capacity output'. Depending on how 'capacity output' figures are obtained, a number of alternative data based measures of capacity utilization are available.

The Production Function Method: This method has been developed and used by Ball and Smolensky (1961), Klein and Preston (1967), Briscoe et al (1970), Harris and Taylor (1985) and others. Here the production function is fitted to published data. The estimated production function captures the long run relationship between the inputs (e.g. capital stock and labor and output). For any period, the figures of actual output are compared to the capacity output estimated at full employment of resources to determine capacity utilization series. Thus the notion of capacity used is the economists notion of maximum output corresponding to all factors of production, including capital stock and the estimation technique is an analytical one based on production function. Suppose the relationship between output and inputs in any period t can be stated as follows:

$$Y_t = \phi (L_t, K_t, t, \varepsilon_t) \qquad \ldots 2.2$$

where Y_t denotes real output, L_t labor input expressed in man-hours, K_t the flow of capital services, t is a proxy for technical change and ε_t is an error term. If ϕ can be specified (e.g. Cobb Douglas) and its parameters estimated, then we can write the relationship for output at peak (full capacity) periods as:

$$Y_t^c = \phi (L_t^f, K_t^f, t) \qquad \ldots 2.3$$

where L_t^f and K_t^f refer to full employment supply of man-hours and available flow of capital services. The index of capacity utilization is then computed as $U_t = Y_t/Y_t^c$ for any period t.

The problems with this method relate to the measurement of capital stock series as well as measurement of full employment levels of man-hours and flow of capital services. The measurement of the two inputs are interrelated and alternative assumptions have been made in estimating K_t^f and L_t^f. Klein and Preston (1967) relate capital utilization to manpower and assume that:

$$(K_t^f/K_t) = (L_t^f/L_t)$$

If the production function is Cobb Douglas, then:

$$(Y_t / Y_t) - (L_t / L_t) \varepsilon_t \quad \ldots\ldots 2.4$$

Full employment labor force is obtained by specifying it as a function of employed labor force, involuntarily unemployed labor force and frictionally unemployed labor force. Full employment man-hours are then obtained by an adjustment factor for actual man-hours used. Thus the rate of unemployment is directly related to the rate of capacity utilization. The index of utilization is obtained as:

$$\log Y_t - \log Y_t^c = (\alpha+\beta)*(\log L_t - \log L_t^f) + \log \varepsilon_t \quad \ldots\ldots 2.5$$

The method used by Klein and Preston assumes that the output observed in any time period is the equilibrium level for the observed rates of utilization of the inputs. If this is not an appropriate assumption as pointed out by Briscoe et al (1970) then the divergence of actual output from full capacity output is composed of two elements. First, there is the divergence due to insufficient utilization of inputs by the industries and second, there is divergence due to insufficient production with the inputs actually observed. This would be because labor hoarding is occurring within the industry or because demand for output is fluctuating regularly so that firms are repeatedly in disequilibrium with respect to output levels (or employment levels for inputs). It is important to distinguish between these components since they have different implications for policies concerned with the elimination of excess capacity. Specifically, we might find inputs

fully utilized for an aggregate of industry but total output below the level it could attain since the resources are not correctly allocated between the industries. Given a proper functioning of the price system and sufficient time, this situation will be corrected. On the other hand, each industry could be at its equilibrium output level for the optimal allocation of resources but resources, as a whole may not be fully employed. To remedy this situation may require a deliberate policy designed to stimulate overall demand, employment of resources and hence supply of output. Briscoe et al (1970) use the simple dynamic adjustment mechanism of Koyck to show the influence of lagged ouput term on the estimation of capacity utilization. If the Cobb Douglas production function is assumed, the equilibrium level of output is:

$$Y_t^* = A\, e^{\beta 1 t} L_t^{\beta 2} K_t^{\beta 3} Z_t$$

.....2.6

and $$(Y_t/Y_{t-1}) = (Y_t^*/Y_{t-1})^{\eta}$$

with restrictions : $0 < \eta < 1$ and $Y_t^* \neq Y_t \neq Y_{t-1}$ Here A, β_1, β_2, and β_3 are parameters to be estimated. Y_t^* is the equilibrium level of output for observed factor inputs and η is the speed of response while Z_t is the error term.

From the above two equations:

$$\ln Y_t = \eta \ln Y_t^* + (1-\eta) \ln Y_{t-1}$$

$$= \eta[\ln A + \beta_1 t + \beta_2 \ln L_t + \beta_3 \ln K_t + \ln Z_t] + (1-\eta) \ln Y_{t-1}$$

Once the parameters are estimated, then capacity utilization series *is* obtained as: $U_t = \ln Y_t - \ln Y_t^c$

This approach brings out clearly the influence of lagged output on the estimates of capacity. Thus the production function approach is analytically better than simple statistical constructs. The problem with this approach relates to measurement of capital input and the ftill employment resources of both labor and capital. Another major problem with this approach is that unless the parameters of the production function are re-estimated sufficiently frequently, utilization rates will become increasingly biased. Furthermore, whenever the parameters are re-estimated, the entire historical series has to be revised (Christiano, 1981).

Output based methods: In the output-based measures, capacities are obtained from the time series of output. Two alternative assumptions are basic to these methods: first, that a variant of a least squares trend line - either linear or quadratic - of output has the same trend as capacity (Paish, 1962;Godley and Shephard, 1964); second, that the peaks of output in each cycle represent the same level of capacity utilization (Wharton Method).

In the first method of Paish (1962) peaks in the index of industrial production are identified and these peaks are used to construct capacity ceilings by reference to similar levels of unemployment in the business cycle, which are held to define the relevant growth rates. Godley and Shephard (1964) estimate capacity output by a regression equation which makes capacity output a function of a quadratic time trend and the growth in the supply of labor. Briscoe, et al (1970) have also used this method to provide an alternative measure of capacity utilization for U.K.

The main criticism is that: firstly, these methods assume that the availability of labor is the basic constraint and ignore other constraints (Hilton and Dolphin, 1970) and secondly, as pointed out by Briscoe and O'Brian (1972) when capacity output is obtained by applying least squares time trends to actual output then the result will yield average rather than maximum levels and the utilization values so derived will contain values greater than 100 per cent.

The second approach of considering peaks in output as reflecting the same level of utilization at each peak has come to be known as trend through peaks method or Wharton method. This measure is associated with Klein and with Wharton Econometric Forecasting Associates Inc. (WEFA). The method is described in Klein and Summers (1966). In this method for any industry, first the seasonally adjusted indices of output figures are plotted and the peaks identified by inspection. A peak quarter is defined as one where output (measured at constant prices) exceeds the level of immediately preceding quarter and the two succeeding quarters. It is assumed that these peaks represent capacity output. Then a straight line is drawn between the major peaks and is extrapolated beyond the last one (in declining industries, a maximum attained within the period is selected and capacity is kept constant at this level). The line drawn is taken to be capacity output. Capacity utilization is the ratio of actual output to contemporaneous points on the line drawn. The capacity utilization figures so derived are aggregated to the industry level using peak output value added weights.

The advantage of this method is that it is simple and can be easily implemented from the published data. Phillips (1963) has summarized the objections to the procedure: peaks may not represent the same level of utilization in each cycle and capacity may not follow a straight line between peaks. The process implies that capacity grows smoothly between the two peaks, without regard to the increase in capital and labor availability. An important feature of the Wharton method is that for an aggregate of industries, such as the manufacturing sector the index never exceeds 100 per cent. It also never actually equals 100 per cent because all industries do not generally reach a major peak at the same time.

For the U.S economy, the objection against the Wharton index is that it has an upward bias since 1958-59. This is because the U.S economy did not achieve complete recovery from the recession of 1957-59 and subsequent peaks in many sectors therefore represented points of substantial under- utilization of capacity. To minimize this upward bias, a modification of the earlier method was suggested by Klein and Preston (1967). In India, the Reserve Bank of India (RBI) has used the Wharton method to derive measures of capacity utilization for the period 1960-61 - 1973-74.

Trend through the peak modified by other information on input flows merges the production function and Wharton methods, retaining information on capital or labor variations between peaks while still depending on those historical peaks to define capacity output. Thus, peak values in Y_t are identified (as in WEFA and are assumed to represent capacity output) and joined by a curve that takes into account developments in both labor and capital stock within the context of the estimated historical relation between these and output. An advantage of this method over the pure production function method is that it is benchmarked using the assumption that observed peaks represent points of ftill resource utilization. An advantage over the Wharton method is that it makes more efficient use of available information regarding what happens to potential output between peaks and since the most recent peak. The disadvantage of this modified method is that as in the production function method, construction of capital stock series poses problems and also when enough new data become available and the production function is re-estimated, the entire historical capacity output time series has to be revised.

Output/capital ratio method: This measure relies on the existence of a stable proportional relation between the stock of capital and potential output. The method assumes that fluctuations in the observed output / capital ratio are due largely to deviations in output from its potential. This method is used by British National Economic Development Office (NEDO), the Deutsche Institute for Wirtschaftsforschung (DIW) and Statistics Canada. A description of this method is given in Christiano(1981).

First, an actual output/capital ratio series (Y_t/K_t), t = 1,2......T is constructed, where Y_t and K_t are output and the capital stock respectively, at time t. Next, a 'capacity' output/capital series is obtained by fitting a linear trend to the actual output/capital series.

$$(Yt/Kt) = a_0 + a_1 t + u_t, \quad t = 1,2,...T$$

where a_0 , a_1 and u_t are fitted by least squares. The capacity output / capital ratio is taken to be the points on a line with time derivative a_1,

raised just enough so that it touches only one of the observed (Y_t/K_t) series , as depicted in figure 2 below.

The adjusted trend (Y/K) ratio - $(Y_t/K_t)^c$ is the assumed capacity output/capital ratio. This method thus assumes that actual and capacity output/capital ratios differ because of deviations of output from its potential. That is it is assumed that:

$$(Y_t/K_t)^c = Y_t^c/K_t$$

The capacity utilization series is then obtained as:

$$CU_t = (Y_t/Y_t^c) * 100$$
$$= (Y_t/K_t) *100 / (Y_t^c/K_t)$$

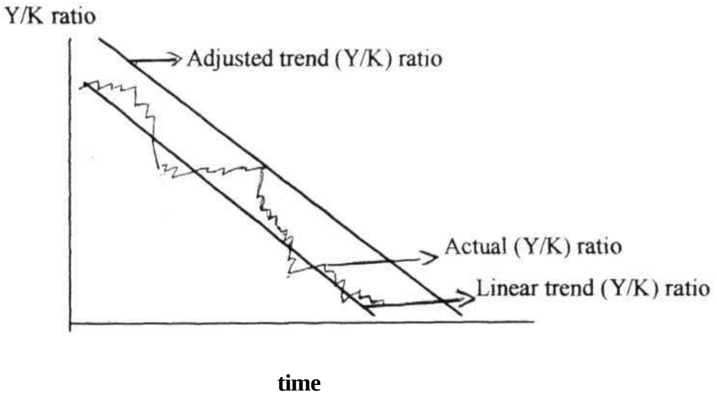


Figure 2

In this approach, the estimation of the capital stock however poses problems as in the production function method. The production function method is more general as it can take account of non-trend like shifts in the capital/labor ratio. This approach like the Wharton

method is simple to carry out as it is based on published data. An advantage over the WEFA method is that it relates the growth and fluctuations in capacity to investment activity.

2.4 Concluding Remarks:

Thus, capacity utilization is a useful concept but difficult to define. This chapter has highlighted the different conceptual problems in the interpretation of the concept of 'capacity'. The review also shows that various measures of capacity utilization have been used in the literature. These measures are widely different with respect to conceptual as well as data base requirements.

The Survey measures of capacity utilization are based on an operational understanding of the term 'capacity' by plant managers and therefore give interesting insights at the micro level. Estimation of capacity utilization series by Wharton approach is simple and can be easily undertaken from published data on output series, yet the procedure gives simple statistical constructs and is not based on a strong theoretical concept. Estimates of capacity utilization via production function are clearly more satisfactory from an analytical point of view than the straightforward application of statistical rules to output time series. The present study is based on the nonparametric frontier production framework and uses linear programming techniques to obtain maximum potential output.

CHAPTER 3

DETERMINANTS OF UTILIZATION

3*1 Introduction:

The discussion in the preceding chapter focussed on the alternative measures of capacity utilization. A number of empirical studies have also focussed on identifying the major determinants of utilization rates. In this chapter the focus is on identifying the major determinants of utilization levels. It is not only important to obtain estimates of capacity utilization but once these estimates reveal significant underutilization of capacity as is the case in many developing countries it is necessary to identify the major determinants of underutilization of capacity. Given the significanace of the manufacturing sector and given that there is existence and persistence of large underutilized capacities which developing countries can ill afford, identifying the major determinants of underutilization is of utmost concern. This can help policy makers in these countries to take timely corrective actions to help increase utilization levels and thereby increase output levels as well as savings, investment, employment etc.

Section 3.2 is a detailed discussion on the major determinants of utilization levels while Section 3.3 contains some concluding remarks.

3.2 Determinants of Utilization:

In recent years, the determinants of capital utilization as well as capacity utilization have received a lot of attention. In the determinants of capital both intended and unintended departures from frill time operation of capital stock are included. In developed countries, the focus is on intended capital idleness as highlighted by Marris (1964). In developing countries, it is unintended capital idleness that has received attention. The five major determinants of capital utilization are the wage rate, the price of capital, the size of the night shift wage premium, the capital intensity of the production process and the plant size. Higher the price of capital, bigger the plant size, more capital intensive the production process, lower the wage rate and less rhythmic the input prices, the higher is capital utilization. These and other determinants like market structure, import dependence of inputs, export dependence of final product etc. have been used in empirical studies by Winston (1971), LeCraw (1978), Lim (1976), Betancourt and Clague (1978) and Kim (1982).

As for capacity utilization, in developed countries, capacity utilization figures are watched closely as they reveal turns in the economy. Less than full capacity utilization is attributed to shortages of demand. In developing countries, excess capacity is attributed to a number of reasons. These include demand constraints as well as supply bottlenecks like non-availability of essential input supplies (including both domestic and imported), shortages of power and transport, labor unrest etc. (Wangwe, 1977; Paul, 1974; NCAER, 1966; Goldar and Renganathan, 1991; Srinivasan, 1992, 1993 etc).

Since increased capacity utilization presents an important means of accelerating growth in capital scarce developing countries, unravelling the determinants of utilization is important for policy purposes. Since idleness may be both intended or unintended, the extent of these two and the reasons for them have important policy implications for governments in LDC's.

In figure 1 below, different levels of capacity utilization are shown. M is the maximum utilization; P is the profit maximizing or cost minimizing utilization; D is the desired utilization and A is actual utilization. M ≠ 8760 hours due to necessary plant shutdown time for maintenance. M, P, D and A are not necessarily in the order or at the level shown in the figure 1.

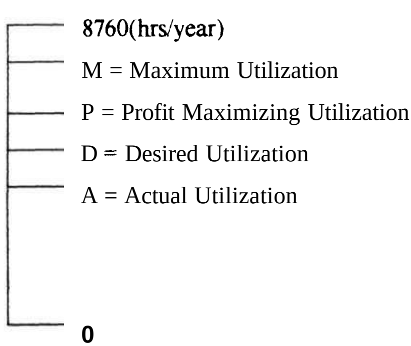


Figure 1: Levels of utilization

M refers to a technical maximum output corresponding to the engineering notion of capacity. P on the other hand corresponds to an economic notion of capacity. Since bringing in economic cost considerations has the effect of lowering the efficient maximum output, P will in general be less than M. In continuous process industries like cement, steel etc. however the two utilization levels may be the same (due to high start up and shut off costs, plants are operated continuously). The profit maximizing level of capacity utilization, P should depend solely on the 'economic' variables incorporated in neoclassical production theory: the range of technology available to the firm and costs of all its factors of production. This neoclassical theory has several implications for the level of the profit maximizing rate of capacity utilization, P. P for a capital intensive production process will be higher than P for a more labor intensive production process since the cost of leaving the capital stock idle will be higher relative to the cost of workers needed to operate additional shifts. As the factor price ratio- wages/capital cost rises, P will decrease as the firm substitutes relatively cheap capital for more expensive labor. Similarly, P will decrease with an increasing shift differential as the cost of multishift labor increases relative to the cost of leaving the plant idle. P can also be influenced by the scale of operations of the firm. As the scale of operations increase, there may be fewer bottlenecks and the lumpiness of individual machines is more easily balanced thereby increasing the average capital utilization.

fa general, in theoretical analysis, P and D have been assumed to be the same and attention has been focussed on two types of underutilization- undesired capacity under utilization (D-A or P-A) and desired capacity underutilization (M-D or M-P since P=D). Undesired capacity underutilization is then attributed to deficient demand, input shortages, technological failure etc. in developing countries. Government policy prescription to increase capacity utilization rates would then concentrate on (macroeconomic) tools to increase demand, eliminate bottlenecks in input availability of both domestic and imported inputs, removing technological gap etc. On the other hand, desired capacity underutilization could be decreased by government policies which change relative factor prices, their variation over the work period, the range of technology available to the firm etc.

However, as LeCraw (1978) points out, the empirical works by Winston (1971) and Kim (1969) supports the conclusion that firms in LDC's do not maximize profits or minimize their costs of operation in their choice of their capacity utilization rates; i.e. D, the desired utilization rate and P, the profit maximizing rate are not necessarily the same. Other factors besides profit maximization have been shown to have a significant impact on the decisions of managers /owners of firms.

A number of non-neoclassical theories (Leibenstein, 1976; McCain, 1975 etc.) imply that desired capacity utilization will be a function of perceived risk, projected profits, ownership pattern, etc. as well as such 'economic' variables as the factor price, shift differential, capital intensity, scale of operation, growth in demand. Thus, firms are willing to trade off between profits and risk and to reduce profits if risk can be avoided. Leibenstein's theory of X-efficiency shows that most firms do not organize themselves to either maximize profits or minimize costs i.e. they operate with organizational inefficiency or X-inefficiency.

Degree of X-efficiency in a firm increases as internal motivation and as external pressure increase. Internal pressure increases as the separation between ownership and management decreases and when profits fall below acceptable limits. Profits provide both information and incentive. Low projected profits could goad managers to work harder while high profits could imply that managers couldn't/will not identify inefficient areas of operations. Thus there is a need to introduce such factors as risk reduction preferences of managers/owners, search costs of finding the profit maximizing organization of production process, costs of supervision to ensure profit maximizing behaviour of employees etc. in the determinants of utilization rates. In traditional theories of the determinants of underutilization, the desired non-profit maximizing capacity underutilization is assumed not to exist or to be insignificant. The reason why P and D have not been differentiated in the literature is because the empirical support for these non neoclassical theories is quite slim since it is difficult to ascertain the profit maximizing mode of operations and compare it with the one chosen by the firm. Government policy for such non profit maximizing capacity underutilization should concentrate on reducing the scope for non profit maximizing managerial discretionary behaviour, increase the information available to firms about multishift operations and try to decrease the real and perceived risk of such operations.

Thus, by making a distinction between alternative types of underutilization it is possible to focus more clearly on the major determinants of utilization and appropriate government policy measures can then be formulated to increase capacity utilization rates.

Another distinction *in* the literature is that between economic capacity and physical capacity as stressed by Harris and Taylor (1985). They distinguish between the excess capacity that could be utilized profitably at higher levels of monetary demand and excess capacity that could not be brought back profitably into production at higher levels of monetary demand. Thus as Robinson (1981) argues: "The general absence of orders which industialists bemoan is an absence of orders at today's prices. It is at least possible that in some severely depressed industries orders would be forthcoming at lower prices, but for such orders to be profitable costs would also have to be reduced".

During periods when business activity is depressed, firms do not employ as many inputs as are available to them either because input prices are too high relative to output prices or because the quantity of goods demanded is depressed. The choice of output level in these periods of lower economic activity is again an economic decision about profitability, subject to the technological 'blue print' embodied in the firm's production function. Spare capacity exists because it is not profitable to produce more output This spare capacity is part of the economic capacity of the firm, provided the available but unused factor inputs could be profitably brought back into production at the higher level of monetary demand.

Explanations of capacity underutilization that are typically given in LDC's are the variability of demand conditions coupled with the observation that capital investments are irreversible decisions. Such reasons are however valid in explaining variability in capacity utilization but are inadequate in explaining the 'persistence' of excess capacity over time. Sahay (1990) shows that persistence of excess capacity over time is a natural outcome under certain trade regimes irrespective of demand conditions or the reversibility of capital decisions. Her study thus provides a direct link between input quotas and excess capacity in developing economies. Capacity underutilization is a natural outcome when quotas are based on installed capacity. Many governments in developing countries issue licences for imported inputs on the basis of installed capacity and not actual production undertaken. A number of studies have shown that firms often invest in additional capacity not to produce output but because it provides a basis for obtaining a more generous allocation of imported inputs. Thus, restrictive trade policy regimes result in substantial economic costs including creation of excess capacity. This creation of idle capacity exacerbates the problem of capital shortages in developing countries.

In addition many markets in manufacturing sectors of developing countries are imperfectly competitive. The possibility of excess capacity as a means of deterring entry has been well documented in the literature on industrial organisation. Because investments in capital are irreversible decisions and represent preemptive commitments to the industry they can be used to discourage entry. An empirical implication would be to expect concentrated industries to have lower capacity utilization.

In many developing countries, manufacturing industries are protected by prohibitive tariffs on imports of final output but face a quota on imports of scarce factor inputs. The justification for quotas is to encourage the growth of domestic industries by protecting their final output from foreign competition but permitting limited imports of technology-embodied inputs. Thus the existence of excess capacity in manufacturing industries of developing countries is explained in terms of quantitative restrictions on imported inputs.

It is also argued that low levels of capacity utilization in the private sector (Chaudhuri,1978) are caused by low levels of public demand (assuming export inelasticity of demand for private sector output). Recent low levels of public sector development expenditure are caused largely by the absence of resource surpluses through the failure to mobilise resources at home and through the large losses suffered by the public sector enterprises induced by low levels of capacity utilization.

Thus, generally speaking the existence of capacity underutilization can be rationalized by demand or supply arguments. Of the latter, an incompatibility or complete absence of inputs to the production process is most common although labor troubles and resistance to multi-shift working have been shown to be important.

In the context of the Indian economy whilst the earlier years of planning were charachterized by shortages of skilled and technical personnel the more recent problems relate to shortfalls in maintenance imports and/or power supplies. From these considerations it appears that future levels of capacity utilization and hence industrial performance will be strongly influenced by the technical relationships that exist between inputs. That is, in the presence of foreign exchange and domestic resource constraints and with the absence of changes in product technology only allocative redistributions in response to shifts in relative prices can achieve improvements in productivity and utilization. Evidence on such technical relationships is therefore essential for any accurate assessment of future industrial performance relating to capacity underutilization. Lynk (1982-83) finds evidence of capital-energy substitutability and capital-materials complementary. This implies that future growth may not be constrained by high priced energy and may be facilitated by offsetting price-induced substitutions. The likely long run constraint to development will be shortage of materials operating most likely through the absence of maintenance imports and charachterized as a foreign exchange constraint and underutilized capacity.

That the framework used to obtain estimates of capacity utilization and explain levels of utilization is important is also clear from the results that have emerged in recent years in studies on economic measures of CU. CU measures obtained in a cost minimization framework dropped proportionately more after the energy crisis of 1973 as compared to traditional measures. This larger movement in economic CU measures is attributed by Berndt and Hesse (1986) to the fact that economic CU measures depend explicitly on input prices while the traditional measures do not. Their study also shows that electricity and fuel price increases had smaller impacts on capacity output relative to the prices of labor or capital.

Thus, economic estimates of CU obtained for DCs proved to be very useful in capturing the effect of energy price shocks of the 1970's. In particular the impact of the two energy price hikes of the early 70 's and late 70 's is reflected in lower levels of CU during the 1970's. Also, the theoretical framework can be used to assess the impact of variable input prices and output demand on CU. Excess capacity or overutilization of capacity can be attributed to changing economic circumstances in the form of changing output demand and input price variations.

33 Concluding Remarks:

The discussion in this chapter shows that in order to identify the factors causing underutilization of capacity it is also important to understand the framework in which estimates of CU have been obtained. Distinguishing between different types of under-utilization is important as it has important inferences for the different determinants of capacity underutilization. In developing countries identifying the determinants of utilization has an important role to play in industrial policy. This can lead to the adoption of appropriate remedial measures to increase utilization levels in capital scarce economies. Since the real cost of capital is high, investing in creating capacity and not utilizing it is a costly proposition. Capacity installed must be used to the maximum possible.

CHAPTER 4

MEASURING CAPACITY UTILIZATION: THE NONPARAMETRIC APPROACH

4.1 Introduction:

Since the 1980's there has been a rapid growth in econometric studies of capacity utilization based on the cost function (Morrison, 1985,1986; Nelson, 1985; Segerson and Squires, 1993, etc.). In recent years, programming models of technology are enjoying a revival in empirical economic research. Capacity utilization measures have been obtained in an alternative framework of frontier production function. This chapter outlines the basic necessity for using this approach as an important alternative methodology which can reveal important insights into an analysis of the estimates and trends in capacity utilization.

This chapter begins first with a note on the nonparametric linear programming (LP) approach to estimation of frontier technology in section 4.2. This section highlights the need for the use of an approach to capacity utilization which has only recently been used in the literature. This is followed by a detailed methodological framework for estimation of capacity utilization in section 4.3. In the present study, a time series on capacity utilization for Indian industries is obtained based on this approach. Section 4.3 contains some concluding remarks.

4.2 The Nonparametric Linear Programming Approach to Production Frontier Estimation:

This section focusses on a number of issues which are involved in using a nonparametric linear programming approach to production frontier estimation and its relevance to the measurement of capacity utilization.

Frontier vs. Average Function: In the first place, in this chapter an alternative approach to estimation of 'frontier' function rather than an 'average' function is given. In recent years, a number of studies have highlighted the importance of estimating 'frontier' rather than 'average' functions. These studies focus on the dichotomy which exists between 'theoretical' frontiers and 'empirical' functions. In theory, for example, a production function is a frontier that bounded feasible combinations of inputs and outputs. Empirically, however, production functions were estimated using notions of central tendency to obtain 'average' or 'most likely' relationships constructed by intersecting data with a function rather than surrounding data with a frontier. While the average function is associated with <u>mean</u> output the term frontier function is associated with <u>maximum</u> possible output for given input levels. Thus the shift from production function to production frontier implies a shift from the estimation of a 'most likely relationship reflecting central tendency' to a 'less likely relationship' that focuses on extremal tendency.

As Fare et al (1994) have pointed out: "...the structure of economic frontiers may differ from that of economic functions although both may be constructed from the same data. Thus, it is important to know whether, and if so in what ways the structure of efficient production differs from the structure of average function. Best practice may be better than average practice because it exploits available substitution possibilities or scale opportunities that average practice does not. Public policy based on the structure of best practice frontiers may be very different from policy based on the structure of average functions".

Specification of Frontier Technology: Studies of frontier technology can be classified according to the way the frontier is specified and estimated. The two fundamental approaches to specification of frontiers are nonparametric and parametric approaches. The parametric approach (either deterministic or stochastic) is the more common approach. Its distinguishing characteristic and its major disadvantage or weakness is the assumption (or imposition) of an explicit functional form for the technology. The nonparametric approach on the other hand does not require any specification about the functional form. Both these approaches have their own advantages and disadvantages (see Forsund, Lovell and Schmidt (1980) for a detailed discussion). In the present study, the nonparametric linear programming approach to frontier production function is used.

The nonparametric linear programming approach to frontier estimation: The nonparametric approach to frontier estimation is based on the early work of Farrell (1957) who provided a computational framework for technical and allocative efficiency. While the nonparametric linear programming techniques are widely used in operations research and management science literature, traditionally, empirical analysis in economics relies heavily on parametric techniques.

The parametric econometric approach to empirical estimation of production functions/frontiers requires the specification and estimation of a particular fiinctional form. However, typically economists do not have good *a priori* information about the true functional form representing technology. Even among flexible functional forms, there are a very large number of possibilities for choosing a parametric functional structure. This suggests the need to develop nonparametric methodologies that would not depend on the choice of a particular functional form. Nonparametric representations of production technologies have been developed over the last two decades.

In the nonparametric linear programming approach, a best practice production frontier is constructed from the observed inputs and outputs as a piecewise linear technology. The nonparametric method is easy to implement empirically, requiring the solution of simple linear programming problems. This approach provides a simple way of constructing frontier technology from data and enables the calculation of distance to that frontier for individual observations or activities. The frontier technology is formed as linear combinations of observed extremal activities yielding the frontier consisting of facets. The nonparametric representation fully charachterize the production technology while imposing a minimum of *a priori* structure. Hence these methods are very flexible and convenient tools for applied work on measurement of technical efficiency as well as capacity utilization.

The main motivation for the study of frontiers till recently has been the measurement of efficiency. In recent years, this has been extended to measurement of capacity utilization and productivity as well.

Measuring efficiency using a nonparametric approach began essentially with the path breaking work of Farrell (1957). The efficiency measures he developed was then specified as a linear programming problem and used to measure efficiency of decision making units (DMU's) by Charnes and Cooper (1961) and Charnes, Cooper and Rhodes (1978) and others. Beginning in the 1970's, Charnes, Cooper and Rhodes popularized the linear programming approach to frontier estimation in what has popularly come to be known as Data Envelopment Analysis (DEA).

Linear programming theory as it originally developed in an activity analysis approach is attributed to W.Dantzig and Von Neumann. W.Leontief developed the general equilibrium framework in his input-output analysis. More recently, the work of Fare, Grosskopf and Lovell (1994) etc. is related to the microeconomic production programming models. In these models, observed activities such as the inputs and outputs of some production units serve as coefficients of activity or intensity variables forming a series of linear segments yielding a piecewise linear frontier technology.

By tightly enveloping data points with linear segments, the programming approach reveals the 'structure' of frontier technology without imposing a specific functional form. The restrictions placed on the 'piecewise linear' reference technology in the nonparametric approach vary widely. The early work of Farrell (1957) was restrictive because of the assumption that production exhibits constant returns to scale (CRS). In a later work, Farrell and Fieldhouse (1962) allow for increasing returns to scale (IRS). In addition other researchers have developed piecewise linear techniques which are restricted to satisfying various types of non-constant returns to scale assumptions(e.g. Afriat, 1972; Koopmans, 1977; Shephard,1974). The least restrictive reference technology used in the literature allows for increasing, decreasing or constant returns to scale (Fare et al, 1985,1994 etc.).

Grosskopf (1986) summarizes the various reference technologies used in the literature and determines the effect of the various restrictions on the resulting efficiency measures. The various technologies are shown to be nested with the most restrictive technology containing the next most restrictive technology and so on. This systematic relationship in turn implies that the measures calculated (for e.g. CU or efficiency) relative to these reference technologies are also nested.

Primal vs. Dual approach: Most applications of the frontier methodology have been to estimating production frontiers. But as is well known, either the cost function or the production function uniquely define the technology. Which one of the two functions is to be estimated depends on one's assumptions and / or data While estimation of production function requires data on input quantities, estimation of cost function requires data on input prices.

The nonparametric approach to production frontiers using quantity information i.e. primal approach has been developed by Afriat (1972), Fare, Grosskopf and Grabowski (1985) etc. On the other hand, the dual approach to production analysis under the assumption of cost minimization or profit maximization has been developed by Afriat (1972), Hanoch and Rothschild (1972), Diewert and Parkan (1983), Varian (1984), Chavas and Cox (1988,1990). Also, Varian (1984) and Banker and Mendiratta (1988) have established relationship between primal and dual nonparametric approaches showing that primal and dual representations can provide nonparametric bounds on the underlying production technology.

Sequential vs. Intertemporal analysis: The use of various indices (like technical efficiency, productivity etc.) determined in a nonparametric framework depends on the nature of data available (see Chavas and Cox, 1994). With cross section data, if firm level information is available, productivity is indistinguishable from technical efficiency (TE). Indices (like TE) obtained are relative, with the efficiency of each firm measured relative to all other firms in the sample. However, these indices do reflect different adoption rates of new technology across different firms.

If time series data are available it enables the measurement of the rate of shift of the frontier technology over time. In the analysis of time series data, two approaches can be distinguished depending on the choice of reference technology :(i)a sequential analysis and (ii) an intertemporal analysis.

In a sequential analysis, the index (e.g.TE) calculated at time t involves a reference technology corresponding to current and previous observations but not subsequent ones. An intertemporal index at time t involves a reference technology evaluated on the basis of observations from all time periods. With time series data, Fare, Grosskopf and Grabowski (1985) for example use sequential analysis to avoid confusing inefficiency with technological progress and measure the efficiency of agricultural production in the Phillipines in any given year relative to production in that and earlier years. The alternative approach (i.e intertemporal) would have been to measure efficiency at each year relative to all years and allow returns to scale to incorporate technical change (see Sato,1981,Pg. 21-60).

If panel data are available e.g. if firm (or country) level data are available both across firms (countries) and over time, then it becomes possible to distinguish between productivity and efficiency: the cross section information across firms (countries) provides a basis for estimating TE indexes within each period and the time series information allows the estimation of productivity indexes across periods (Fare, Grosskopf and Zhang, 1994; Chavas and Cox, 1994).

Programming models of technology are enjoying a revival in both firm and industry studies (Fare, Grosskopf and Li, 1992). Most of these studies relate to the measurement of efficiency. While the works of Farrell (1957) as well as Burley (1980) are restrictive because of the assumption of constant returns to scale , recent studies on the measurement of technical efficiency (TE) relaxes this assumption and enables the determination of scale inefficiency to technical inefficiency. Again, if scale inefficiency prevails, it is possible to determine if this is due to increasing, or decreasing returns to scale (Fare, Grosskopf and Grabowski, 1985).

Nonparametric frontier estimation has also been used for development of productivity indexes e.g Fare et al (1992). Perelman (1995) uses both parametric and nonparametric frontier models to productivity measurement for OECD countries in various industrial sectors. The nonparametric framework enables decomposition of productivity growth into two components- technical progress and efficiency change.

In recent years, the nonparametric framework used for deriving TE measures has been extended to measurement of capacity utilization. (Fare, 1984; Fare et al, 1994; Fare, Grosskopf and Kokkenlenberg, 1989; Fare, Grosskopf and Valdamanis, 1989).

4.3 Methodology for CU Measurement - The Nonparametric Linear Programming Approach:

In this section an the methodology for the estimation of capacity utilization based on an explicit economic theoretical framework is given. Also, rather than using econometric techniques to fit a parametric cost function based on cost-output observations, in the study, linear programming problems are solved to fit a nonparametric production frontier above input-output observations. This methodology not only enables the estimation of CU but also provides estimates of efficiency, enables the calculation of scale economies and permits determination of the nature of scale inefficiency i.e whether increasing, decreasing returns prevail or whether there are constant returns to scale. The nonparametric linear programming models have been used in the literature by Burley (1980), Fare, Grosskopf and

Lovell (1985,1994), Grosskopf (1986), Fare, Grosskopf and Kokkenlenberg (1984), Fare Grosskopf and Grabowski (1985), etc.

Following them, maximum potential output of an observation (activity, firm) using N inputs to produce a scalar output is defined as the output that can be achieved using the best practice frontier technology. Here, the best practice technology is constructed from observed inputs and outputs. In general, the linear programming approach can be extended to multiple outputs and inputs (see Fare et al, 1994).

Suppose there are t =1,2,...T years of observations in an industry, producing a scalar output $u^t \in R_+$, by means of a vector of inputs $x^t \in R^N_+$ Also, the model assumes that each input is used by some firm and that each firm uses some input. Also, each firm produces some output i.e. $u^t > 0$ for all t.

Following Shephard (1974), the linear reference (or frontier) technology with constant returns to scale (CRS) is specified as follows:

$$L^K(u^t) = \{(x^t, u^t) \in R_+^{N+1} : u^t \leq ZzV,\ \Sigma z^t x_n^t \leq x_n^t, n=1,...N,\ z \in R_+^T\} \quad ....4.1$$

where the vector $z^t = (z^1, z^2, ...z^t)$ is the intensity vector and x^t and u^t represent inputs and outputs respectively. These intensity variables serve to connect the observed input and output points to form the piecewise linear best practice technology relative to which efficiency and CU are measured. In other words, they are (variable) weights given to each observation relative to which (x^t, u^t) is being compared. The only restriction on the intensity vector (z) is that it be nonnegative which implies that the best practice technology exhibits constant returns to scale.

The **maximum** obtainable output given the reference technology $L^K(u^t)$ is obtained as the solution to the linear programming problem:

$$\phi^{*K}(x^t) = \max Z zV$$

$$\text{subject to } z^t x_n{}^t \leq x_n{}^t ,$$

$$n = 1,2,\ldots N, \; z \in R^T{}_+ , \qquad \ldots \; 4.2$$

The term $\phi^{*K}(x^t)$ is the maximum potential output for observed inputs and outputs. Thus (4.2) specifies a series of T programming problems, one for each year (observation); the solution of which yields the maximum obtainable output for each year.
By comparing $\phi^{*K}(x^t)$ to the observed output u_t.

$$\text{Efficiency} = \text{TE} = \text{PE} = u^t / \phi^{*K}(x^t), \quad t = 1,2,\ldots T \qquad \ldots 4.3$$

since the inputs can theoretically produce an output of $\phi^{*K}(x^t)$. This measure obtained under the **restriction** of CRS is often referred to as the Farrell output measure of TE. **Efficiency** prevails **if** $u^t = \phi^{*K}(x^t)$.

To illustrate this measure, consider figure 1. With one output, one input and three observations which would correspond to individual years and are denoted by A, B and C in the figure. The reference technology constructed from these observations and satisfying CRS i.e. $L^K(u^t)$ is bounded by OD and the x-axis.

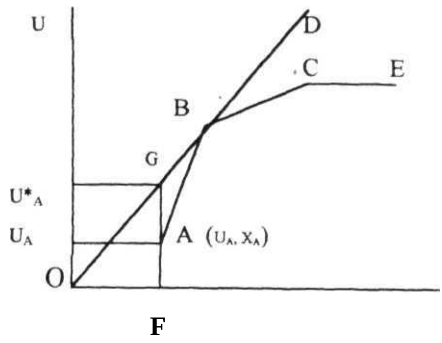


Figure 1

For observation A, then maximum potential output given x_A is at point G i.e. U_A^* Thus the Farrell measure of TE is given by U_A/U_A^*.

To obtain a measure of plant capacity, Johansen's (1968) definition is used :"... the maximum amount that can be produced per unit of time with existing plant and equipment, provided that the avaiability of variable factors are not restricted". For each observation, t, following Fare, Grosskopf and Kokkenlenberg (1989), the study interprets "....the existing plant and equipment" as a subvector of fixed factors x_f^t .The remaining factors are considered variable and thus for each t , denote $x^t = (x_f^t, x_v^t)$. If inputs i = 1,2.....I be fixed and the remaining N-I or I+1,....N indicate variable factors. In order to calculate Johansen's definition of plant capacity output, there is a need to relax the bounds on the subvector of variable inputs x_v, while the fixed factors are bounded by actual availability i.e x_f for each observation, t = 1,2.....T.

In terms of the model, the requirement "…. that the availability of the variable factors is not restricted" is interpreted as follows: for each variable factor, the sums :

$$\sum_{t=1}^{T} z^t x_{vi}^t \qquad , i = I+1, \ldots\ldots N$$

….. 4.4

are unrestricted. Thus 4.4 does not restrict the intensity vector Z. Therefore, these constraints are dropped below and plant capacity is computed as:

$$\phi^*(x_f^t) = \max \sum_{t=1}^{T} z^t u^t$$

$$\text{subject to} \quad \sum_{t=1}^{T} z^t x_{fi}^t \leq x_{fi}^t , \quad i = 1, \ldots\ldots I, \ z \in R^T_+$$

… 4.5

$$z(x_f^t) = \{z \in R^T_+ : \sum_{t=1} z^t x_{fi}^t \leq x_{fi}^t , i = 1, \ldots I\}$$

…… 4.6

Plant capacity utilization is defined using 4.2 and 4.5 as:

$$(PCU)^t = \phi^{*K}(x^t) \,/\, \phi^*(x_f^t) \ , \quad t = 1, \ldots\ldots T$$

….. 4.7

i.e. the ratio of maximum potential output when inputs are given as observed over maximum potential capacity when fixed inputs are given as observed and all other factors are allowed to vary freely. Also, since problem 4.2 contains all of the constraints of problem 4.5, $\phi^{*K}(x^t) \leq \phi^*(x_f^t)$ and thus $(PCU)^t < 1$ for all t, with full capacity utilization if equality holds.

In figure 2 below, OAB is a total product curve for given fixed factors x_f^t. If $x^t=(x_f^t,x_v^t)$,then $(PCU)^t$ is given as $\phi(x_f^t,x_v^t)/\phi^*(x_f^t)$ i.e.$(PCU)^t$ relates $\phi^*(x_f^t)$ to $\phi^{*K}(x_f^t,x_v^t)$. This diagram illustrates that the measure of plant capacity utilization eliminates technical (in)efficiency, which would otherwise result in downward bias to the utilization rates of individual observations. An unadjusted (for TE) measure of plant capacity utilization can also be obtained as :

$$(CAPUT)^t = uV\, \phi^*(x_f^t)\ .$$

which is obtained as the ratio of actual output to maximum plant capacity output with fixed inputs and assuming all other variable inputs vary freely. $\phi^*(x_f^t)$ is achieved when usage of the variable input is unrestricted. This variable input usage can be calculated as $\sum z^{*t}\ x_v^t$ where $z^{*t}$are the solution values for the intensity variables in problem 4.5 for observation t.

The variable input utilization rates can thus be calculated as:

$$(INUT)_n^t = x_n / \sum_{t=1}^{T} z^{*t} x_n^t \qquad \text{....4.8}$$

Thus (4.8) measures the ratio of actual to optimal use of variable inputs. Thus, if this rate is greater than unity it implies that the input is overutilized relative to optimal capacity. If the ratio is less than unity, then that input is underutilized. By the nature of problem 4.5 the fixed factor cannot be underutilized since $\sum z^t x_f^t < x_f^t$.

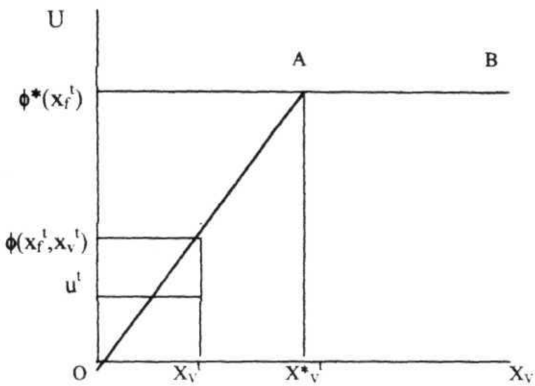


Figure 2

The measures of efficiency and capacity utilization so far were defined using technology satisfying CRS (Farrell, 1957; Burley, 1980). Analogs relative to less restrictive reference technologies can also be defined.

Following Afriat (1972), the assumption of CRS may be relaxed to allow for variable returns to scale technology by restricting $\sum z^t = 1$. In terms of the three observations A, B and C in figure 1 our new technology is bounded by FABCE and the part of the x-axis

starting at F and going to infinity. The variable returns to scale technology is specified as :

$$L^{W}(u^t)=\{x^t \in R^n_+ : u^t \leq \Sigma z^t u^t, \Sigma z^t x_n^t \leq x_n^t, z^t \in R^t_+, \Sigma z^t = 1\}, t = 1,....T$$

.....4.9

This enables the derivation of another efficiency measure relative to this new variable returns to scale reference technology.

$$W_o^t = u^t / \phi^{*W}(x^t)$$

.....4.10

where $\phi^{*W}(x^t)$ can be calculated as the solution to the programming problem:

$$\phi^{*W}(x^t) = \max \Sigma z^t u^t$$

$$\text{subject to } \Sigma z^t x_n^t \leq x_n^t \ , z^t \in R^t_+ \ , \Sigma z_t = 1$$

...4.11

An output based scale efficiency measure is obtained as:

$$S_O^t = \phi^{*W}(x^t) / \phi^{*K}(x^t)$$

4.12

$S_O^t = 1$ iff the technology exhibits CRS at the observed input-output combination. Thus observation B is the only scale efficient observation in figure 1. The per cent of potential output lost due to scale inefficiency is $1 - S_O^t$.

At this point, it is noted that the output loss measured by S_O^t as deviations from optimal scale could also include output loss due to technological change. In other words, S_O^t cannot distinguish between economies of scale and technological change. To avoid this problem and obtain a scale efficiency measure which excludes output loss due to technological change, Fare, Grabowski and Grosskopf (1985) construct the reference technology for a given year t, based only on inputs and outputs achieved in year t and the earlier years in the sample.

Given that S_O^t captures output loss due to deviations from optimal scale, it can be determined if scale inefficiency *is* due to increasing returns such as at A or decreasing returns such as at C. In order to do this it is necessary to compute the following measure:

$$\phi^{*S}(x^t) = \max \Sigma z^t u^t$$

$$\text{subject to } \Sigma z^t x^t_n < x^t_n,\ z^t \in R^t_+,\ \Sigma z^t < 1 \qquad \ldots 4.13$$

which differs from ϕ^{*S} (x^t) only in the restriction on the z's namely $\Sigma z^t < 1$ for ϕ^{*S} (x^t). This restriction imposes nonincreasing returns to scale. In terms of figure 1 this technology is bounded by OBCE and the x-axis. It is now possible to determine whether there are constant, decreasing or increasing returns to scale by a three step procedure. Now, $S_O^t = 1 \Rightarrow \phi^{*W}(x^t) = \phi^{*K}(x^t) \Leftrightarrow$ the technology exhibits CRS at that observation. The nature of scale inefficiency can be uncovered by comparing $\phi^{*W}(x^t)$ and $\phi^{*S}(x^t)$. Thus, if $S_O^t < 1$ and $\phi^{*S}(x^t) < \phi^{*W}(x^t)$, then there is decreasing returns to scale for that observation.

Grosskopf (1986) summarizes the relationship between various technologies. Since CU is measured relative to the frontier, the specification of technology determines the frontier and therefore affects CU estimates. The various technologies are shown to be nested with the most restrictive technology containing the next most restrictive, etc. This systematic relationship also exists for the frontiers and in turn implies that the CU (or efficiency) measures which are calculated relative to these reference technologies are also ordered. It follows that the value of CU is closest to unity when measured relative to the least restrictive reference technology (i.e. variable returns to scale, VRS). Thus, it is important to know what type of 'bias' a particular reference technology will impart to the resultant (efficiency/CU) measures. Relatively restrictive technologies will in general yield relatively low values of CU.

An empirical application of this framework is given in Burley (1980) and Fare, Grosskopf and Kokkenlenberg (1989). While Burley (1980) obtains a measure for productive efficiency for US manufacturing, Fare, Grosskopf and Kokkenlenberg (1989) obtain measures of plant capacity utilization rates. Burley's results show that productive efficiency ranges from 0 916 in 1949 to 1.000 in 1966, 1969 and 1971. Also, over the sample period (1947-71) there was a mild increase in efficiency and technological change in addition has been significantly capital and energy using and labor and intermediate input saving. The LP formulation enables the estimation of slack resources i.e. the surplus of factor requirements (residual resources) after achieving the optimum or theoretical maximum output in a particular year. As time progresses from 1947 to 1971 the labor slack consistently reduces, indicating that average technologies have tended to become labor saving. The most common binding constraint is the level of intermediate materials. By contrast slack capital increases in years of actual production decline i.e. 1954, 1958 and 1970. Fare, Grosskopf and Kokkenlenberg (1989) use data on a sample of 19 coal fired steam electric generating plants operating in Illinois in 1978.

Each observation uses three inputs- capital is the fixed factor and labor and fuel are the variable inputs. Plant capacity utilization rates (pcu) are calculated for two variations of the technology- CRS and VRTS i.e. with the additional restriction $\sum z^t = 1$. The results suggest that there is a good deal of variation across the sample, PCU ranges from less than 30 per cent to 100 per cent. There is also fairly little variation between the two technologies, mean (PCU) is 0.723 for CRTS and 0.751 for variable RTS. Also as compared to the frontier measure of capacity utilization (mean = 0.723) another measure of plant capacity utilization obtained as the ratio of observed output to maximum plant capacity output has a mean pcu of 0.656. This measure is unadjusted for inefficiency and is therefore biased downward.

4.4 Concluding Remarks:

To summarize the methodology outlined in this chapter: a production framework and not a cost framework is used. Also a frontier production framework is used to obtain capacity utilization estimates using a nonparametric linear programming approach. Although the linear programming approach has wide applications its value has been underestimated, while it is the econometric approach which is more widely used in empirical economic studies. The reasons why nonparametric techniques have not gained acceptance could be due to the following reasons: (i) the estimates that nonparametric approach produces really have no statistical properties i.e. mathematical programming procedures produces 'estimates' without standard errors, t-ratios etc. Hence no inferential results can be obtained.(ii)a second disadvantage of the nonparametric approach is that the frontier is computed from a supporting subset of observations from the sample (extremal points) and is therefore particularly susceptible to extreme observations and measurement error. (see Seiford and Thrall, 1990; Forsund, Lovell and Schmidt, 1980). The methodology presented in this chapter also enables the estimation of productive efficiency besides that of scale economies and the nature of returns to scale. In recent yaears this nonparametric LP framework has been used extensively by Byrnes, Fare and Grosskopf, 1984; Byrnes, Fare, Grosskopf and Lovell, 1988; Fare,Grabowski and Grosskopf, 1986 etc. This approach also yields interesting information on input utilization rates for the variable factors as outlined in section 4.3. This rate thus indicates whether the variable input is over or under- utilized relative to optimal capacity (output. In the context of the industries considered in the present study, this approach can reveal whether input availabilities were a constraint on achieving optimal capacity output in these industries.

The methodology given in this chapter is used in the present study to obtain estimates of capacity utilization for eighteen industry groups corresponding to the ASI two digit classification for the period 1960-61 to 1992-93.The results of the study are given in chapters 7 and 8. In the following chapter 5, the data sources and measurement of variables required for the study is given.

CHAPTER 5

DATA SOURCES AND MEASUREMENT OF VARIABLES

5.1 Introduction:

The importance of the data base in an empirical study like the present one needs hardly be emphasized. The longer the time series the greater the problem encountered in ensuring consistency of **the** data over time and consistency of the different series with each other. The main data source for the present study is the Annual Survey of Industries of the Central Statistical Organization. The data collected pertains to the organized or registered manufacturing sector or the factory sector. The data aggregated at the two digit level of classification is used in the study. The study covers eighteen industry groups at the two digit level and the period covered extends from 1960-61 to 1992-93. The nonparametric production frontier framework used for deriving capacity utilization measures requires data on output as well as four inputs - namely, capital labor, energy and intermediate materials.

In the section which follows i.e. Section 5.2, the nature of the **data** sources used in the study is reviewed. In Section 5.3 a description of the measurement of the variables used in the study is given while Section 5.4 contains some concluding remarks.

5.2 Sources of Data:

The Annual Survey of Industries (ASI) conducted every year **since 1959** by **the** National Accounts Statistics Office and processed by **the** Central Statistical Organization (CSO) is the main source of data **for** this study. The ASI is an important data source for studies on the organized industrial sector in India as it provides a fairly consistent data set over a long period of time and at detailed **levels of** disaggregation. It provides detailed information on various characteristics like value added, value of output, employment, capital stock, wages, value of fuels consumed, value of intermediate inputs used etc.

The data from the ASI are available for the organized or registered manufacturing sector. The coverage of the ASI extends to the entire 'Factory sector' comprising of all industrial units called 'factories'. The ASI data cover the factory sector with the exception of defence factories, oil storage depots and technical training institutes. The Factory sector includes both census and sample sectors. The census sector includes factories in which the manufacturing process is carried on with the aid of power and which employ on an average fifty or more persons, as well as those in which the manufacturing process is carried on without the aid of power and which employ 100 persons or more, and all electricity undertakings. The sample universe consists of the remaining factories registered under section 2(m)(i) and 2(m)(ii) of the Factories Act, 1948. These are units which employ between **ten and ninety-nine workers without the aid of power.**

The manufacturing sector is divided into 23 two-digit major groups which are further subdivided into three digit groups. In most cases information is provided at a still lower level of disaggregation.

The criterion for the classification of a factory in ASI is the value of its principal products. This often results in shifts of factories from one industrial class to another in subsequent surveys and thus affects the comparability of data over time.

Another problem with the ASI data was posed by the change in the industrial classification since 1973-74 when the National Industrial Classification replaced the ASI classification used since 1959. In addition, over time there has been a change in the reference period. The reference period for the ASI data from 1959 to 1965 is the calendar year for all industries except in cases of sugar, cotton ginning, cleaning and processing and electric light and power. From ASI - 1966 however the reference period is the accounting year of the factory ending on any day between 1st April and 31st March of that year.

Till 1971-72 the data were available separately for the census and sample sectors. Since the census and sample figures can be matched only at the three-digit level of disaggregation the data had to be first collected at the three digit level, and then aggregated upto the two digit level.

Despite certain weaknesses, the ASI data still remains the basic data source for detailed information on various economic characteristics.

In addition to the ASI data which is the principal data source, the current study also used data published in the Reserve Bank of India

Bulletin (RBI). The output series from ASI is at current prices. For the purpose of deflation the appropriate price indices for the different industries from the official series - Index Number of Wholesale Prices in India (base 1970-71) have been used. Again the value of fuels consumed and the value of intermediate materials used by the different industry groups as given in the ASI is in current prices. To obtain the values in real terms (with base 1970-71) the appropriate Wholesale Price Indices (WPI) have been used. The WPI of Fuels, Light and Lubricants is used for fuels consumed while for materials, an appropriate weighted price index of intermediate inputs is used. The detailed description of these indices used is given in Section 5.3.

Data on Unit Value Index of Materials (UVIM) have been obtained from various issues of the RBI Report on Currency and Finance. Three different series on UVIM with base years 1958, 1968-69 and 1978-79 are available. For the purpose of the study the three series were spliced to obtain a UVIM series for the entire period with a common base. This series was then converted to base 1970-71.

The price index of construction used in the study (for capital stock estimation) is the implicit deflator obtained as the ratio of Gross Domestic Capital Formation at current and constant (1970-71) prices from the National Account Statistics of the CSO.

5.3 Measurement of Variables:

The current study based on nonparametric linear programming approach to estimation of production frontier requires time series data on output and the four inputs namely, capital, labor, energy and intermediate materials for the eighteen industry groups covered in the study. The section below discusses the measurement of the variables and the issues involved.

Measurement of Output: The data collected from the ASI on value of output is at current prices and therefore must be corrected for price changes. The appropriate Wholesale Price Indices with base 1970-71 from the RBI bulletin have been used for purposes of deflation to obtaining the value of output at constant prices. The detailed categories for which the wholesale price data are available do not match exactly with the two digit classification of the ASI. A close and detailed scrutiny of the available data was required before selecting the suitable price deflators.

Also while ASI data on the value of output produced is given at ex-factory price (which do not include excise duties and other distributive margins) it may not be entirely appropriate to use the WPI numbers (which excludes excise duties) to deflate it. The study has however used the WPI numbers for deflation purposes.

Measurement of Capital Stock: The problem of constructing a time series of capital in real terms has received a lot of attention; yet there is no consensus about a unique measure of real capital. Several theoretical and empirical problems are involved in measuring capital stock. Goldar (1986) provides a very useful review of both the conceptual problems and the shortcomings of the various existing estimates of capital stock for Indian manufacturing.

The first problem *is* to determine whether gross fixed capital formation or net fixed capital formation should be adopted as the measure of capital input. Ideally, for purposes of economic analysis it is desirable to use the estimate of net capital stock provided a reasonable measure of true economic depreciation can be found out. But existing estimates of depreciation are either tax-based accounting concepts or based on certain rules of thumb.

The next problem relates to the measurement of a time series of real capital. Capital is usually measured by the "perpetual inventory method". In this method, the time series of the stock of capital is built up step by step from time series of (Rupee value of) investment and prices of capital goods.

For Indian industry most of the earlier studies used unsatisfactory measures of capital input. Banerji's (1975) study while using an appropriate deflator for capital goods prices is based on an arbitrary assumption for obtaining base year capital stock. Hashim and Dadi's (1973) study represents a significant improvement over earlier studies. In particular they have paid close attention towards obtaining the base year capital stock. The limitation however is in the capital goods deflator used - the use of price index of manufactured articles rather than a price index based on machinery and construction prices. Ahluwalia's (1985) study also draws heavily on Hashim and Dadi's estimates of gross fixed capital stock at replacement cost for 1960, but uses the wholesale price index for machinery and equipment for deflating gross investment series. By far the most detailed attention paid to the measurement of capital stock for Indian industry is the study by Goldar (1986). The study gives a detailed review of the various existing estimates for capital stock and the estimates provided by Goldar are a clear advancement over the earlier studies. Careful attention is paid to obtaining the base year capital stock, obtaining an appropriate deflator and making allowances for discarding of assets.

For the purpose of the present study, the measure of gross fixed capital stock at constant prices is obtained as follows. The measure of capital stock includes land and excludes working capital. Working capital has been excluded in many earlier studies including Goldar's (1986). The estimates of capital stock are also gross of depreciation.

The perpetual inventory method is used to obtain the time series on capital stock. Let K_O denote the base year capital stock, I_t (1960) the gross investment (at base year prices) in fixed assets in year t, then fixed capital stock in year T denoted by K_T is given by:

$$K_T = K_O + \sum_{t=0}^{T} I_t$$

The gross investment I_t is given by:

$$I_t = [B_t - B_{t-1} + D_t] / P_t$$

where B_t is the book value of fixed assets at the end of year t, D_t is the amount of depreciation allowances made during year t and P_t is the capital goods price deflator.

The methodology in the present study for I_t is thus similar to that used by Goldar (1986). The deflator used *is* also similar: a weighted average of price indices of construction and machinery is used, the weights being the relative magnitudes of these two categories of assets in the base year. For construction, the implicit price deflator computed as the ratio of the index of gross domestic capital formation at current and constant (1970-71) prices obtained from the National Accounts Statistics (CSO) is used. For machinery and transport equipment, two price indices, one for machinery produced domestically and the other for imported machinery are combined. For domestic machinery, the official Wholesale Price Index Number of Machinery and Transport Equipment from the RBI is used. For imported machinery the unit value index of imports (UVIM)is used. For the period of the study, the unit value indices are available at three different base years, 1958, 1968-69 and 1978-79. From the available series, first a UVIM with common base is constructed for the entire time period and then converted to base 1970-71. To combine the two price indices, assumptions similar to those made by Goldar. Are made. Since the proportion of imported machinery in total investment in machinery has been declining, the two price indices (domestic and imported) have been combined in the ratio of 1:1 for the period 1960-65 and in the ratio 3:1 for the subsequent period.

To obtain the base year (1960) capital stock the study relies heavily on Hashim and Dadi's study. The gross-net ratios given by Hashim and Dadi at the three digit level are used and assumptions similar to those made by them have been made for the puipose of the present study. For land, like Goldar the study assumes the gross-net ratio to be unity. From the ASI (1960) the book values of (1) land, (2) building and construction, (3) plant and machinery and (4) other assets, as existing at the end of 1960, are obtained. Multiplying these figures by their corresponding gross-net ratios, and then adding gross fixed assets at purchase prices for industries at the three digit level (e.g.S_{381}) are obtained. From the Hashim-Dadi study,the ratio of gross fixed assets at current (1960) prices and at purchase prices at the two digit industry level (e.g.Metal product MP_{38}) are obtained. This ratio is then multiplied by the figure of gross fixed assets at purchase prices obtained at the three-digit level (this three digit industry being a constituent part of the two digit industry whose ratio has been obtained). Thus, gross fixed assets in the three digit industry at the end of 1960 at current (1960) prices is obtained as (K_{381}):

$$K_{381}\ (1960) = S_{381} * MP_{38}$$

This procedure thus enables the estimation of gross fixed assets at the end of 1960 at 1960 prices for all the eighteen two digit industry groups in the study. The base year capital stock is then converted to constant prices using the deflator constructed. To this base year stock (at constant 1970-71 prices), yearly deflated gross values of investment at constant (1970-71) prices were added to obtain the capital stock series at constant prices. In the present study no allowance has been made for discarding of assets.

Measurement of Labor Input: In the case of labor, the stock available to the industry is the number of persons employed by it during a year. The ASI publishes annual data on 'workers' as well as 'employees' and either of them can be used as a measure of labor input. 'Total employees' as a measure of labor input includes both 'workers' as well as 'persons other than workers'. The latter category of employees consists of supervisors, technicians, managers, clerks and other similar types of employees. It has been argued that this category of employees is as important for getting the work done as the workers who operate the machines and therefore their services should be taken into account in the measurement of labor input (see Sinha and Sawhney, 1970).

In the present study the ASI data on total employees is taken as a measure of labor input. Using total employees as a measure of labor input thus involves the assumption that 'workers' and 'persons other than workers' are perfectly substitutable. This is clearly an assumption which is not realistic and is thus a limitation of this measure of stock of labor input

Measurement of Energy Input: The ASI publishes annual data on total value of fuels consumed at current prices. Fuels consumed represents total value of all items of fuels, lubricants, electricity, water etc. consumed by the factory during the accounting year except those that directly enter into products as materials consumed. To obtain the value of fuels consumed at constant prices the price index of energy i.e. the official Wholesale Price Index Number of Fuels, Lights and Lubricants with base 1970-71 from the RBI Bulletin is used.

Measurement of Materials Input: Again the ASI is the source of published data on value of total materials consumed. These data are in current prices. Total materials consumed represents the total delivered value of all items of raw materials, chemicals, packing materials and stores which actually entered into the production process of the factory during the accounting year. To arrive at the value of intermediate goods consumed at constant prices the study uses a weighted constructed price index for materials which was derived for each industry separately. For each industry the ASI gives detailed quantity and expenditure data on a large number of items. The detailed data are available for five broad groups of intermediate inputs consumed: Basic materials, chemicals and auxiliary materials, packing materials, consumable stores and materials consumed for repair and maintenance. For the base year (1960) the shares of these five intermediate inputs consumed in total value of materials consumed was obtained. In most cases basic materials account for 80 to 90 per cent of the total expenditure on materials. Using these shares as weights a weighted price index of materials input was obtained. After going through the list of basic materials consumed by each industry the study has used appropriate indices from the official series on Index Number of Wholesale Prices. For Chemicals and Auxiliary materials the Wholesale Price Index Number of Chemicals and Chemical Products is used. For packing materials, a weighted average of Price Indices of Paper Products, Wood and Wood Products and Jute Hemp and Mesta Textiles is obtained. For consumable stores, again a weighted average of price indices of Wood and Wood Products, Paper and Paper products, Non-metallic Mineral Products, Basic Metals Alloys and Metal Products and Chemical and Chemical products is used. For materials consumed for repair and maintenance the price index of Machinery and Machine tools is used. For each industry, thus, a weighted price index of intermediate goods consumedis constructed. This index is then used to obtain the value of intermediate goods consumed at constant (1970-71) prices.

5.4 Conclusions:

Thus, the ASI is the primary source of data for the present study. Despite several weaknesses, it remains an important data source for

studies on the industrial sector. The present study has also paid particular attention to the measurement of the variables, especially to the measurement of capital stock and also to the construction of a deflator for intermediate materials input. Despite the attention paid to the measurement of the variables, it is important to keep in mind the limitations in the use of such a long time series for empirical purposes of obtaining trends in capacity utilization.

CHAPTER 6

REVIEW OF STUDIES ON CAPACITY UTILIZATION IN INDIA

This chapter is a review of the studies of capacity utilization in India. A review of the studies shows that this aspect of the performance of the industrial sector has received very little attention in the literature. A review of the empirical studies on capacity utilization (CU) for Indian industries shows that, so far, only traditional measures which are essentially statistical constructs based on official published data have been estimated.

Also, the studies for India are for specific years or a short time period. The coverage also extends to a limited number of industries or only the aggregate manufacturing sector. No comprehensive studies on capacity utilization exist for India which have been based on an economic notion of capacity and whose coverage is comprehensive in terms of the time period of the study as well as coverage of the industrial sector.

The official publication, Monthly Statistics of Production of Selected Industries (MSP) in India published by the Central Statistical Organization (CSO) gives monthly and annual figures of installed capacity and production in physical units for a wide range of industrial products. This data has been used in many studies to obtain estimates of CU. However the MSP data are subject to a number of limitations as pointed out by Krishna (1972). Also, given the nature of controls in the Indian economy both installed capacity and actual production data are subject to a number of biases as pointed out by Sahay(1991).

The official Index of Industrial Production available with base periods of 1956,1960,1970 and 1980-81 have also been used to obtain CU measures based on trend-through-peak method. Ahluwalia (1985) points to the limitations of this data source, say for e.g. with respect to changing weights and combining indices with different base periods.

In addition to the MSP data on installed capacity and production and the official indices of production, some studies on CU for India have been based on Survey data. Detailed proforma's including questions on installed capacity, actual production, reasons for underutilization of capacity etc. have been mailed to individual firms. These survey data reveal valuable insights at the firm level on causes of underutilization of capacity.

We now review the studies on capacity utilization for India.

One of the earliest traditional estimates of CU for the period 1951-59, based on MSP data on installed capacity and production is given in Budin and Paul (1961). The study covers 75 industries for which installed capacity data are available. The study shows increased utilization of capacity in the industrial sector over the period from 1951 to 1959 (from 62% in 1951 to 91.53% in 1959). The study also analyses inter-industry variations in CU. Industries were classified into three categories - infrastructural, intermediate and consumer goods industries. Almost full utilization in infrastructure during second plan period is indicated by the study. The study also shows that intermediate goods industries and some consumer goods industries like paper products and enamelware had large excess capacities.

The NCAER (1966) study is based on MSP data and mail survey data and covers 276 industrial products classified into two major groups namely metal products and non-metal products. The study is for the period 1955-64. A detailed analysis is made for five groups of industries namely, metal products, machinery other than electrical, electrical machinery and appliances, transport equipment and chemical and chemical products. The study shows that CU rate is 89% for all industries. The mail survey showed a very poor response rate but revealed valuable insights into causes of underutilization. These causes include shortages of raw materials, foreign exchange, spares and machinery and labor unrest.

The study by Koti (1967) at the Gokhale Institute gives estimates of CU for the year 1966-67 and analyses the factors affecting it. The study is based on survey data. Out of 1175 companies to whom questionaires were sent, replies were obtained from 287 companies, of which only 151 companies provided adequate details. The study is thus based on these 151 companies and covers 234 products. Of these 20 were found to have fully utilized capacity. On the whole the study shows that the extent of underutilized capacity is considerable. Products with more than 60% unutilized capacity include chemicals, fertilizers and drugs, steel, rubber, steel forgings and non-ferrous alloys etc.

As regards causes of excess capacity, shortages of raw materials (indigenous and imported) and lack of demand were almost equal in importance. Labor problems followed by power shortages were the other important causes of underutilization.

On a more extensive basis, estimates of CU have been calculated by the RBI. Two different estimates of CU have been obtained. In the first study (1969), trends in underutilization of capacity for the period 1963-67 using data on installed capacity and actual production were obtained. The study covers 163 industries. Seventytwo of these had high underutilization of over 30%. Twentyeight industries in 1963 and twentyone in 1969 had excess utilization, all from the metal and engineering and chemicals group.

The second RBI study (1970) is based on the Wharton Index - a trend-through-peaks method. The RBI index is based on monthly peaks. Manufacturing industries were classified into use-based and input-based groups. The former include basic, capital, intermediate and consumer goods industries. The latter group consists of agro-based industries, metal-based and chemical based industries. The utilization ratio for All Manufacturing industries which was between 87 and 90 per cent during 1960-65 declined to 79.8 and 80.2 per cent in 1968. The later studies by RBI (1970,1972,1975) update the series and show further declines in CU to a low 77.4% in 1971.

The explanations for the causesof underutilization of capacity in the RBI studies are offered in terms of the the general recessionary trends noticed in the Indian economy since 1965, the performance of the agricultural sector, shortages of raw materials, lack of demand etc.

Another study based on MSP data on installed capacity and production for the period 1961-71 for 42 industries is that by Paul(1974). According to Paul, MSP classifies only 18 product groups as working on a three-shift basis, 7 on a two-shift basis and all the remaining 275 on a single shift basis while a large number of manufacturing units which are classified under single shift in MSP actually operate on a two or three-shift basis. In this study therefore an adjustment is made for shift work and installed capacity is recomputed similar to Winston's (1971) study for Pakistan.The study recomputes installed capacity assuming 2.5 shifts for MSP industries operating two-shifts and 2 shift for those shown operating single shift.

The study shows that while CU rate is around 80%, when adjusted for shift patterns, utilization rate is no more than 53% .The study also reveals that the overall utilization index increased from 50.4% in 1961 to 55.3% in 1965, declined to 51.3% by 1967 and increased therafter to 55.3% till 1970 and was 54.3% in 1971.

The study also attempted to explain CU as a function of six variables using regression analysis. The six variables used are market structure, pressure of demand, size of the firm, import substitution, effective rate of protection and import content of production.

The production function method forms the basis of the study by Nayar and Kanbur (1976) who obtain estimates of CU for the period 1945-65. CU rates based on both the Cobb Douglas and CES production functions show high utilization rates of over 97 to 99%. Data is mainly from CMI and ASI. Full employment supply of labor services is obtained from the Year Book of Labor Statistics of ILO.

Most of the studies reviewed above are for the early period and are limited in coverage of industries and time period. Besides these some other studies on capacity utilization concentrate only on the conceptual aspects relating to the notion of capacity for eg. Seth

(1986) and Nandamohan (1992). Some studies have also been made for specific industries like coal, fertilizers etc. (Productivity, 1975). For the cotton mill industry in India, the study by Sastry (1980) deserves special mention. A detailed review of the early studies is given in Padma Suresh (1991). In recent years there have been a few more studies on CU for Indian industry. Given below is a review of some of these studies.

Goldar and Renganathan (1991): The main object of this study is to analyze econometrically the effect of market structure and government policies on CU in Indian industries. The methodology adopted is very similar to that of Paul (1974). However, unlike Paul (1974), this study makes an attempt to incorporate explicitly the effect of industrial policy into the econometric analysis.

This study makes use of production and capacity data drawn from DGTD sources. For measuring market concentration the share of the top three firms in total industry sales published by CMIE is used. As a measure of demand pressure, the growth rate of production between 1978 and 1983 was used. To capture the effect of tariff and trade policies on CU, the study uses the level of effective protection enjoyed by industries as an explanatory variable. Also, four dummy variables have been used to reflect the nature of licensing and other controls the industries were subject to.

The study shows a significant positive relationship between demand pressure and CU and also between market concentration and CU. The finding of a significant positive relationship between market concentration and CU reflects to some extent the problem of demand defeciency arising from excessive entry of new firms. The study also points to an inverse relationship between the level of effective protection enjoyed by the industries and the rate of *CV* attained by them. However the relationship between CU and the dummy variables representing industrial policy is not very clear, pointing to limitations in data and inadequacies of the methodology adopted to incorporate the influence of industrial policy into the analysis.

Srinivasan (1992): The first study by Srinivasan (1992,a) examines the determinants of CU in Indian industries. Data on full capacity and utilization levels for different industrial sectors is taken from CM1E (1987). An alternative data source used is World Bank (1989) which provides time series on CU ratios from 1970 to 1984. For selected industries from four broad sectors: basic, capital, intermediate and consumer goods. A correlation analysis between actual and capacity outputs and between capacity expansion and lagged outputs or capacity utilization rates was also carried out. While a high correlation was obtained in the former case, no systematic relationship was found in the latter case.

A cross section regression analysis using industry wise data was carried out to determine the factors influencing CU. Only industry charachteristics notably capital intensity, scale of operations and variability in demand due to seasonal and other factors were included while other explanatory variables like import substitution, effective rate of protection were not included due to lack of comparative data. The study shows that a high variability in demand leads to lower CU. A positive relation is obtained between CU and the explanatory variables, capital intensity, scale of operation and market concentration.

In a later study, Srinivasan (1992,b) uses methods in disequilibrium and shortage modelling to estimate the extent of slack or shortage in each year for different industries. The supply factors that affect CU include availability of raw materials and inputs, infrastructural bottlenecks such as power shortages and transport bottlenecks etc. The demand factors include changes in domestic or foreign demand caused by changes in tastes or by the general macro economic situation. Industry groups like diesel engines, railway wagons and vanaspati which operate with more than excess capacity face mainly demand constraints. Agricultural tractors and cotton cloth (mill) with excess capacity of more than 25% face mainly supply constraints.

Ajit (1993): The study shows a declining trend in the industrial sector in India over the twenty year period 1970-90. The trends in CU (based on data on installed capacity and actual production from CSO) for 86 industries accounting for one-fourth of weight in Index Number of Industrial Production have been examined using a use-based classification. On an average during 1970-90, nearly one-fourth of installed capacity remained underutilized. CU in all industrial groups have shown a declining trend, although during the 1980's there has been some modest improvement in CU. Average CU at 76.1% in 1980's was higher than the average CU rates of 73.3% in the 1970's. Among the use-based groups the extent of underutilization of capacity was highest in basic goods industries (37%) followed by capital goods(34%), consumer goods(25%) and intermediate goods(10%). A significant improvement in CU was noticed in basic goods and capital goods industries in the 1980's, a conclusion supported by Goldar and Renganathan(1991).

Also CU in the industrial sector was postulated as a function of income (proxy for demand), imports of capital, intermediate goods and a dummy variable to capture the effect of changes in government policy. The predominant factor influencing CU has been demand. Evidence also suggests that easing of government controls etc. does lead to higher CU.

Burange (1992): In this study, CU indices are computed for the period from 1951 to 1986-87 for the organized manufacturing sector of the Indian economy The index constructed is a weighted arithmetic mean of capacity utilization calculated by the formula:

$$U = \sum u_i w_i / \sum w_i$$

Where U is the index of CU, u_i is the capacity utilization (ratio of actual to capacity output) of ith product and w_i is the capacity output valued added weight of ith product. This study uses data from the MSP on installed capacity and output.

The study reveals that at the one-digit level of industrial classification the aggregate manufacturing sector showed an increase in capacity utilization from 65.97% to 68.51% during 1951 to 1955. It fluctuated between 72.23% and 73.38% during 1956 to 1959, between 68.6% and 77.41 per cent during 1960 to 1969 and between 62.13% and 73.66% during 1970 to 1986-87. At the two digit industrial classification, manufacture of machinery other than electrical showed wide fluctuations in CU over the period of study. CU in manufacture of electrical machinery increased from 58.0 per cent in 1951 to 94.65 per cent in 1961. Then it declined to 53.78% in 1983-84. CU in manufacture of rubber products, paper and paper products, tobacco manufactures was higher on an average among all industries over the entire period though in paper and paper products it declined throughout. CU in manufacture of chemical and chemical products, manufacture of leather and fur products was lower over the entire period.

This study also classifies the products of organized manufacturing sector into (i) consumer goods, (ii) intermediate goods or raw materials and (iii) capital goods. The consumer goods category is further classified into (a) consumer durable goods and (b) consumer non-durable goods. CU in consumer goods was more or less steady at around 70 per cent. But it fluctuated widely in capital goods industries; increasing from 34.04 per cent in 1951 to 92.18 per cent in 1967 and declining to 47.59 per cent in 1973. From 1974 onwards, it increased again to 79.17 per cent in 1982-83 and again declined thereafter. The intermediate goods showed an increasing trend in CU from 73.32% in 1951 to 81.09 per cent in 1964 and then declined continuously to 55.98 per cent in 1983-84.

Among the consumer goods, CU in consumer durables fluctuated widely from 32.41 to 89.22 per cent over the period. The fluctuations in utilization of consumer non-durables are relatively smaller (between 59.23 to 79.83%) with no long term trend.

Unlike the other studies reviewed the study by Burange (1992) provides us with a continuous series of CU over the entire period from 1951 to 1986-87. But the indices constructed arwe the traditional

indices based on data on installed capacity and production from MSP. As pointed out above the data are subject to a number of limitations while the CU estimates themselves are not based on an economic notion of capacity.

In a later study, Burange (1993) estimates the implications of full capacity utilization of the manufacturing sector in the Indian economy using input-output framework. The study is carried out using the open Leontief model and also the semi-closed model endogenizing household demand. The working of the models are illustrated using 1973-74 data and CU indices constructed in the earlier study, by Burange (1992). The study shows that by fully utilizing the capcity of the manufacturing sector, the output, income and employment increases by 22.86, 16.31 and 14.11 per cent respectively in the open model and will increase by 38.68, 37.08 and 38.59 per cent in the semi-closed model.

Padma Suresh (1991): This study uses the econometric cost minimization framework to obtain two economic measures of capacity utilization for four two digit industries corresponding to the ASI classification for the period 1960-61 to 1982-83. These two digit industries form part of the basic and capital goods industries. The translog variable cost function is specified and estimated. In this study, capacity output corresponds to the minimum point of the shortrun average total cost curve and the tangency between the short and longrun average cost curves. Economic measures of CU obtained in this study are closer to unity and spanned both sides of unity unlike traditional measures. A significant conclusion reached in the study is that since economic measures are closer to unity this suggests that

actual output levels are determined by cost considerations. The low correlations between economic and traditional measures also suggests the importance of deriving economic measures.

Conclusions:

The review of the studies on capacity utilization for India reveal the importance of obtaining estimates of CU for a long time period and for a wide range of industries and which are based on an economic notion of capacity. While in developed countries a number of studies have used both the parametric cost minimization and the nonparametric production framework to obtain economically meaningful measures of CU, in India there is a lack of such studies. The present study is based on the nonparametric production frontier and estimates of capacity utilization are obtained for eighteen two digit industry groups of the Factory sector for the period 1960-61 to 1992-93. The results obtained in the study are given in the following chapters.

CHAPTER 7

CAPACITY UTILIZATION IN INDIAN INDUSTRIES: 1960-61 – 1992-93

7.1 Introduction:

This chapter presents the results of the current study on capacity utilization for the organized industrial sector in India. In the study trends in capacity utilization (CU) for eighteen industry groups corresponding to the ASI two digit classification are estimated. The trends in capacity utilization are estimated for the period 1960-61 to 1992-93. These estimates are obtained in a production framework by using nonparametric linear programming techniques. The nonparametric framework also enables the estimation of capacity utilization under an alternative assumption of variable returns to scale. The framework used also makes possible the estimation of productive efficiency for the industry groups. In addition an estimate of scale efficiency can be obtained and the nature of scale economies prevailing in the industries in each year can be determined. The details of the methodology used here are given in Chapter 4, while the data base requirements have been discussed in chapter 5.

This chapter begins with a brief review of the industrial sector in India in Section 7.2. There is a considerable amount of literature on the performance of the industrial sector in India especially with respect to industrial growth. In the light of this discussion, the estimates of capacity utilization obtained in the present study are analyzed. CU estimates obtained in the study are analyzed against the background of general industrial sector performance in the economy. In Section 7.3 the results on productive efficiency or technical efficiency obtained by the use of linear programming technique are discussed. Section 7.4 contains the main results on trends in capacity utilization (CAPUT) rates for the eighteen industry groups for the period 1960-61 to 1992-93. In Section 7.5, the trends in Plant Capacity Utilization Rates (PCU) are given. These measures are obtained with the assumption of constant returns to scale (CRS). Section 7.6 gives estimates of CU with the alternative assumption of variable returns to scale (PCUVRS). Section 7.7 is a comparison of the three measures of capacity utilization i.e. PCU, CAPUT and PCUVRS. Section 7.8 is a summary and conclusion of the results given in this chapter.

7.2 The Industrial Sector in India:

Since independence industrialization in India has been seen as a means of achieving rapid growth and prosperity. The share of industries has increased substantially from 11.8 per cent of GDP in 1950-51 to 24.6 per cent in 1990-91. In addition there has been a substantial widening of the industrial base and the composition of industries has also undergone significant transformation. The share of capital goods in industrial value added increased steadily at a high pace from 4.7 per cent in 1956 to 23.7 per cent in 1990. The share of basic goods increased relatively moderately from 22.3 per cent to 38.4 per cent. Consumer goods on the other hand declined considerably in relative importance with the share in industrial value added falling from 48.4 per cent in 1956 to 20.5 per cent in 1990 (Krishna, 1997-98).

While there has been considerable diversification of the industrial base, the growth performance has however fallen short of targets both with respect to magnitude of growth rate and stability over time. The considerable literature on examination of long term trends in industrial sector performance points to three phases of growth scenario: the first phase of rapid growth from the early 1950's to the mid-1960 's; the second phase of deceleration from the mid-1960's to late 1970's followed by rapid growth since the 1980's.

The rapid growth, subsequent deceleration and the revival of growth in the 1980's as well as the causes for the different rates of growth in the different sub-periods has been the focus of a number of studies. The study by Ahluwalia (1985) gives average annual growth rates of net value added for the period 1959-60 to 1965-66 and 1966-67 to 1979-80 for industry groups according to use-based and input-based classification. Her study shows that in the first sub-period, net value added in the registered industrial sector grew at an average rate of 8.0 per cent per annum. In the post-1965 period the growth rate was substantially lower at 5.7 per cent. The corresponding growth rates for registered manufacturing were 7.6 and 5.5 per cent. The decline was most pronounced in the Capital and Basic Goods industries, from 15.4% to 6.6% and from 11.0 to 5.0 per cent respectively. However, Consumer Goods and its main sub-category i.e. Consumer Non-durables experienced mild acceleration. Intermediate Goods and Consumer Durables too experienced mild deceleration. Thus deceleration was largely confined to heavy industry consisting of basic and capital goods industries which account for about 50 per cent of the total value added in the industry in 1979-80.

In the input-based classification, only the Metal-based category suffered marked deceleration from a growth rate of 14.1 per cent in the pre-1965 period to 6.1 per cent in the subsequent period. Ahluwalia's study also showed that significant deceleration in growth occurred only among fast or medium growth industries with an annual rate of over 5 per cent during 1959-65. These industries accounted for 63 per cent of value added in total registered manufacturing.

The reasons attributed to the deceleration in industrial growth by Ahluwalia (1985) as well as others include slowdown in public investment, lack of infrastructure, the performance of the agricultural sector, the policy of import substitution, domestic terms of trade as well as restrictive industrial and trade policies. Thus deceleration in industrial growth has been explained by both demand as well as supply side factors although demand side factors are considered to be more important.

The industrial sector again showed improved growth performance in the 1980's as compared to the earlier period of 1966-79. The liberalization of industrial and trade policies continued with the reforms program picking up since the mid-1980's. The growth rate of manufacturing value added increased from 4.9 in 1970's to 7.0 per cent per annum in the 1980's. Within the manufacturing sector, in the 1980's the registered segment grew at 8.1 per cent while the unregistered segment grew much less impressively at 5.8 per cent per annum. Also the increase in the growth rate of the manufacturing sector is due to the increase in the growth rate of the unregistered manufacturing sub-sector which increased its growth rate from 4.1 to 7.5 per cent per annum between the first and second half of the 1980's. The growth rate of registered manufacturing sector was the same (8.1%) in both halves of the 1980's. Thus policy changes undertaken in the latter half of the 1980's do not seem to have led to an increase in the growth rate of the registered manufacturing sub-sector.

Ahluwalia (1991) notes that the period 1980-81 to 1985-86 was marked by significant acceleration in the growth of value added in the manufacturing sector and all its use-based sectors. Consumer Durables showed the highest increase in growth rates from 8.0 to 14.2 per cent per annum during the period 1966-67 to 1979-80 as compared to the period 1980-81 to 1985-86. On the other hand Capital Goods industries which grew at 15.6 per cent during 1959-60 to 1965-66 showed a decline to 6.7 per cent during 1966-67 to 1979-80and a mild revival to 7.8 per cent dviring the first half of the 1980s. Intermediate Goods and Consumer Durables showed an improvement in growth rates from 4.4 to 6.5 and 4.8 to 7.6 per cent per annum respectively during the deceleration period and the first half of the 1980s.

A significant finding by Ahluwalia (1991) is that in registered manufacturing employment declined by 0.7 per cent and capital intensity increased by 8.4 per cent per annum during 1980-81 to 1985-86. It was generally argued by economists that the high growth of the early 1980's being import and energy intensive would not be able to be sustained. The rapid growth in Consumer Durables was attributed to the rise in real incomes of people in the middle categories in the 1980's. The other reasons advanced for the revival of growth include better performance of the infrastructure sector, improvement in the rate and pattern of gross domestic capital formation in general and public investment in particular, less adverse trends in inter sectoral terms of trade in favor of non-agriculture and reforms in industrial and trade policies.

The liberalization measures introduced in 1991 however do not seem to have led to an increase in the growth rates in the first two post –1991 reform years. As against a growth rate of 8.3 per cent in 1990-91 the general index of industrial production registered only a marginal increase of 0.6 per cent in 1991-92 and 2.3 per cent in 1992-93. The growth rate did however increase in the next three years.

Thus the review of industry reveals the significant changes that have accompanied the growth of the industrial sector in India. Trends in capacity utilization which are presented in the following sections are analyzed keeping in mind the performance of the industrial sector in India

7.3 Trends in Productive Efficiency in Indian Industries:

While the main focus of the current study is on obtaining capacity utilization estimates, the nonparametric linear programming framework used here also enables the estimation of a measure of productive or technical efficiency. As described in Chapter 4 this measure is based on the construction of frontier production function. Thus this framework is based on the technical relationship of factor inputs and output. The best practice technology (BPT) is constructed from observed inputs and outputs using linear programming techniques. The knowledge of the BPT determines the reference relative to which technical or productive efficiency is judged. In fact, the study uses a Farrell (1957) output efficiency measure to gauge the distance between the frontier and actual output achieved. This framework has been used by Burley (1980) to obtain productive efficiency measures for US manufacturing for the period 1947-71.

Productive or technical efficiency is obtained as the ratio of actual output to maximum potential output as defined in Chapter 4. The factors of production are the inputs - capital, labor, energy and materials. The data on the factors of production as well as output is obtained from the ASI. The description of the data sources has been given in Chapter 5. The measure of productive or technical efficiency is obtained for the eighteen industry groups corresponding to the ASI two digit classification for the period, 1960-61 to 1992-93.

The current study is based on the two digit level of aggregation of the Factory Sector. A list of the two digit indutry groups included in the study and their NIC code is given in Table 1 of the Appendix. The percentage share in Net Value Added for the major industry groups arranged in descending order of net value added is given in Table 2 of the Appendix. From this table it can be seen that in 1985-86, the three major industry groups (excluding electricity) namely, Chemicals (inds. no. 31), Basic Metals (inds. no. 33) and Non Electrical Machinery (inds. no. 35) togeather accounted for 30% of net value added. Rubber (inds. no.30), Food Products(inds. no. 2 Transport Equipment(inds. no. 37), Electrical Machinery (inds. no. 36) and Cotton Textiles (inds. no.23) also accounted for between 6 to 8% of net value added each.

Table 7.1 gives the estimates of productive efficiency (PE/TE) for each year for the study period from 1960-61 to 1992-93 for the eighteen industries in the organized industrial sector. The average PE for each industry group over the period of the study is given at the bottom of the table.

Twelve of the eighteen industries had average PE of over 90 per cent, five industries had average PE of between 80 to 90 per cent while one industry i.e. inds. no.30 (Rubber, Plastic and Petroleum Products) had average PE of 77 per cent over the entire period. Metal Products (34) and Cotton Textiles (23) had the highest average levels of PE. There is also a significant difference in the movement of PE between different industries over time. Except for industry no. 27 (Wood and Wood Products) all industries recorded their lowest levels of PE before 1979-80. For the entire period, lowest TE was recorded for Rubber, Plastic, Petroleum and Coal (49%) during 1967-68 and 1968-69.

A large number of industries had almost full efficient levels of production in many years after 1980-81 and particularly after 1990-91. The exception here is industry 22 (Beverages, Tobacco and Tobacco Products) whose performance with respect to PE is very poor particularly in the terminal years of the study.

Also, in three industries namely 23(Cotton Textiles), 34(Metal Products) and 37(Transport Equipment) PE was high throughout the

Table 7.1

Trends in Productive Efficiency Rates for Two Digit Industries (1960-61 to 1992-93)

	Industry Group								
Year	20-21	22	23	24	25	26	27	28	29
1960-61	1.000	1.000	0.959	1.000	0.750	0.545	0.992	0.836	1.000
1961-62	1.000	0.961	1.000	0.997	0.944	0.643	1.000	0.850	0.916
1962-63	0.979	0.844	0.989	0.877	0.901	0.656	0.932	0.851	0.837
1963-64	0.901	0.826	1.000	0.757	1.000	0.750	0.968	0.865	1.000
1964-65	0.964	0.901	1.000	0.786	0.947	0.941	1.000	0.878	0.934
1965-66	1.000	0.985	0.983	0.607	0.822	1.000	1.000	0.980	0.910
1966-67	0.992	1.000	0.994	0.608	0.829	1.000	0.951	1.000	0.871
1967-68	0.857	0.944	1.000	0.605	0.914	0.841	0.894	0.992	0.984
1968-69	0.860	0.890	0.986	0.649	0.812	0.916	0.987	0.993	1.000
1969-70	0.981	0.991	1.000	0.644	0.780	1.000	0.984	0.961	1.000
1970-71	0.954	0.954	0.904	0.907	0.727	1.000	0.896	1.000	1.000
1971-72	0.847	0.898	0.919	1.000	0.781	1.000	0.993	0.936	0.940
1972-73	0.790	0.737	0.911	1.000	0.800	0.876	0.980	0.954	0.921
1973-74	0.818	0.775	0.961	0.807	0.844	0.971	1.000	0.991	0.901
1974-75	0.955	1.000	1.000	0.932	0.912	0.775	0.972	1.000	0.980
1975-76	0.953	0.820	0.970	0.896	0.952	0.767	0.952	0.996	0.985
1976-77	0.922	0.886	0.998	0.876	0.963	0.832	0.979	0.993	1.000
1977-78	0.996	0.842	1.000	0.925	0.906	0.828	0.975	0.997	1.000
1978-79	0.962	0.829	1.000	0.934	0.846	0.695	0.990	0.977	0.953
1979-80	0.964	0.877	0.976	0.963	0.853	0.613	0.969	0.942	0.960
1980-81	0.848	0.813	1.000	0.965	0.986	0.702	1.000	0.976	0.911
1981-82	0.909	0.837	1.000	1.000	1.000	0.804	0.897	1.000	0.931
1982-83	1.000	0.884	0.972	0.979	0.925	0.864	0.909	0.960	0.950
1983-84	0.997	0.950	1.000	0.992	0.792	0.722	0.869	1.000	0.949
1984-85	0.968	0.952	0.932	0.983	0.651	0.707	0.883	0.968	0.946
1985-86	0.964	0.805	0.917	1.000	0.732	0.627	0.858	0.931	0.894
1986-87	0.948	0.753	0.998	0.994	0.992	0.678	0.895	0.957	0.892
1987-88	0.939	0.845	1.000	0.969	1.000	0.701	0.924	0.979	0.968
1988-89	1.000	0.868	0.970	0.940	0.898	0.816	0.960	1.000	0.920
1989-90	1.000	0.737	0.979	0.948	0.791	0.904	0.924	1.000	0.944
1990-91	1.000	0.742	1.000	1.000	0.793	0.855	1.000	1.000	0.949
1991-92	1.000	0.793	1.000	1.000	0.886	0.962	1.000	1.000	0.978
1992-93	1.000	0.773	1.000	1.000	0.931	1.000	1.000	0.898	1.000
Average	0.948	0.870	0.979	0.895	0.868	0.818	0.956	0.959	0.949

contd.

Mote: Productive efficiency rates estimated as the ratio of actual to maximum output as given in chapter 4 and based on AS I data

Table 7.1 (contd.)

Trends in Productive Efficiency Rates for Two Digit Industries (1960-61 to 1992-93)

Tear	Industry Group 30	31	32	33	34	35	36	37	38
1960-61	0.647	1.000	0.884	1.000	0.942	1.000	0.708	0.957	0.902
1961-62	0.651	0.944	0.891	1.000	0.942	0.946	0.716	1.000	0.915
1962-63	0.596	0.984	0.965	0.864	0.970	0.931	0.669	0.961	0.998
1963-64	0.547	1.000	0.973	0.927	0.997	0.982	0.666	0.961	1.000
1964-65	0.512	0.980	0.971	1.000	1.000	0.964	0.634	0.986	0.917
1965-66	0.518	0.964	0.979	0.900	1.000	0.930	0.651	1.000	0.915
1966-67	0.494	0.898	0.993	0.933	0.965	0.845	0.627	0.974	0.931
1967-68	0.490	0.876	0.961	0.861	0.973	0.812	0.629	0.938	0.848
1968-69	0.490	0.910	0.912	0.841	0.976	0.803	0.642	0.930	0.840
1969-70	0.508	0.887	1.000	0.859	0.979	0.898	0.664	0.975	0.994
1970-71	0.541	0.909	0.961	0.875	0.944	0.898	0.686	0.970	0.872
1971-72	0.594	0.923	0.944	0.889	0.922	0.891	0.692	0.981	0.806
1972-73	0.601	0.936	0.937	0.898	0.936	0.800	0.729	0.968	0.790
1973-74	0.716	0.906	0.967	0.823	0.970	0.897	0.760	0.975	0.776
1974-75	0.871	0.916	1.000	0.964	0.967	0.956	0.792	0.973	0.862
1975-76	0.867	0.881	0.906	0.898	0.953	0.897	0.763	0.930	0.847
1976-77	0.859	0.899	0.939	0.867	0.964	0.987	0.794	1.000	0.865
1977-78	0.916	0.945	1.000	0.952	0.939	0.991	0.818	0.993	0.826
1978-79	0.825	1.000	0.949	0.946	0.968	1.000	0.854	0.982	0.937
1979-80	0.899	0.973	0.969	0.914	1.000	0.975	0.851	0.915	0.897
1980-81	1.000	0.924	1.000	1.000	0.955	1.000	0.932	0.929	0.897
1981-82	1.000	0.946	1.000	1.000	1.000	1.000	0.959	0.923	0.933
1982-83	1.000	0.983	0.962	0.988	1.000	1.000	1.000	0.976	0.968
1983-84	0.913	1.000	0.907	0.874	0.968	0.946	1.000	0.993	0.950
1984-85	0.935	0.999	0.957	0.847	0.996	1.000	0.986	1.000	0.944
1985-86	1.000	0.972	0.947	0.874	0.972	0.983	0.940	0.962	1.000
1986-87	0.931	0.971	0.925	0.888	1.000	0.942	0.953	0.985	0.892
1987-88	0.918	0.977	0.937	0.880	1.000	0.950	1.000	0.979	0.939
1988-89	0.982	1.000	0.962	0.954	1.000	0.964	1.000	0.969	0.884
1989-90	0.825	1.000	0.983	0.988	0.969	1.000	1.000	0.984	1.000
1990-91	0.886	1.000	1.000	1.000	0.970	1.000	1.000	1.000	0.944
1991-92	0.924	0.955	1.000	0.981	1.000	0.968	0.969	0.966	0.994
1992-93	0.960	0.953	0.994	1.000	0.984	0.976	1.000	1.000	1.000
Average	0.770	0.952	0.960	0.924	0.973	0.943	0.821	0.971	0.912

33 year period and fluctuated in a narrow range between 0.9 to 1.0. Besides, industry no. 35 (Non-electrical Machinery) also had PE levels of over 90 per cent in all years except between 1966-67 to 1973-74 when PE averaged 85.5 per cent. Food Products (20-21) recorded lowest PE of 79 per cent in 1972-73 and full efficient production in all years during 1988-89 to 1992-93. This industry also had comparatively low levels of productive efficiency in 1967-68, 1968-69, 1971-72, 1973-74 and 1980-81. Non-metallic Mineral Products (32) started with lower levels of efficiency in the first two years of the study but had over 90 per cent PE levels in the remaining 31 years. Paper and Printing and Publishing (28) also had low levels of PE during 1960-61 to 1964-65 as compared to the rest of the period. Similarly Electrical Machinery also shows a continuous rising trend in PE after low levels in the mid- 1960's. This industry (36) has recorded high levels of near to full efficient production in the period after early 1980's. Industry no.27 (Wood and Wood Products) on the other hand, recorded low levels of PE during 1981-82 to 1986-87. Significant fluctuations in year to year PE levels in industries 22(Beverage, Tobacco and Tobacco Products), 24(Wool, Silk and Synthetic fibre), 25(Jute, Hemp and Mesta Textiles) and 26(Textile products). The trends in productive efficiency can be clearly observed from the graphs which plot the PE series for two digit industry groups over the study period.

In Tables 7.2 and 7.3 average levels of productive efficiency over different time periods for the two digit industry groups is given. These periods in Table 7.2 correspond to the three periods in the debate on industrial growth and deceleration. Thus the first period chosen, from 1960-61 to 1965-66 corresponds to the period of rapid industrial growth, the second period, in the study, from 1966-67 to 1979-80 corresponds to the period of deceleration in Indian industry while the third period from 1980-81 to 1992-93 corresponds to the period of revival of growth rates in the manufacturing sector. Table 7.3 on the other hand is a decade wise average for the industry groups for the three decades of the 1960's, 1970's and the 1980's. In addition the average for the three year period of the 1990s is also shown separately. From Table 7.2 it is clear that PE levels in the post liberalization period i.e. after 1980-81 were higher than in the earlier period in Wool, Silk and Synthetic Fibre (24), Rubber, Plastic and Petroleum Products(30), Non Metallic Mineral Products(32), Metal Products(34), Non Electrical Machinery (3 5), Electrical Machinery(36) and Miscellaneous Industries(38). A remarkable deterioration in productive efficiency levels in Inds. No. 22 (Beverages, Tobacco and Tobacco Products)and an improvement in industry 30(Rubber, Plastic, Petroleum and Coal) is also clear. Eight of the eighteen industry groups also had lower PE levels during 1966-67 to 1979-80. These include Food Products (20-21), Cotton Textiles (23), Jute Textiles (25), Chemicals and Chemical Products (31), Basic Metals (33), Non Electrical Machinery (35) , Transport Equipment (37) and Miscellaneous Industries(38). In another five industries namely Food Products(20-21),Cotton Textiles (23), Chemical and Chemical Products (31),Basic Metals(33) and Transport Equipment (37), PE during 1980-81 to 1992-93 and between 1960-61 to 1965-66 were nearly the same i.e. from initial high levels PE declined during 1966-67 to 1979-80 and increased again to nearly the same levels in

Table 7.2

Period wise Average Productive Efficiency Rates for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1965-66	0.974	0.920	0.989	0.837	0.894	0.756	0.982	0.877	0.933
1966-67-1979-80	0.918	0.889	0.973	0.839	0.851	0.865	0.966	0.981	0.964
1980-81-1992-93	0.967	0.827	0.982	0.982	0.875	0.795	0.932	0.975	0.941

contd.

Table 7.3

Decade wise Average Productive Efficiency Rates for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1969-70	0.953	0.934	0.991	0.753	0.870	0.829	0.971	0.921	0.945
1970-71-1979-80	0.916	0.862	0.964	0.924	0.858	0.836	0.971	0.979	0.964
1980-81-1989-90	0.957	0.844	0.977	0.977	0.877	0.752	0.912	0.977	0.931
1990-91-1992-93	1.000	0.769	1.000	1.000	0.870	0.939	1.000	0.966	0.976

contd.

Table 7.2 (contd.)

Period wise Average Productive Efficiency Rates for Two Digit Industries

Period	Industry Group 30	31	32	33	34	35	36	37	38
1960-61-1965-66	0.579	0.979	0.944	0.948	0.975	0.959	0.674	0.978	0.941
1966-67-1979-80	0.691	0.918	0.960	0.894	0.961	0.904	0.736	0.965	0.864
1980-81-1992-93	0.944	0.975	0.967	0.944	0.986	0.979	0.980	0.974	0.950

Table 7.3 (contd.)

Decade wise Average Productive Efficiency Rates for Two Digit Industries

Period	Industry Group 30	31	32	33	34	35	36	37	38
1960-61-1969-70	0.545	0.944	0.953	0.918	0.974	0.911	0.661	0.968	0.926
1970-71-1979-80	0.769	0.929	0.957	0.902	0.956	0.929	0.774	0.969	0.848
1980-81-1989-90	0.950	0.977	0.958	0.929	0.986	0.979	0.977	0.970	0.941
1990-91-1992-93	0.923	0.970	0.998	0.994	0.985	0.981	0.990	0.989	0.979

the last period. In Textile Products (26), Paper, Printing and Publishing(28) and Leather and Leather Products(29) on the other hand, PE levels were higher during 1966-67 to 1979-80 as compared to the other two periods.

Table 7.3 shows the decade wise average levels of PE for the various industry groups. In thirteen of the eighteen industry groups PE levels were highest in the first three years of the 1990's with full and near full efficient production in seven industries. In another three industries namely, Jute Textiles(25), Chemical and Chemical Products(31) and Metal Products(34), the PE levels during 1991-93 were only marginally less than during the period from 1980-81 to 1989-90. Only in industry 22(Beverage, Tobacco and Tobacco Products) the PE in early 1990's is lowest as compared to earlier decades. Similarly industry 30(Rubber, Plastic, Petroleum and Coal Products) recorded significant increase in PE in the period of the 1980's as compared to earlier two decades but showed a decrease in PE in the early 1990's. Textile Products, (inds. no. 26) also shows much higher PE of 93.9% in early 1990s compared to only 75.2% in the 1980s.

In Table 7.4 the industry groups are classified in terms of Process or Input-based and Use-based classification. While a strict meaningful classification is only possible at a lower digit level of industries, since the present study is based on two digit level of classification, the grouping used is not very correct. The grouping of industries according to the use based and input based classification *is* given in Table 3 of the Appendix. In the Process or Input-based classification there are six industry groups namely Agro-based, Mineral-based, Metal-based, Chemical-based, Machinery-based and Miscellaneous Industries. In the use-based classification there are three groups namely Basic and Intermediate Goods, Capital Goods and Consumer Goods. Consumer Goods is also divided into Consumer Durables and Consumer Non-durables.

From Table 7.4 it is clear that Mineral-based industries had high average PE of over 95% throughout the period with 99.8% average PE levels in the early 1990's. The largest increases in PE were however in the Chemical-based and Machinery-based industries. Chemical-based industries had lowest average PE of only 74.5% during 1960-61 to 1969-70. Both these industries recorded significant increases in PE during the 1980's. While Chemical-based industries showed slight decrease in PE in early 1990's Machinery-based industries continued to show increase in PE during the 1990's. The period of 1980's witnessed a decline in PE for Agro-based industries while Metal-based industries and Miscellaneous industries showed a decline during the 1970's. As compared to other Process-based industries, Agro-based industries had lowest average productive efficiency levels in the early 1990's.

The Use-based classification of industries in Table 7.4 shows a decade-wise consistent increase in average PE in the case of Basic and Intermediate Goods as well as Capital Goods. CapitalGoods industries had lowest average PE levels (84.7%) as compared to other use-based industries. But average PE increased in the 1970's and even further in the 1980's and early 1990's. Consumer Goods industries on the other hand showed a decline in PE during the 1970's and 1980's. This decline was due to a decline in PE levels in both

Table 7.4

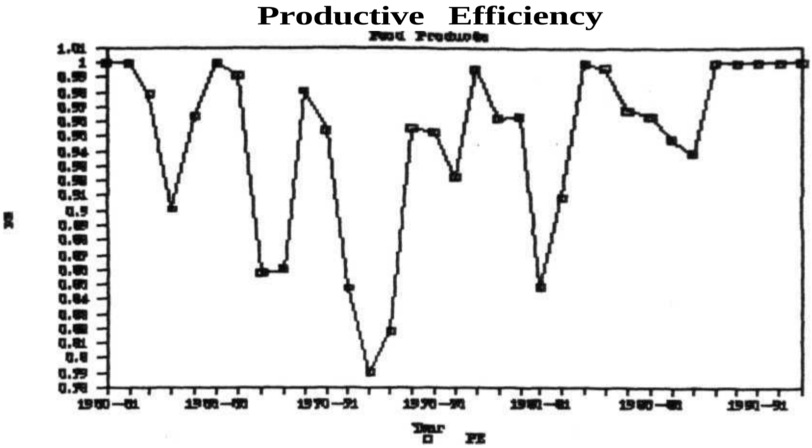
Decade wise Average Productive Efficiency Rates by Process and Use Based Classification

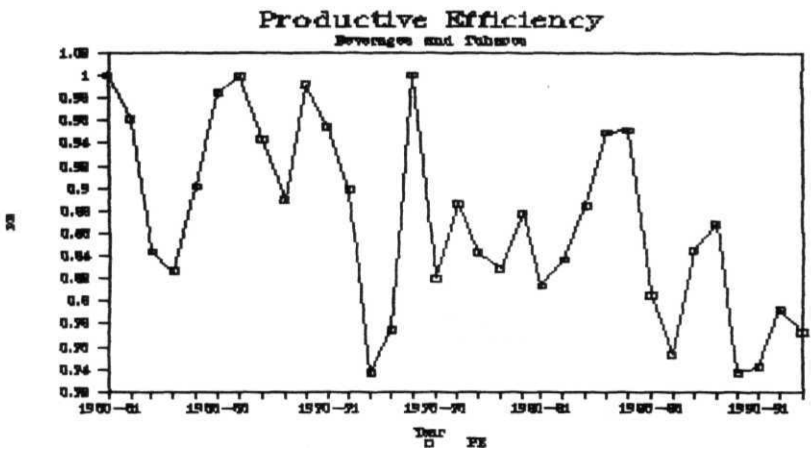
Process Based Classification

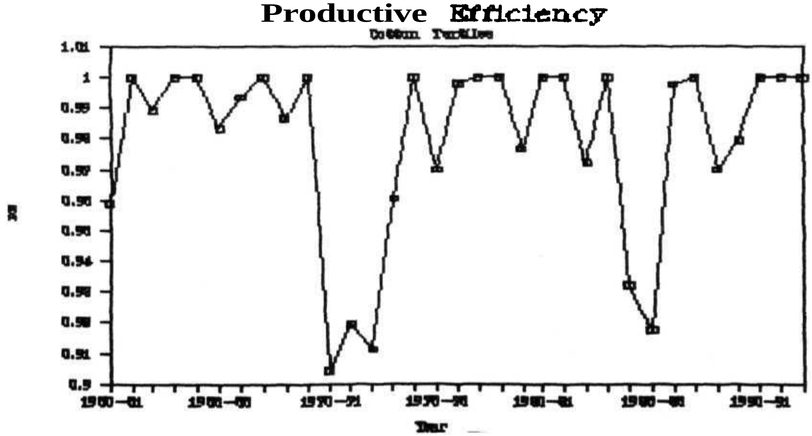
Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1.Agro based	0.903	0.914	0.909	0.943
2. Mineral based	0.953	0.957	0.958	0.998
3. Metal based	0.946	0.929	0.957	0.989
4. Chemical based	0.745	0.849	0.963	0.946
5.Machinery based	0.847	0.891	0.975	0.987
6.Misc. industries	0.935	0.906	0.936	0.977
Total	0.888	0.908	0.950	0.973

Use Based Classification

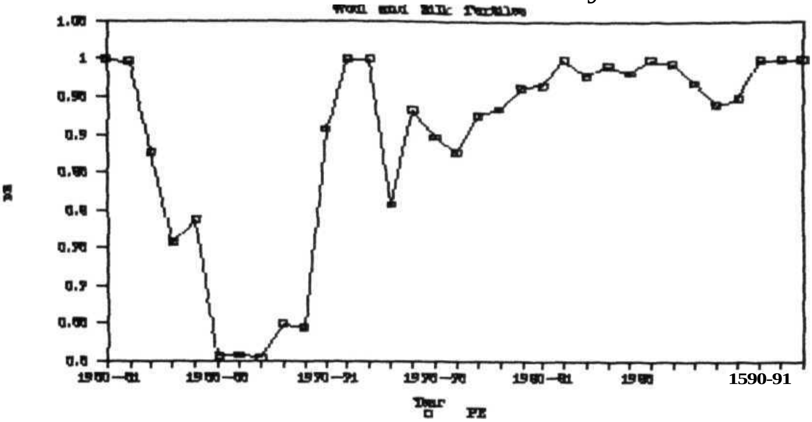
Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1.Basic and intermediate goods	0.881	0.920	0.954	0.968
2. Capital goods	0.847	0.891	0.975	0.987
3. Consumer goods	0.923	0.887	0.881	0.937
(a) Durables	0.948	0.909	0.926	0.989
(b) Non - Durables	0.905	0.871	0.851	0.903


Productive Efficiency
Food Products
Year
PE


Productive Efficiency
Beverages and Tobacco
Year
PE


Productive Efficiency
Cotton Textiles
Year

Productive Efficiency



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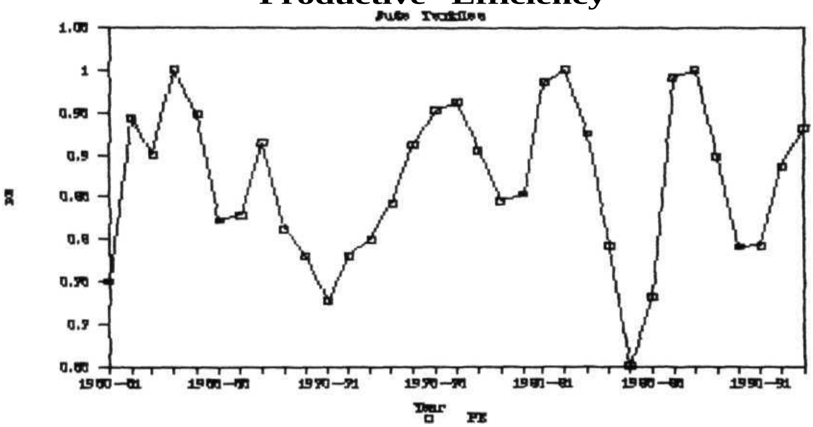
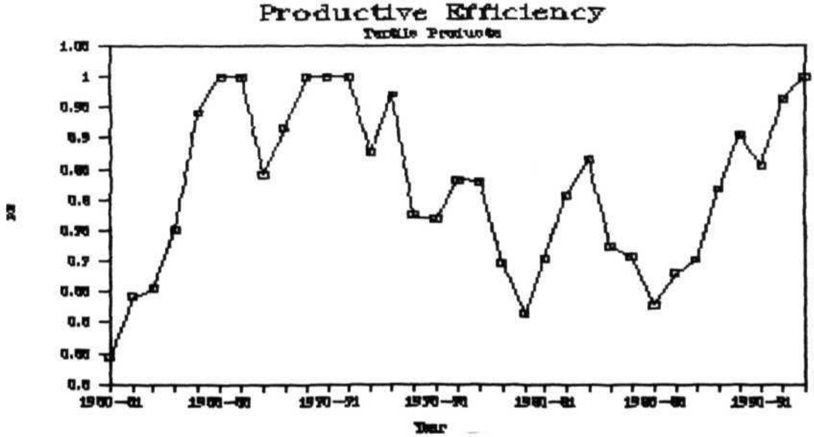
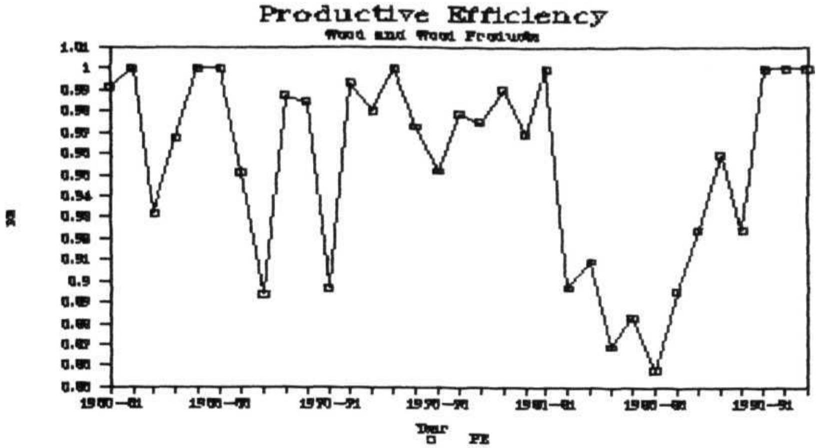
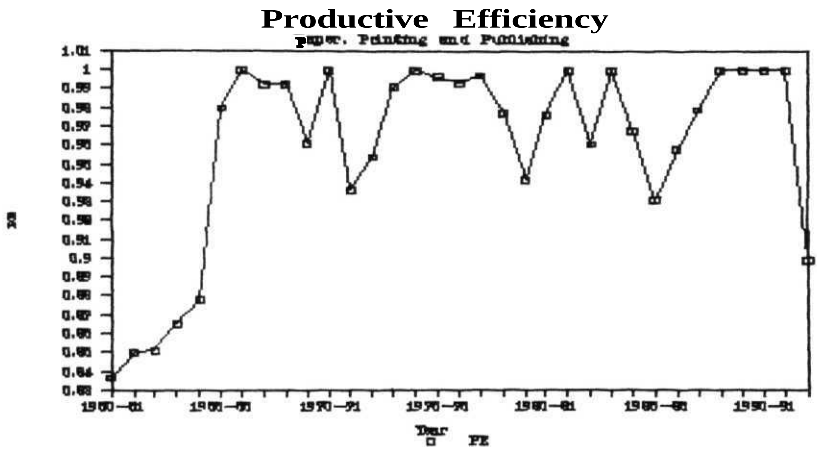
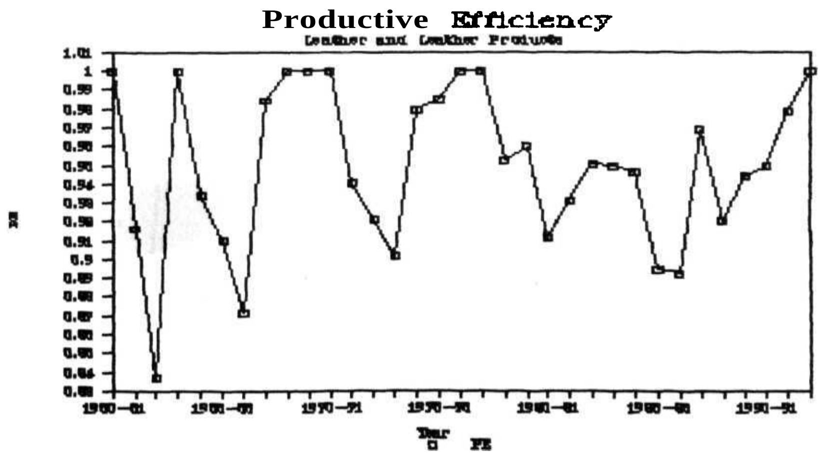


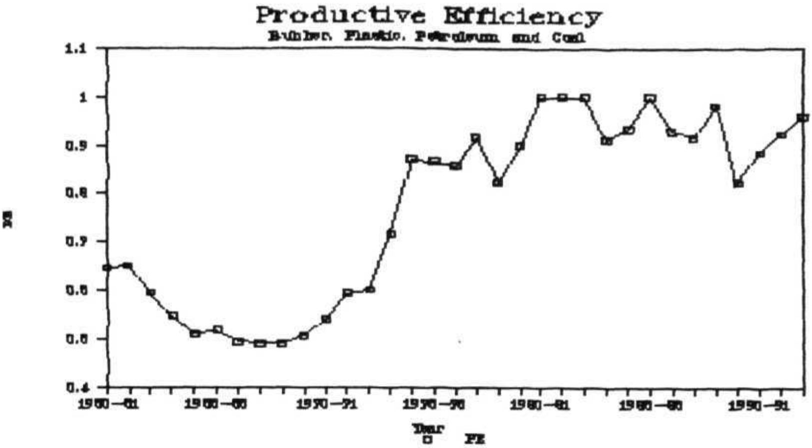
Productive Efficiency



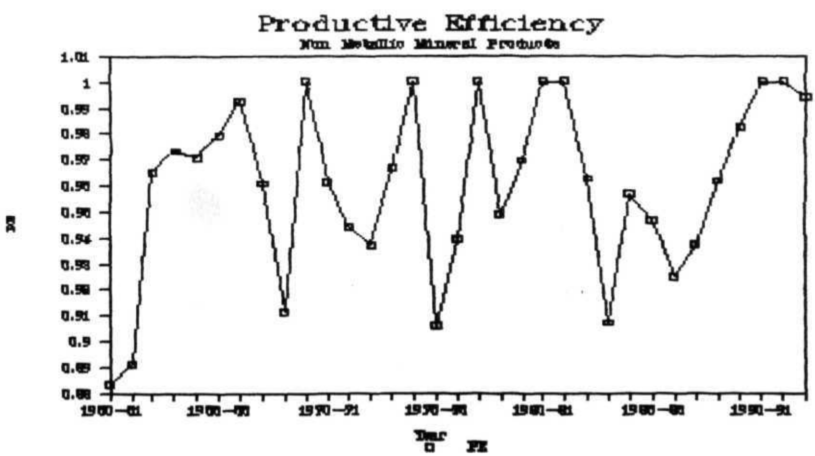

Productive Efficiency
Wood and Wood Products
Year
PE


Productive Efficiency
Paper, Printing and Publishing
Year
PE

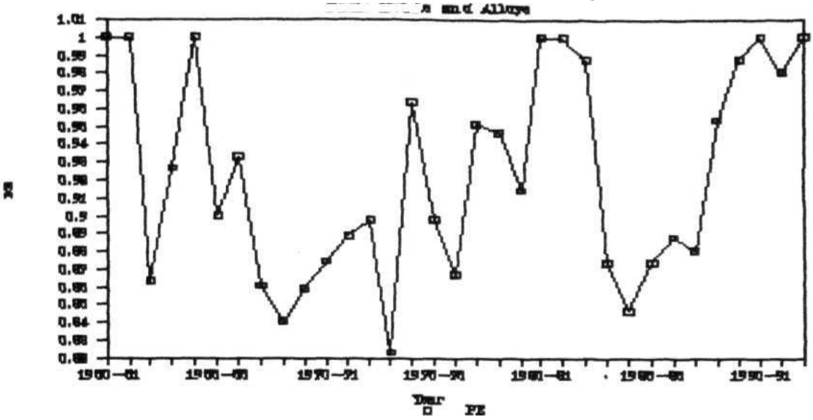

Productive Efficiency
Leather and Leather Products
Year
PE


Productive Efficiency
Rubber, Plastic, Petroleum and Coal
Year
PE


Productive Efficiency
Chemicals and Chemical Products
Year
PE


Productive Efficiency
Non Metallic Mineral Products
Year
PE

Productive Efficiency



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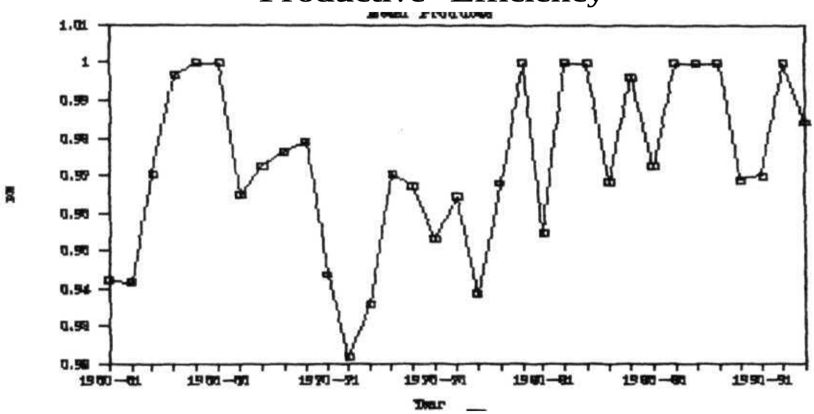

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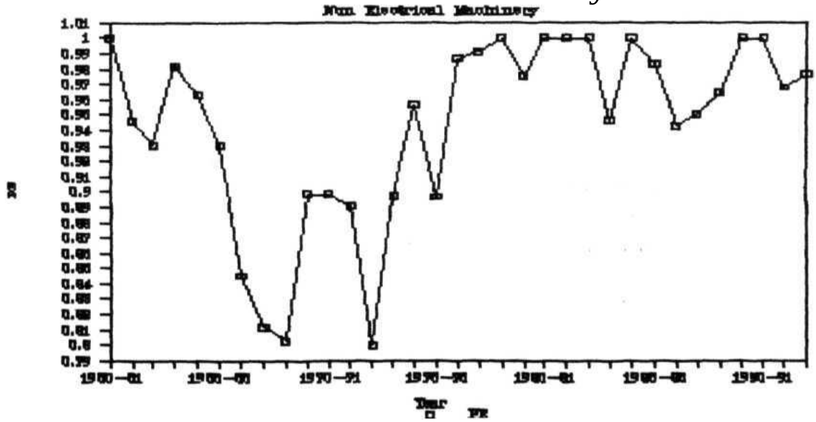
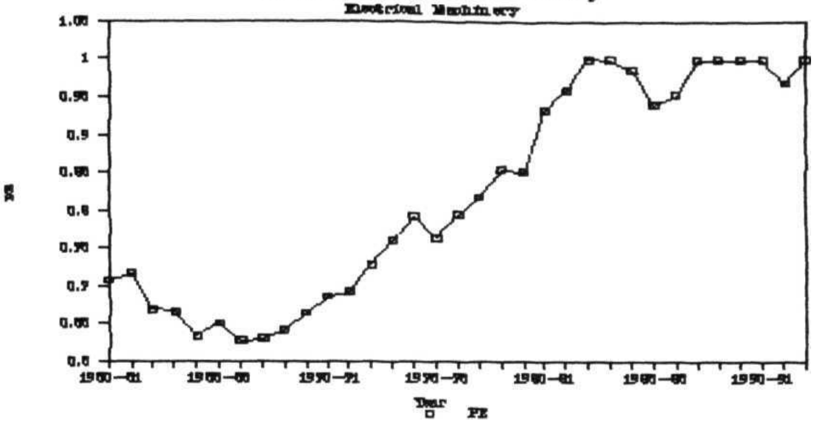
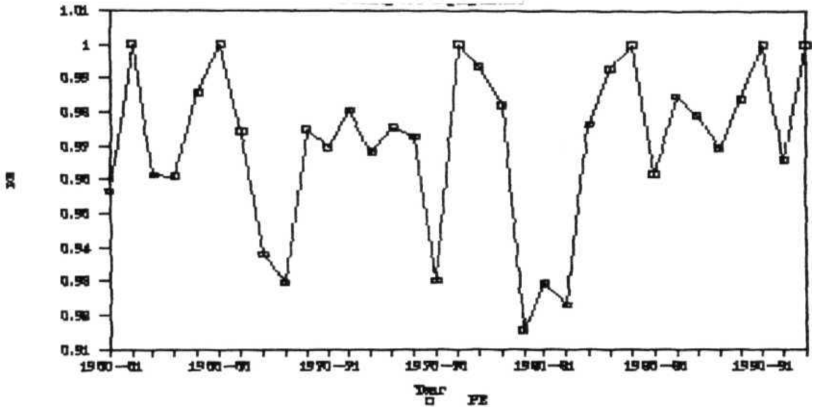


Productive Efficiency

Electrical Machinery

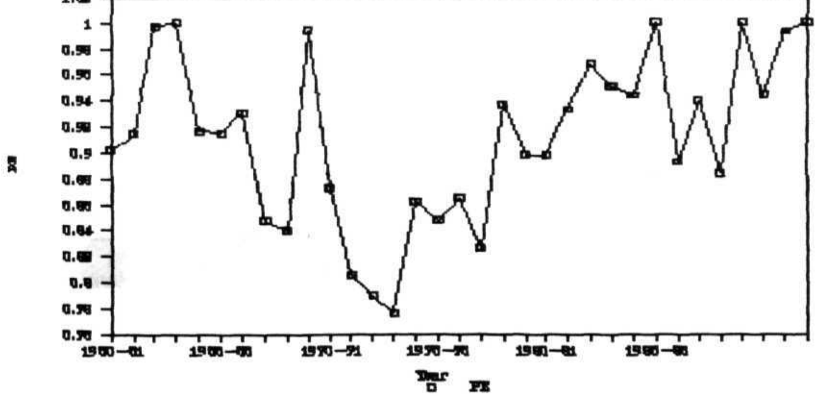


Productive Efficiency



Productive Efficiency

Other Manufacturing Industries



Durables as well as Non-durables. However, while Consumer Durables recorded an increase in PE in 1980s and rose to further high levels in early 1990s (average:98.9%), Consumer Non-durables on the other hand continued to show decreasing PE levels in 1980s and an increase to average level of 90.3% in early 1990's.

7.4 Trends in Capacity Utilization (CAPUT) Rates for Indian Industries:

In this section the results on trends in capacity utilization rates for Indian industries are given and analyzed. This measure is defined as the ratio of actual output to maximum potential plant capacity output as given in Chapter 4. Measures of capacity utilization are generally defined in this way as the ratio of actual output to some measure of potential output. This measure is denoted as CAPUT and is obtained for each of the eighteen two digit industries for the thirtythree year period. Since this measure is unadjusted for inefficiency, the results will be biased downward as compared to the measure of plant capacity utilization (PCU) given in the followings section.

Table 7.5 gives the unadjusted CAPUT rates for each of the two digit industries for the period of the study from 1960-61 to 1992-93. Average capacity utilization rate (CAPUT) for the entire period 1960-61 to 1992-93 is given at the bottom of the table.

From the Table it can be seen that Non Metallic Mineral Products (32) has the highest average CAPUT rate of 89.6%. Paper and Publishing (28) and Wool, Silk and Synthetic fibre (24) also have average utilization levels of 84.1% and 80.1% over the 33-year period. Transport Equipment (37) has average CAPUT rate of 79.3%. Other industries with capacity utilization rate of over 70% but less than 80% are Cotton Textiles (23), Textile Products (26), Wood and Wood Products and Furniture and Fixtures (27), Non-electrical Machinery (35), and Electrical Machinery (36). Seven other industries have capacity utilization rates between 60 to 70%. These include Food Products (20-21), Leather and Leather Products (29), Rubber, Plastic and Petroleum Products (30), Chemical and Chemical Products (31), Basic Metals (33), Metal Products (34) and Miscellaneous Industries (38). Jute, Hemp and Mesta Textiles (25) and Beverage, Tobacco and Tobacco Products (22) have the lowest average capacity utilization rates of 57.9% and 55.2% respectively.

Also, twelve of the eighteen industries have lowest capacity utilization rate in a year between 1983-84 to 1993-94. CAPUT rates are lower in 1992-93 as compared to 1960-61 for a number of industries. In industry 30 i.e, Rubber, Plastic and Petroleum Products, capacity utilization rates declined till 1965-66 and then increased to 100% in 1982-83. Thereafter, there has been a declining trend till 1992-93 with the CAPUT rate of 59.7% in 1992-93 being more than the CAPUT rate of 52.3% in 1960-61. In the case of Electrical Machinery (36) industry also CAPUT in 1992-93 (85.1%) is more than in 1960-61 (67.4%). Industry groups 26 (Textile Products) and 28 (Paper and Printing and Publishing) also have higher capacity utilization rates in 1992-93 as compared to 1960-61. However, in all other fourteen industries capacity utilization rates are lower in the terminal year of the study. The steepest decline in capacity utilization

Table 7.5

Trends in Capacity Utilization **Rates** for **Two** Digit **Industries**
(CAPUT) (1960-61 to 1992-93)

	Industry Group								
Tear	**20-21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
1960-61	0..954	1 .000	0 .930	0 .871	0.688	0 .474	0.958	0.791	0 .940
1961-62	1..000	0 .961	1 .000	0 .838	0.805	0 .606	0.751	0.816	0 .857
1962-63	0..940	0 .806	0 .969	0 .824	0.901	0 .574	0.847	0.793	0 .757
1963-64	0,.808	0 .737	0 .940	0 .753	1.000	0 .727	0.899	0.828	0 .889
1964-65	0,.817	0 .746	0 .937	0 .786	0.868	0 .939	1.000	0.793	0 .898
1965-66	0 .817	0 .830	0 .864	0 .589	0.673	0 .993	0.945	0.855	0 .864
1966-67	0 .760	0 .799	0 .803	0 .562	0.661	0 .938	0.855	0.867	0 .861
1967-68	0 .555	0 .753	0 .819	0 .557	0.779	0 .821	0.780	0.861	0 .982
1968-69	0 .625	0 .680	0 .802	0 .624	0.643	0 .916	0.825	0.871	1 .000
1969-70	0 .811	0 .733	0 .778	0 .607	0.579	1 .000	0.825	0.914	0 .954
1970-71	0 .773	0 .526	0 .617	0 .739	0.540	0 .989	0.727	1.000	0 .930
1971-72	0 .652	0 .608	0 .619	0 .865	0.589	0 .905	0.819	0.910	0 .784
1972-73	0 .543	0 .565	0 .640	0 .900	0.589	0 .876	0.799	0.931	0 .747
1973-74	0 .499	0 .518	0 .604	0 .693	0.537	0 .971	0.787	0.901	0 .777
1974-75	0 .590	0 .471	0 .652	0 .754	0.418	0 .773	0.657	0.845	0 .700
1975-76	0 .614	0 .411	0 .675	0 .831	0.581	0 .765	0.647	0.800	0 .680
1976-77	0 .602	0 .501	0 .703	0 .850	0.606	0 .832	0.679	0.855	0 .758
1977-78	0 .680	0 .523	0 .727	0 .904	0.601	0 .828	0.695	0.888	0 .646
1978-79	0 .645	0 .512	0 .768	0 .930	0.549	0 .695	0.693	0.863	0 .662
1979-80	0 .621	0 .456	0 .675	0 .963	0.542	0 .585	0.692	0.855	0 .621
1980-81	0 .443	0 .411	0 .665	0 .923	0.639	0 .646	0.628	0.822	0 .450
1981-82	0 .531	0 .465	0 .631	1 .000	0.601	0 .691	0.561	0.856	0 .488
1982-83	0 .712	0 .473	0 .634	0 .939	0.544	0 .690	0.583	0.784	0 .467
1983-84	0 .615	0 .489	0 .625	0 .836	0.414	0 .555	0.422	0.729	0 .424
1984-85	0 .584	0 .470	0 .566	0 .845	0.442	0 .514	0.515	0.739	0 .477
1985-86	0 .567	0 .376	0 .586	0 .920	0.543	0 .440	0.496	0.774	0 .418
1986-87	0 .550	0 .346	0 .596	0 .863	0.505	0 .421	0.548	0.781	0 .402
1987-88	0 .586	0 .341	0 .565	0 .798	0.395	0 .421	0.567	0.822	0 .492
1988-89	0 .639	0 .343	0 .591	0 .736	0.387	0 .468	0.603	0.792	0 .453
1989-90	0 .680	0 .356	0 .640	0 .803	0.381	0 .562	0.577	0.884	0 .480
1990-91	0 .643	0 .348	0 .635	0 .829	0.366	0 .515	0.608	0.888	0 .420
1991-92	0 .629	0 .344	0 .623	0 .773	0.342	0 .540	0.593	0.906	0 .412
1992-93	0 .612	0 .317	0 .639	0 .742	0.391	0 .569	0.602	0.750	0 .408
Average	0 .670	0 .552	0 .713	0 .801	0.579	0 .704	0.702	0.841	0 .670

contd.

Mote: Capacity utilization rates estimated as the ratio of actual to plant capacity output as given in chapter 4 and based on ASI data.

Table 7.5 (contd.)

Trends in Capacity Utilization **Rates** for Two Digit Industries
(CAPUT) (1960-61 to 1992-93)

Year	30	31	32	33	34	35	36	37	38
1960-61	0.523	1.000	0..882	1.000	0.897	1.000	0.674	0.944	0.871
1961-62	0.556	0.773	0..891	0.993	0.846	0.847	0.681	1.000	0.757
1962-63	0.473	0.843	0..965	0.673	0.960	0.832	0.606	0.930	0.998
1963-64	0.478	0.815	0.973	0.736	0.996	0.902	0.590	0.918	1.000
1964-65	0.436	0.798	0.971	0.748	1.000	0.849	0.562	0.953	0.866
1965-66	0.341	0.797	0.979	0.650	0.962	0.797	0.597	0.979	0.816
1966-67	0.368	0.638	0.993	0.622	0.843	0.685	0.513	0.896	0.756
1967-68	0.376	0.638	0.960	0.542	0.613	0.663	0.536	0.829	0.771
1968-69	0.429	0.642	0.911	0.560	0.767	0.687	0.522	0.832	0.773
1969-70	0.448	0..618	1.000	0.594	0.769	0.768	0.574	0.861	0.932
1970-71	0.480	0..669	0.961	0.600	0.730	0.776	0.629	0.831	0.779
1971-72	0.537	0..699	0.942	0.624	0.709	0.765	0.616	0.852	0.578
1972-73	0.543	0.,701	0.935	0.640	0.711	0.664	0.646	0.851	0.501
1973-74	0.562	0..665	0.930	0.562	0.674	0.744	0.725	0.845	0.425
1974-75	0.783	0..601	0.842	0.589	0.615	0.778	0.589	0.772	0.423
1975-76	0.,805	0..588	0.865	0.631	0.583	0.726	0.635	0.722	0.448
1976-77	0..787	0..654	0.932	0.590	0.617	0.814	0.723	0.786	0.520
1977-78	0..867	0..698	0.997	0.588	0.634	0.817	0.739	0.766	0.573
1978-79	0..730	0.721	0.939	0.654	0.610	0.840	0.753	0.663	0.641
1979-80	0..783	0.684	0.888	0.612	0.653	0.809	0.773	0.663	0.605
1980-81	0..864	0.616	0.872	0.648	0.580	0.833	0.844	0.673	0.582
1981-82	0.912	0.653	0.877	0.653	0.602	0.817	0.821	0.704	0.511
1982-83	1.000	0.682	0.877	0.624	0.562	0.810	0.864	0.715	0.607
1983-84	0.798	0.660	0.811	0.543	0.497	0.746	0.764	0.713	0.586
1984-85	0.810	0.683	0.871	0.540	0.539	0.756	0.791	0.721	0.578
1985-86	0.903	0.670	0.828	0.511	0.499	0.703	0.783	0.651	0.674
1986-87	0.819	0.669	0.789	0.545	0.476	0.690	0.780	0.700	0.593
1987-88	0.791	0.668	0.772	0.533	0.531	0.728	0.882	0.694	0.662
1988-89	0.767	0.675	0.814	0.571	0.503	0.722	0.869	0.742	0.608
1989-90	0.626	0.706	0.830	0.580	0.484	0.772	0.925	0.761	0.719
1990-91	0.576	0.896	0.833	0.543	0.447	0.761	1..000	0.797	0.697
1991-92	0.608	0.574	0.854	0.500	0.442	0.691	0.844	0.669	0.723
1992-93	0.597	0.686	0.789	0.562	0.400	0.636	0..851	0.730	0.809
Average	0.648	0.699	0.896	0.623	0.665	0.771	0..718	0.793	0.678

rate *is* in Beverages and Tobacco (22) where it dropped from 100% utilization in 1960-61 to 31.7% in 1992-93. Industry (38) i.e. Miscellaneous Industries shows a sharp decrease in capacity utilization rates after 1969-70 but shows an improvement after 1974-75 with capacity utilization levels fluctuating yet maintaining an upward trend. From Table 7.5 it can also be seen that although nine of the eighteen industries had ftill or over 90% capacity utilization levels in 1960-61 ; in 1992-93 no industry had CAPUT levels exceeding 90% while only two industries had CAPUT levels of over 80% (but less than 85%) while four other industries had CAPUT levels of 40% or less. The trends in CAPUT for the two digit industry groups over the study period is depicted graphically in the following pages.

In Table 7.6 average CAPUT levels for each of the eighteen industries for three time periods which correspond to the debate on industrial growth and deceleration are given. The three periods are from 1960-61 to 1965-66, 1966-67 to 1979-80 and the third period from 1980-81 to 1992-93. From the table it can be seen that eleven of the eighteen industries average capacit utilization levels show a continuous declining trend over the three time periods with highest CAPUT levels in the first period from 1960-61 to 1965-66 and lowest utilization levels in the last period from 1980-81 to 1992-93. The fall is particularly sharp in industry 22 i.e. Beverages and Tobacco, where CAPUT levels fell from 84.7% during 1960-61 to 1965-66 to 39.1% during 1980-81 to 1992-93. Jute, Hemp and Mesta Textiles (25) as well as Leather and Leather Products (29) and Metal Products (34) also had only about 50% or less capacity utilization levels in the last period. In three industries namely, Wool and Silk Textiles (24), Rubber, Plastic, Petroleum and Coal Products(30) and Electrical Machinery (36) there was an increasing trend in average CAPUT levels with the highest utilization levels during 1980-81 to 1992-93. In Rubber, Plastic, Petroleum and Coal (30) capacity utilization increased from 46.8% in the first period to 77.5% in the last period. Electrical Machinery (36) too had steadily increasing utilization levels with CAPUT during 1980-81 to 1992-93 being 84.8% which is the highest among all industries for that period. Similarly Wool and Silk Textiles (24) also had about the same utilization levels in the last period i.e. an average of 84.7%.

In two other industries, 26 (Textile Products) and 28 (Paper and Printing) capacity utilization levels were highest in the second phase i.e. from 1966-67 to 1979-80. The utilization levels again declined in the last period particularly in the case of Textile Products. Only in two of the industries , Chemicals and Miscellaneous Industries (31 and 38 respectively) the CAPUT levels declined in the second period from high levels in the first period and again increased in the last period as compared to the intermediate period.

From Table 7.7 which gives a decade wise average CAPUT levels for the various industries it can be seen that Electrical Machinery (36) had increased utilization levels over the decades with average utilization in the early 1990's being 88.9%. On the other hand Rubber, Plastic and Petroleum Products (30) has increasing utilization levels over the first three decades but shows a sharp decline in the early 1990's. In Food Products (20-21), average utilization levels are the lowest in the decade of the 1980's but again show an increase in

Table 7.6

Period wise Average Capacity Utilization (CAPUT) Rates for Two Digit Industries

	Industry Group								
Period	20-21	22	23	24	25	26	27	28	29
1960-61- 1965-66	0.889	0.847	0.940	0.777	0.823	0.719	0.900	0.813	0.867
1966-67- 1979-80	0.641	0.576	0.706	0.770	0.587	0.850	0.748	0.883	0.793
1980-81- 1992-93	0.599	0.391	0.615	0.847	0.458	0.541	0.562	0.810	0.445

Table 7.7

Decade wise Average Capacity Utilization (CAPUT) Rates for Two Digit Industries

	Industry Group								
Period	20-21	22	23	24	25	26	27	28	29
1960-61- 1969-70	0.809	0.805	0.884	0.701	0.760	0.799	0.868	0.839	0.900
1970-71- 1979-80	0.622	0.509	0.668	0.843	0.555	0.822	0.719	0.885	0.730
1980-81- 1989-90	0.591	0.407	0.610	0.866	0.485	0.541	0.550	0.798	0.455
1990-91- 1992-93	0.628	0.337	0.632	0.781	0.366	0.541	0.601	0.848	0.413

Table 7.6 (contd.)

Period wise Average Capacity Utilization (CAPUT) Rates for Two Digit industries

Period	Industry Group 30	31	32	33	34	35	36	37	38
1960-61-1965-66	0.468	0.838	0.944	0.800	0.944	0.871	0.618	0.954	0.885
1966-67-1979-80	0.607	0.658	0.935	0.601	0.695	0.753	0.641	0.798	0.623
1980-81-1992-93	0.775	0.680	0.832	0.566	0.505	0.744	0.848	0.713	0.642

Table 7.7 (contd.)

Decade wise Average Capacity Utilization (CAPUT) Rates for Two Digit Industries

Period	Industry Group 30	31	32	33	34	35	36	37	38
1960-61-1969-70	0.443	0.756	0.953	0.712	0.885	0.803	0.585	0.914	0.854
1970-71-1979-80	0.688	0.668	0.923	0.609	0.654	0.773	0.683	0.775	0.549
1980-81-1989-90	0.829	0.668	0.834	0.575	0.527	0.758	0.832	0.707	0.612
1990-91-1992-93	0.594	0.719	0.825	0.535	0.430	0.696	0.899	0.732	0.743

the 1990's. In seven industries there has been a continuous decline over the decades with industries like Beverages and Tobacco (22), Textile Products (25), Leather and Leather Products (29) and Metal Products (34) having very low average capacity utilization levels in the early 1990's of 33.7%, 36.6%, 41.3% and 43.0% respectively. Textile Products (26) and Paper and Printing and Publishing (28) had highest average utilization levels between 1970-71 to 1979-80 while Wool, Silk and Synthetic Products (24) and Rubber, Plastic and Petroleum Products (30) had highest average utilization levels in the early 1980's.

In Table 7.8 the decade wise average CAPUT levels according to the two classifications of Input Based or Process Based and Use Based classification are given.

From the Process Based classification in Table 7.8 it can be observed that Mineral-based industries averaged the highest utilization levels in all time periods. Average utilization levels in the 1960's was 95.3% and in the early 1990's it averaged 82.5%. But like Agro -based and Metal-based industries there was a declining trend over the decades. Metal-based industries had low average utilization levels of 48.3% in the early 1990's. Machinery-based industries on the other hand after a marginal decline in the second decade (from 76.7% to 74.4%) again recorded an increase through the 1980's (to 76.6%) and further in the early 1990's (to 77.6%). This increase too is however not very significant so this industry group does not show significant fluctuations and maintains consistent average utilization levels over the decades. Chemical-based industries show an increase in utilization levels till 1980's (from 60% in

Table 7.8

Decade wise Average Capacity Utilization (CAPUT) Rates by Process and Use Based Classification

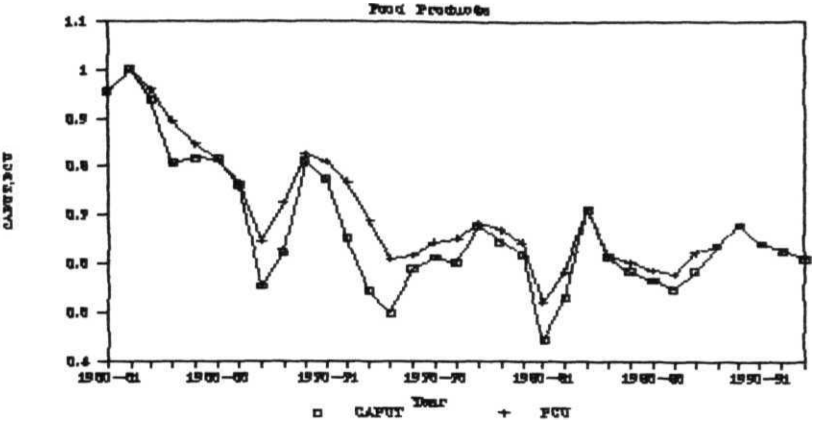
Process Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	0.808	0.703	0.606	0.592
2. Mineral based	0.953	0.923	0.834	0.825
3. Metal based	0.799	0.632	0.551	0.483
4. Chemical based	0.600	0.678	0.749	0.657
5. Machinery based	0.767	0.744	0.766	0.776
6. Misc. industries	0.877	0.640	0.534	0.578
Total	0.801	0.720	0.673	0.652

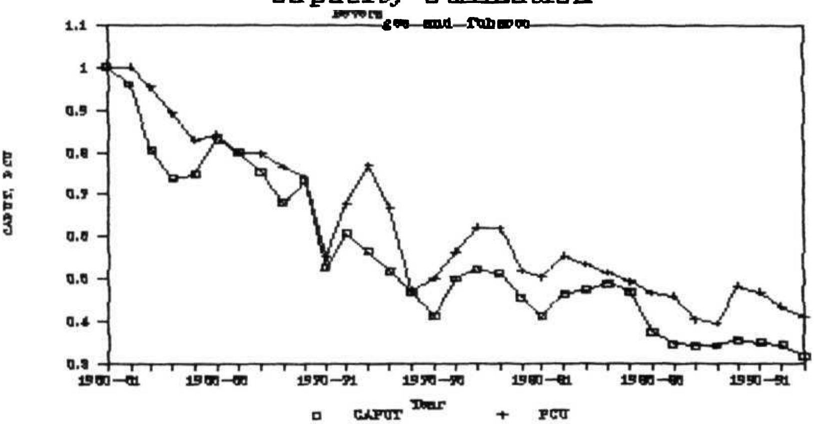
Use Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Basic and intermediate goods	0.783	0.722	0.665	0.614
2. Capital goods	0.767	0.744	0.766	0.776
3. Consumer goods	0.827	0.644	0.540	0.570
(a) Durables	0.861	0.634	0.581	0.672
(b) Non - Durables	0.804	0.651	0.513	0.502

Capacity Utilization



Capacity Utilization



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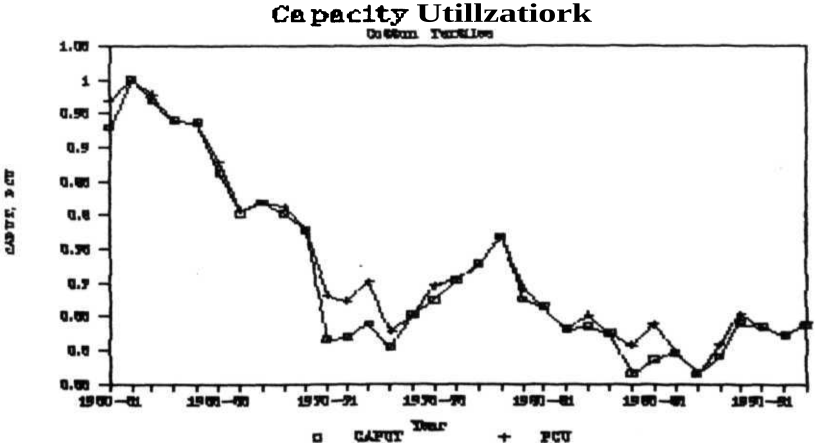
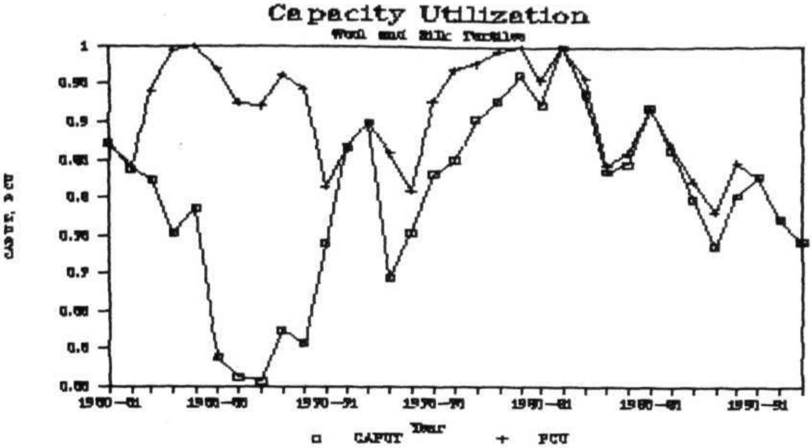
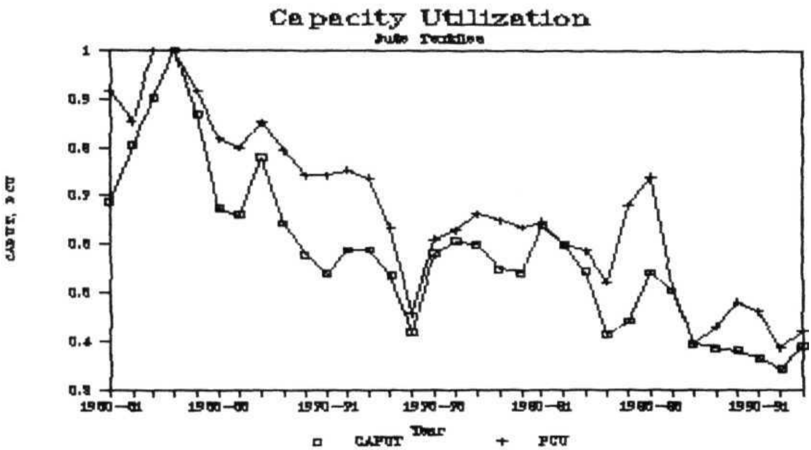
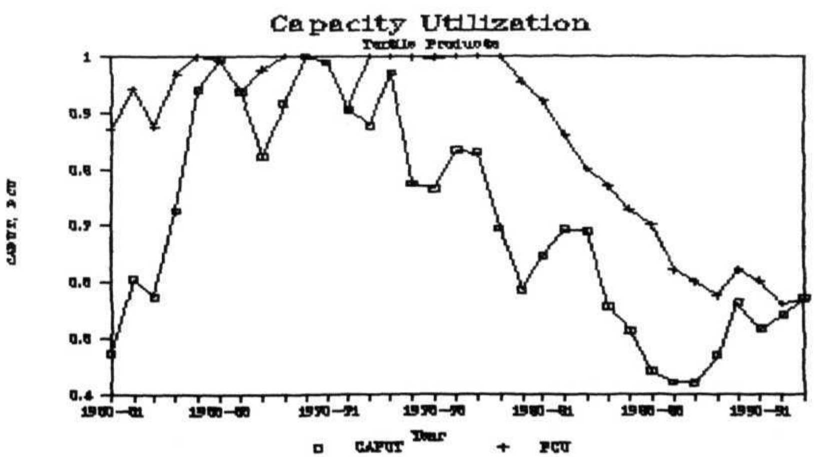




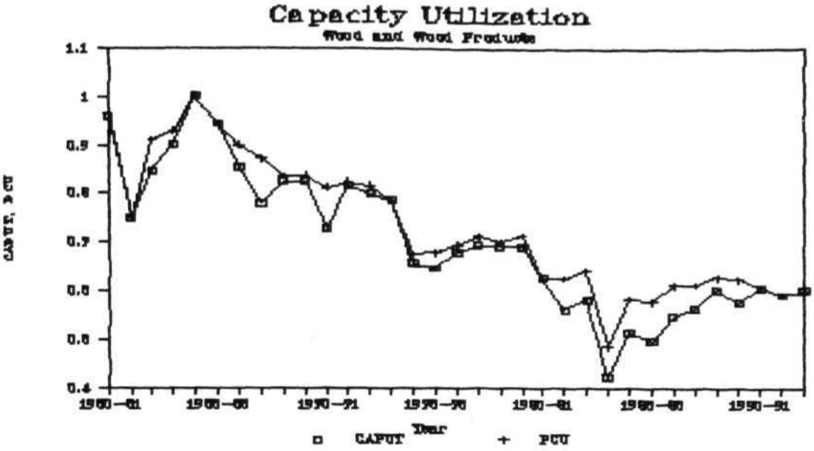
Capacity Utilization
Wool and Silk Textiles
CAPUT, PCU
Year
CAPUT
PCU

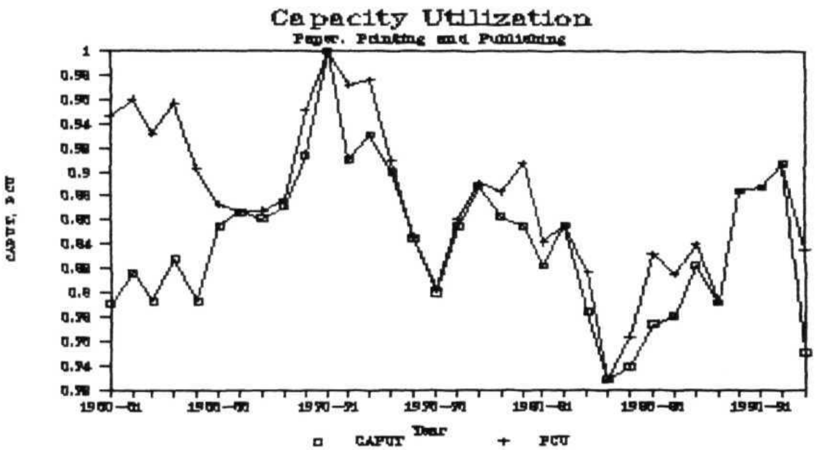


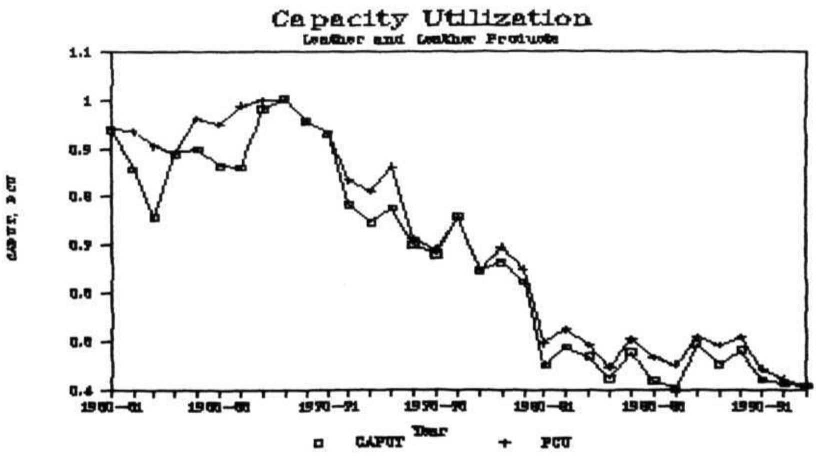
Capacity Utilization
Jute Textiles
CAPUT, PCU
Year
CAPUT
PCU



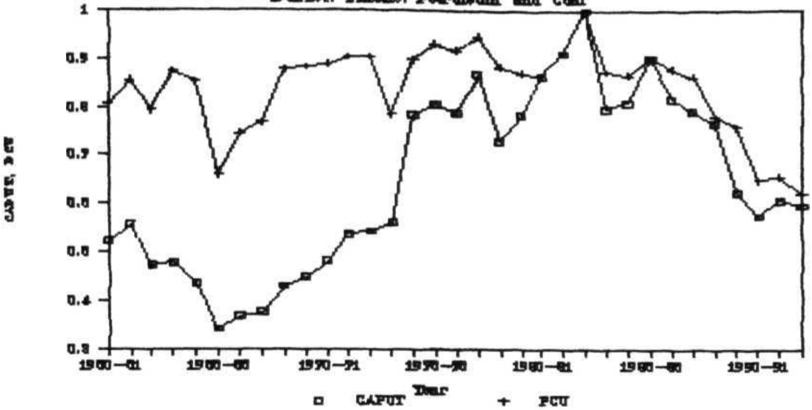
Capacity Utilization
Textile Products
CAPUT, PCU
Year
CAPUT
PCU


Capacity Utilization
Wood and Wood Products
Year
CAPUT
PCU

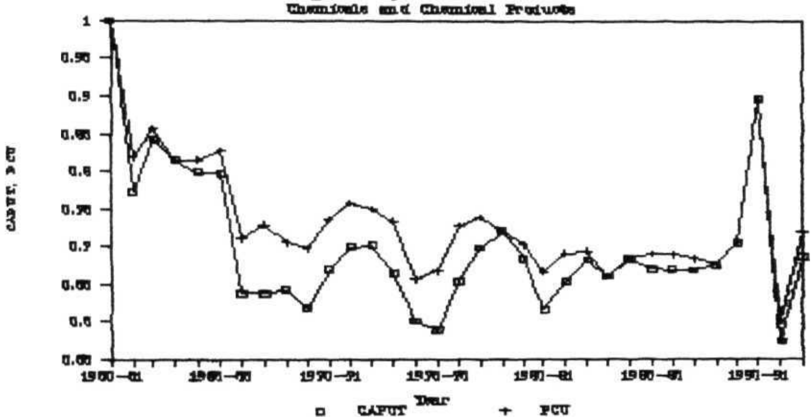

Capacity Utilization
Paper, Printing and Publishing
Year
CAPUT
PCU


Capacity Utilization
Leather and Leather Products
Year
CAPUT
PCU

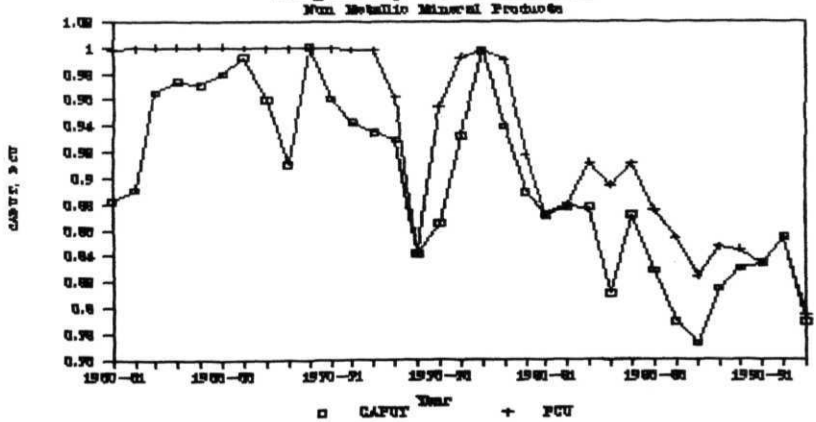
Capacity Utilization
Rubber, Plastic, Petroleum and Coal

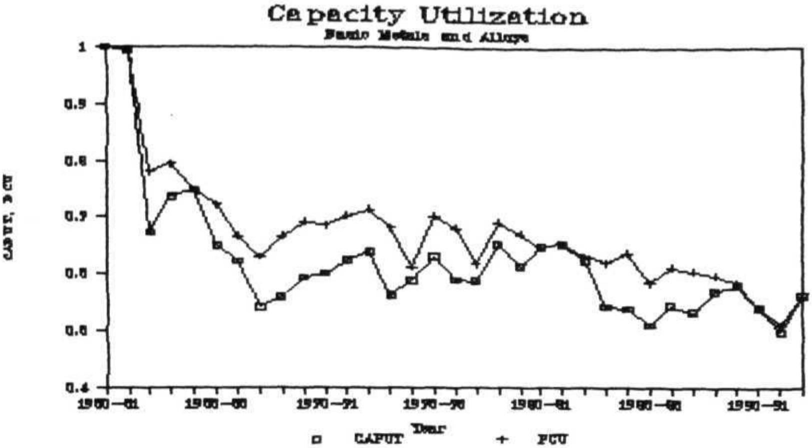


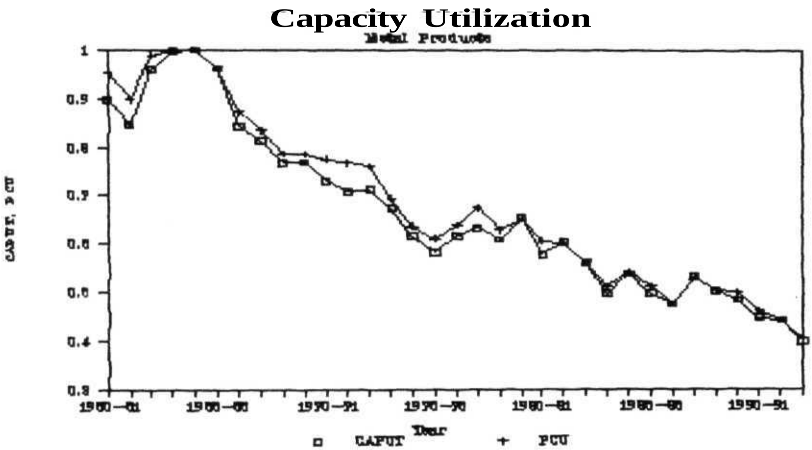
Capacity Utilization
Chemicals and Chemical Products

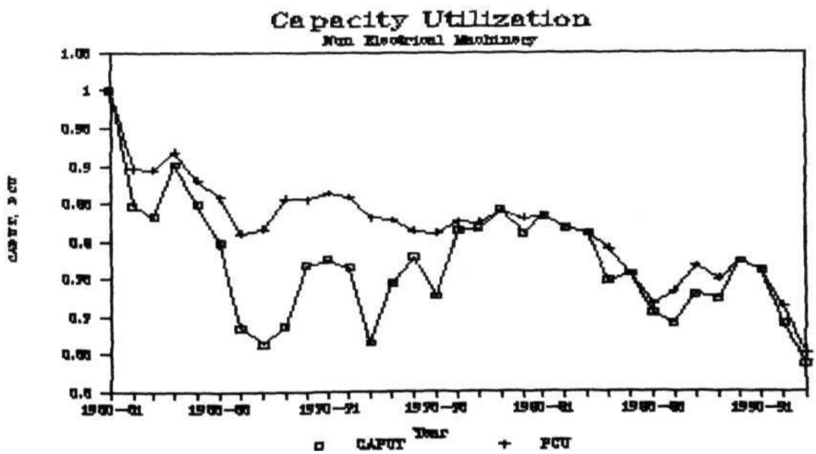


Capacity Utilization
Non Metallic Mineral Products

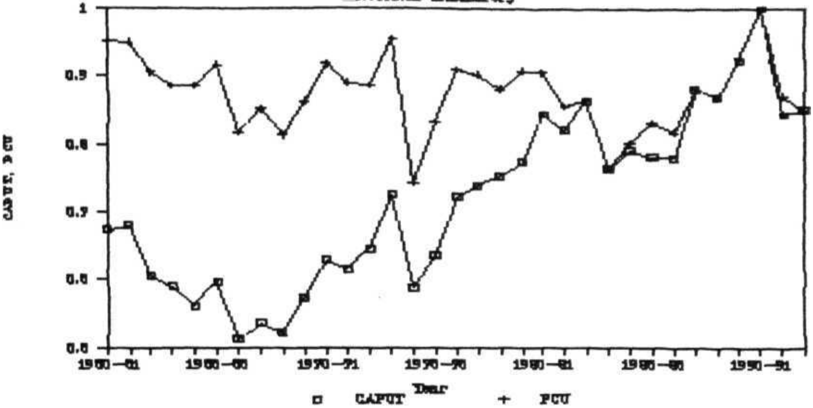



Capacity Utilization
Basic Metals and Alloys
CAPUT, PCU
Year
CAPUT
PCU

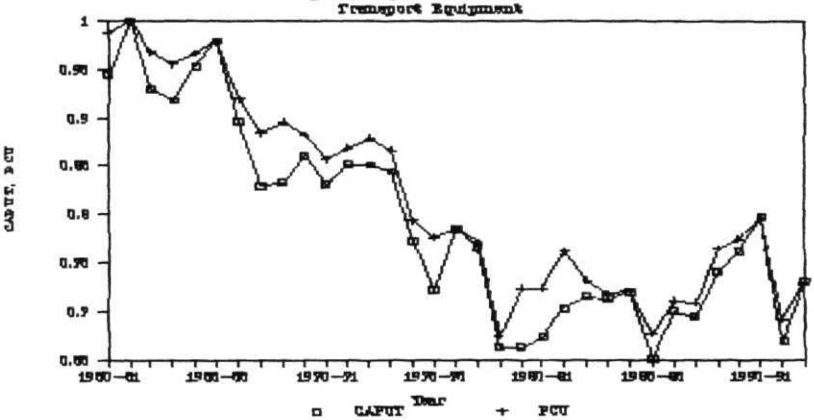

Capacity Utilization
Metal Products
CAPUT, PCU
Year
CAPUT
PCU


Capacity Utilization
Non Electrical Machinery
CAPUT, PCU
Year
CAPUT
PCU

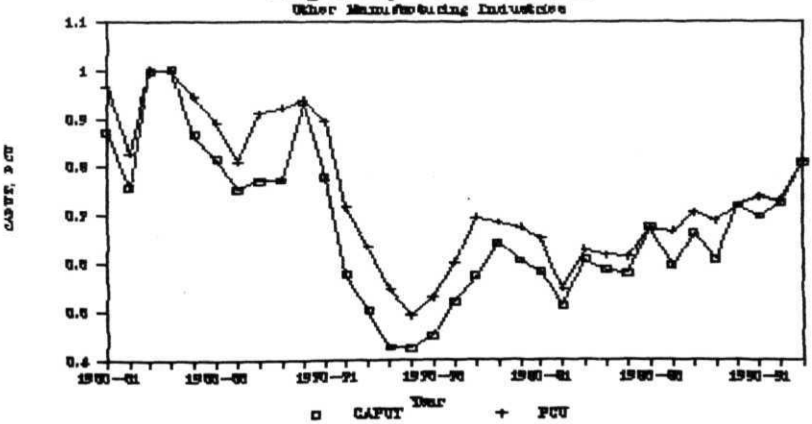
Capacity Utilization
Electrical Machinery



Capacity Utilization
Transport Equipment



Capacity Utilization
Other Manufacturing Industries



1960's to 67.8% in the 1970's and 74.9% in the 1980's) but a decline in the early 1990's (65.7%). Other Manufacturing Industries on the other hand shows a decline till the decade of the 1980's but slight uptrend in early 1990's.

From the Use Based classification in Table 7.8, a sharp decline in capacity utilization levels for Consumer Goods industries (from 82.7% in 1960's to 54% in 1980's) can be noted, although there was a slight increase in average utilization levels in the 1990's (to 57%). This decline is particularly sharp in the case of both Consumer Durables as well as Consumer Non-durables. Although Consumer Durables show improved average utilization levels in the early 1990's. Capital Goods industries on the other hand maintained more or less same average utilization levels with a slight decline during 1970-71 to 1979-80. Basic and Intermediate Goods on the other hand show a continuous decline in capacity utilization levels from average utilization levels of 78.3% in 1960's to 61.4% in early 1990's.

7.5 Trends in Plant Capacity Utilization (PCU) Rates for Indian Industries:

In this section the results on plant capacity utilization rates are given. The methodology used is the nonparametric linear programming production framework outlined in Chapter 4. The measure of plant capacity utilization (PCU) rate is obtained as the ratio of maximum potential output when inputs are given as observed over maximum potential plant capacity when fixed inputs are given as observed and all other factors are allowed to vary freely. This measure of plant capacity utilization denoted by PCU is obtained for each of the two digit industry groups included in the study for the period from 1960-61 to 1992-93. The results are given in Table 7.9.

From Table 7.9 it can be noted that all industry groups show a declining trend in PCU rates. With the exception of 3 industries namely Wool and Silk Textiles (24), Textile Products (26) and Rubber, Plastic, Petroleum and Coal Products(30), all industries started with PCU levels of over 90%. Even these three industries had PCU levels of 80% and over, although less than 90% in 1960-61. The graphs of the trends in PCU rates of the various industries given in the following pages clearly shows the declining trend. As can be observed from the trend, this decline is however less in the case of a few industries like Wool and Silk Products (24), Paper and Printing and Publishing (28), Non Metallic Minerals (32), Electrical Machinery (36) and Transport Equipment (37).

Average utilization rates for the entire period for the various industries are as follows:

Over 90% average PCU: Wool and Silk Products(24) and Non Metallic Minerals(32);

Between 80-90% average PCU: Textile Products(26), Paper and Printing and Publishing(28), Rubber, Plastic Petroleum and Coal(30), Non Electrical Machinery(35), Electrical Machinery(36) and Transport Equipment(37);

Between 70-80% average PCU: Food Products(20-21), Cotton Textiles(23), Wood and Wood Products(27), Leather and Leather Products(29), Chemicals(31), and Miscellaneous Industries (38);

Between 60-70% average PCU: Beverages and Tobacco(22), Jute Textiles(25),Basic Metals(33) and Metal Products(34).

These averages however conceal significant differences in levels of PCU over the period. From fairly high utilization levels of over 90% in almost all industries PCU levels fell to rather low levels in early 1990's. Twelve of the eighteen industries had lowest PCU rate in the period after 1985-86, another three had lowest utilization rates in the early 1980's while three other industries had lowest PCU rates between 1974-75 to 1979-80. Industries which had very low PCU rates towards the end of the period of study include Beverages and Tobacco (22), Jute Textiles (25), Leather and Leather Products (29) and Metal Products (34). These industries had PCU levels as low as 40-50 % or less. On the other hand, in Wool, Silk and Synthetic Fibres (24), Paper and Printing and Publishing (28), Rubber, Plastic and Petroleum Products (30) Non Metallic Mineral Products (32). Electrical Machinery (36) and Miscellaneous Industries (38) the decline in PCU levels towards the end of the period is not so significant. Jute, Hemp and Mesta Textiles (25) had PCU rate of only 38.6 % in 1991-92. Similarly in 1988-89, PCU in Beverage, Tobacco and Tobacco Products (22) was only 39.5% while PCU rate in Leather and Leather Products (29) in 1992-93 was only 40.8%. Metal Products too showed a decline with PCU of only 40.6% in 1992-93. On the other hand Electrical Machinery had highest PCU of 85.1% in 1992-93. Paper and Printing and Publishing also had PCU of 83.5%, Miscellaneous Industries had PCU of 80.9% while Non-metallic Minerals had PCU of 79.3% in 1992-93. Thus, overall the trends in

Table 7.9

Trends in Plant Capacity Utilization Rates for Two Digit Industries (PCU) (1960-61 to 1992-93)

	Industry Group								
Tear	20-21	22	23	24	25	26	27	28	29
1960-61	0,.954	1.000	0.970	0.871	0.917	0.870	0.967	0.946	0.940
1961-62	1..000	1.000	1.000	0.840	0.853	0..942	0..751	0.961	0.935
1962-63	0..961	0.955	0.979	0.939	1.000	0.876	0..909	0.932	0.905
1963-64	0,.896	0.892	0.940	0.995	1.000	0.968	0.929	0.957	0.889
1964-65	0..848	0.828	0.937	1.000	0.916	0.998	1.000	0.903	0.961
1965-66	0.817	0.843	0.878	0.971	0.819	0.993	0.945	0.873	0.949
1966-67	0.767	0.799	0.808	0.925	0.798	0.938	0.899	0.867	0.988
1967-68	0.647	0.797	0.819	0.921	0.852	0.975	0.873	0.868	0.998
1968-69	0.727	0.765	0.813	0.962	0.793	1.000	0.836	0.878	1.000
1969-70	0.827	0.739	0.778	0.943	0.742	1.000	0.838	0.951	0.954
1970-71	0.810	0..551	0.682	0.815	0.743	0.989	0.811	1.000	0.930
1971-72	0.770	0.,677	0.673	0.865	0.754	0.905	0.824	0.972	0.834
1972-73	0.688	0..767	0.702	0.900	0.737	1.000	0.815	0.976	0.810
1973-74	0.610	0..669	0.629	0.859	0.637	1.000	0.787	0.909	0.862
1974-75	0.618	0..471	0.652	0.809	0.458	0.998	0.675	0.845	0.714
1975-76	0.644	0..501	0.696	0.927	0.610	0.998	0.680	0.803	0.690
1976-77	0.653	0..565	0.704	0.970	0.629	1.000	0.694	0.860	0.758
1977-78	0.683	0,.621	0.727	0.978	0.664	1.000	0.712	0.891	0.646
1978-79	0.671	0.618	0.768	0.995	0.650	1.000	0.700	0.883	0.695
1979-80	0.644	0.520	0.692	1.000	0.635	0.954	0.714	0.907	0.647
1980-81	0.522	0.505	0.665	0.957	0.648	0.920	0.628	0.842	0.494
1981-82	0.584	0.556	0.631	1.000	0.601	0.860	0.626	0.856	0.524
1982-83	0.712	0.534	0.652	0.959	0.588	0.799	0.641	0.817	0.492
1983-84	0.617	0.515	0.625	0.843	0.523	0.769	0.486	0.729	0.447
1984-85	0.604	0.494	0.607	0.860	0.680	0.727	0.584	0.763	0.504
1985-86	0.589	0.467	0.639	0.920	0.741	0.701	0.578	0.831	0.467
1986-87	0.580	0.459	0.598	0.869	0.509	0.621	0.612	0.816	0.451
1987-88	0.624	0.404	0.565	0.823	0.395	0.600	0.613	0.840	0.508
1988-89	0.639	0.395	0.610	0.783	0.431	0.574	0.629	0.792	0.492
1989-90	0.680	0.483	0.654	0.847	0.481	0.621	0.624	0.884	0.509
1990-91	0.643	0.469	0.635	0.829	0.461	0.602	0.608	0.888	0.443
1991-92	0.629	0.434	0.623	0.773	0.386	0.561	0.593	0.906	0.421
1992-93	0.612	0.411	0.639	0.742	0.420	0.569	0.602	0.835	0.408
Average	0.705	0.627	0.727	0.900	0.669	0.859	0.733	0.878	0.705

contd.

Note: Plant capacity utilization rates estimated as the ratio of maximum output to plant capacity output as given in chapter 4 and based on ASI data.

Table 7.9 (contd.)

Trends in Plant Capacity Utilization **Rates** for Two Digit **Industries** (PCU) (1960-61 to **1992-93)**

	Industry Group								
Tear	30	31	32	33	34	35	36	37	38
1960-61	0.809	1.000	0.998	1.000	0.952	1.000	0.952	0.987	0.966
1961-62	0.854	0.818	0.999	0.993	0.898	0.896	0.950	1.000	0.827
1962-63	0.794	0.857	1.000	0.779	0.989	0.894	0.906	0.967	1.000
1963-64	0.874	0.815	1.000	0.794	1.000	0.918	0.886	0.955	1.000
1964-65	0.852	0.814	1.000	0.748	1.000	0.881	0.886	0.967	0.945
1965-66	0.658	0.827	1.000	0.721	0.962	0.858	0.917	0.979	0.892
1966-67	0.745	0.711	1.000	0.667	0.874	0.810	0.818	0.920	0.812
1967-68	0.767	0.728	0.999	0.630	0.836	0.817	0.852	0.884	0.910
1968-69	0.877	0.706	0.999	0.666	0.786	0.856	0.813	0.895	0.920
1969-70	0.882	0.697	1.000	0.691	0.786	0.855	0.864	0.883	0.938
1970-71	0.888	0.736	0.999	0.687	0.774	0.864	0.918	0.857	0.893
1971-72	0.903	0.757	0.998	0.702	0.769	0.859	0.890	0.868	0.717
1972-73	0.904	0.749	0.998	0.713	0.760	0.830	0.886	0.879	0.634
1973-74	0.784	0.734	0.962	0.682	0.695	0.829	0.954	0.866	0.547
1974-75	0.898	0.656	0.842	0.611	0.636	0.814	0.743	0.794	0.491
1975-76	0.929	0.668	0.955	0.703	0.612	0.810	0.832	0.776	0.529
1976-77	0.917	0.728	0.993	0.680	0.639	0.825	0.910	0.786	0.602
1977-78	0.947	0.739	0.997	0.618	0.676	0.824	0.903	0.771	0.694
1978-79	0.884	0.721	0.990	0.691	0.630	0.840	0.881	0.675	0.685
1979-80	0.871	0.703	0.916	0.670	0.653	0.830	0.908	0.724	0.674
1980-81	0.864	0.666	0.872	0.648	0.607	0.833	0.906	0.724	0.649
1981-82	0.912	0.690	0.877	0.653	0.602	0.817	0.856	0.762	0.548
1982-83	1.000	0.694	0.911	0.632	0.562	0.810	0.864	0.732	0.627
1983-84	0.874	0.660	0.894	0.622	0.513	0.789	0.764	0.718	0.617
1984-85	0.866	0.684	0.910	0.638	0.541	0.756	0.802	0.721	0.613
1985-86	0.903	0.690	0.875	0.585	0.513	0.715	0.832	0.677	0.674
1986-87	0.880	0.689	0.853	0.613	0.476	0.733	0.818	0.711	0.665
1987-88	0.862	0.684	0.824	0.606	0.531	0.767	0.882	0.709	0.704
1988-89	0.781	0.675	0.847	0.598	0.503	0.749	0.869	0.765	0.688
1989-90	0.759	0.706	0.845	0.587	0.500	0.772	0.925	0.774	0.719
1990-91	0.651	0.896	0.833	0.543	0.461	0.761	1.000	0.797	0.738
1991-92	0.658	0.601	0.854	0.510	0.442	0.714	0.871	0.693	0.728
1992-93	0.622	0.720	0.793	0.562	0.406	0.652	0.851	0.730	0.809
Average	0.838	0.734	0.934	0.674	0.684	0.817	0.876	0.817	0.741

PCU rates show a declining trend for all industries over the period 1960-61 to 1992-93.

In Tables 7.10 and 7.11 average PCU rates for the two digit industry groups for different time periods is given. In Table 7.10 the time periods chosen are the same as in the analysis on PE and CAPUT trends. The time periods correspond to the three classifications of rapid growth from 1960-61 to 1965-66, the period of deceleration during 1966-67 to 1979-80 and the revival of growth from 1980-81 onwards till the end of the period of study i.e. 1992-93. From Table 7.10 it is clear that seventeen of the eighteen industries showed lower PCU during 1980-81 to 1992-93 as compared to 1960-61 to 1965-66. Thus the period of rapid industrial growth in the early 1960's also coincided with high PCU rates. But the revival of industrial growth since 1980's has not been accompanied by an increase in PCU rates. Textile Products showed a sharp decline in PCU rates after 1980-81. Similarly, industry groups 22 (Beverages and Tobacco) and 29 (Leather and Leather Products) had less than 50% PCU rates during 1980-81 to 1992-93. Metal Products (34) too had low PCU of 51.2% during this period. On the other hand Electrical Machinery (36), Non Metallic Mineral Products (32) and Wool and Silk Products (24) had PCU of over 85%. Paper and Printing and Publishing (28), Rubber, Plastic and Petroleum and Coal Products (30) also had PCU rates of over 80% but less than 85%.

In Table 7.11 a decade wise average of PCU levels i.e. average PCU rates for **the** periods **1960-61 to** 1969-70, **1970-71 to 1979-80,** 1980-81 to 1989-90 and 1990-91 to 1992-93 is given. From the table it is clear that Electrical Machinery (36) had high PCU levels of

Table 7.10

Period wise Average Plant Capacity Utilization (PCU) Rates for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1965-66	0.912	0.920	0.951	0.936	0.918	0.941	0.917	0.929	0.930
1966-67-1979-80	0.697	0.647	0.725	0.919	0.693	0.983	0.776	0.901	0.823
1980-81-1992-93	0.618	0.471	0.626	0.862	0.528	0.687	0.602	0.831	0.474

contd.

Table 7.11

Decade wise Average Plant Capacity Utilization (PCU) Rates for two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1969-70	0.844	0.862	0.892	0.937	0.869	0.956	0.895	0.913	0.952
1970-71-1979-80	0.679	0.596	0.693	0.912	0.652	0.984	0.741	0.905	0.759
1980-81-1989-90	0.615	0.481	0.625	0.886	0.560	0.719	0.602	0.817	0.489
1990-91-1992-93	0.628	0.438	0.632	0.781	0.423	0.578	0.601	0.876	0.424

contd.

Table 7.10 (contd.)

Period wise Average Plant Capacity Utilization (PCU) Rates for Two Digit Industries

Period	Industry Group 30	31	32	33	34	35	36	37	38
1960-61-1965-66	0.807	0.855	1.000	0.839	0.967	0.908	0.916	0.976	0.938
1966-67-1979-80	0.871	0.717	0.975	0.672	0.723	0.833	0.869	0.827	0.717
1980-81-1992-93	0.818	0.697	0.861	0.600	0.512	0.759	0.865	0.732	0.675

Table 7.11 (contd.)

Decade wise Average Plant Capacity Utilization (PCU) Rates for Two Digit Industries

Period	30	31	32	33	34	35	36	37	38
1960-61-1969-70	0.811	0.797	1.000	0.769	0.908	0.878	0.884	0.944	0.921
1970-71-1979-80	0.892	0.719	0.965	0.676	0.684	0.832	0.883	0.800	0.647
1980-81-1989-90	0.870	0.684	0.871	0.618	0.535	0.774	0.852	0.729	0.650
1990-91-1992-93	0.643	0.739	0.827	0.538	0.437	0.709	0.907	0.740	0.758

90.7% in early 1990's. This industry had highest utilization rates during the early 1990s as compared to the three earlier periods. In seven other industries, namely Food Products (20-21), Cotton Textiles (23), Paper and Printing and Publishing (28), Chemicals (31), Electrical Machinery (36), Transport Equipment (37) and Miscellaneous Industries (38) too, PCU rates in early 1990's were higher as compared to the 1980's indicating an improvement in utilization levels in the early 1990's. However in the remaining industries PCU rates continued to decline throughout the entire period.

In Table 7.12 the decade wise average PCU rates according to two classifications are given - Process or Input Based and Use Based classification respectively.

From Table 7.12 it can be seen that Mineral-based industries had the highest PCU rates throughout and PCU declined from 100% in 1960s to 82.7% in early 1990's. Metal-based industries on the other hand showed a sharp decline with PCU declining from 83.9% in the first decade to 48.8% during 1990-91 to 1992-93. The PCU rate of 48.8% in the early 1990's is lowest as compared to other Process-based industries. Machinery-based industries showed a decline in utilization rates from 90.2% in 1960's to 78.5% in 1980s and maintained this rate in the early 1990's. Agro-based industries showed a continued decline in PCU rates from 89.6% in 1960's to 62% in early 1990's.

The Use Based classification in Table 7.12 shows that all Use Based industry groups showed a continous decline in PCU rates over time. Capital Goods industries had highest PCU rates throughout the different time periods. Consumer Durables had a comparable high

Table 7.12

Decade wise Average Plant Capacity Utilization (PCU) Rates by Process and Use Based Classification

Process Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	0.896	0.770	0.663	0.620
2. Mineral based	1.000	0.965	0.871	0.827
3. Metal based	0.839	0.680	0.577	0.488
4. Chemical based	0.804	0.806	0.777	0.691
5. Machinery based	0.902	0.838	0.785	0.785
6. Misc. industries	0.937	0.703	0.570	0.591
Total	0.896	0.794	0.707	0.667

Use Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Basic and intermediate goods	0.885	0.786	0.696	0.629
2. Capital goods	0.902	0.838	0.785	0.785
3. Consumer goods	0.896	0.729	0.613	0.601
(a) Durables	0.908	0.694	0.626	0.680
(b) Non - Durables	0.887	0.753	0.605	0.548

PCU in early 1960's (90.8%). Consumer Non-durables had the lowest average PCU rate of 54.8% in early 1990's. Consumer Durables on the other hand had higher PCU rate in early 1990s as compared to the 1980's.

7.6 Plant Capacity Utilization Rates with Variable Returns to Scale in Indian Industries:

In section 7.5 the results on plant capacity utilization (PCU) rates were obtained under the assumption of constant returns to scale(CRS) assumption. In this section the results on plant capacity utilization rates for the eighteen two digit industry groups for study period under an alternative assumption of variable returns to scale (VRTS) are presented. This measure is denoted by PCUVRS. The results for this alternative assumption are obtained as given in Chapter 4. Thus this measure is obtained as the ratio of maximum output to maximum plant capacity output with the assumption of variable returns to scale. Grosskopf (1986) summarizes some of the reference technologies used in the programming literature and shows that they are nested. He suggests that the same systematic relationship exists for the frontiers of those technologies. Hence CU measures which are measured relative to those reference technologies are also nested. Thus the measure of plant capacity utilization (PCU) obtained under the most restrictive assumption of CRS (in section 7.6) will be lower than the plant capacity utilization rates obtained with the less restrictive assumption of variable returns to scale (PCUVRS) given in this section.

In Table 7.13 the results on PCUVRS for the various industries obtained from the linear programming solutions for the period of the study are given with the average utilization rates for each industry given at the bottom row of the table. As can be seen from the table and by comparing with the results in Table 7.9, plant capacity utilization rates with variable returns to scale (PCUVRS) are higher than PCU with CRS assumption(PCU). This is also clear from the trends in the two rates depicted graphically in the following pages. In fourteen of the eighteen industries under consideration, average PCUVRS are higher than 90% for the period of the study i.e. 1960-61 to 1992-93. In three industries average PCUVRS was between 80-90% while Other Manufacturing Industries had the lowest average of 79.2%.

Also many industries (thirteen of them) had lowest PCUVRS levels before 1979-80. Lowest PCUVRS in Miscellaneous Industries (38) was 49.5% in 1974-75. Jute, Hemp and Mesta Textiles (25) also had lowest PCUVRS (57.8%) in 1974-75. In all other industries even lowest levels of PCUVRS were higher than 70%. Non Metallic Mineral Products (32) had the highest average PCUVRS of 97.5% over the entire period with Non-Electrical Machinery (36) following with 97.1%.

From Table 7.13, it can be noted that Food Products (20-21) has low PCUVRS in 1967-68, 1973-74, 1974-75 and again during 1980-81 and 1981-82. Beverages and Tobacco (22) had low PCUVRS in 1970-71, 1974-75 while Cotton Textiles (23) had low utilization levels between 1970-71 to 1974-75. On the other hand, high PCUVRS after the mid-1980's is clear in the case of Rubber, Plastic,

Table 7.13

Trends in Plant Capacity Utilization Rates for Two Digit Industries (PCUVRS) Variable Returns to Scale (1960-61 to 1992-93)

Tear	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61	1.000	1.000	1.000	1.000	1..000	1,.000	1.000	1.000	1.000
1961-62	1.000	1.000	1.000	0.950	1..000	1.000	0.756	1.000	0.961
1962-63	0.983	1.000	1.000	0.983	1..000	0.877	0.894	0.976	0.926
1963-64	0.929	0.819	0.983	0.999	1,.000	0.971	0.933	0.991	0.932
1964-65	0.905	0.864	1.000	1.000	0,.924	1.000	1.000	0.935	0.976
1965-66	0.889	1.000	0.964	0.971	0.828	1.000	1.000	0.920	0.969
1966-67	0.849	1.000	0.914	0.927	0.819	0.942	1.000	0.916	0.995
1967-68	0.725	0.999	0.950	0.928	0.992	0.975	0.971	0.868	0.999
1968-69	0.832	0.995	0.961	0.964	0.930	1.000	0.960	0.894	1.000
1969-70	0.963	1.000	0.935	0.953	0.870	1.000	0.967	0.959	0.974
1970-71	0.959	0.778	0.729	0.819	0.874	1.000	0.932	1.000	0.995
1971-72	0.927	0.958	0.741	0.891	0.936	0.924	0.953	0.976	0.932
1972-73	0.838	0.998	0.799	0.923	0.971	0.991	0.963	0.986	0.811
1973-74	0.750	0.939	0.742	0.874	0.849	1.000	0.943	0.921	0.968
1974-75	0.759	0.785	0.813	0.821	0.578	0.999	0.842	0.867	0.861
1975-76	0.814	0.845	0.875	0.939	0.841	0.999	0.846	0.825	0.858
1976-77	0.836	0.913	0.893	0.976	0.879	0.999	0.884	0.890	1.000
1977-78	0.889	0.982	0.934	0.983	0.961	1.000	0.932	0.927	0.911
1978-79	0.885	0.999	1.000	0.995	0.966	0.994	0.928	0.921	0.993
1979-80	0.859	0.938	0.910	1.000	0.962	0.967	0.947	0.945	0.998
1980-81	0.701	0.926	0.890	0.959	1.000	0.985	0.867	0.893	0.784
1981-82	0.792	0.998	0.854	1.000	0.955	0.964	0.874	0.945	0.858
1982-83	0.975	0.948	0.899	0.983	0.958	0.969	0.910	0.873	0.842
1983-84	0.858	1.000	0.880	0.891	0.854	0.923	0.731	0.788	0.793
1984-85	0.845	0.974	0.865	0.912	1.000	0.915	0.870	0.830	0.918
1985-86	0.829	0.918	0.911	1.000	0.989	0.954	0.866	0.902	0.875
1986-87	0.825	0.968	0.869	0.955	0.909	0.894	0.928	0.891	0.856
1987-88	0.857	0.908	0.828	1.000	0.738	0.903	0.955	0.915	0.965
1988-89	0.925	0.913	0.878	1.000	0.903	0.869	1.000	0.871	0.967
1989-90	1.000	0.977	0.972	1.000	0.982	0.989	1.000	0.973	1.000
1990-91	0.980	0.989	0.966	1.000	0.985	0.997	0.990	1.000	0.987
1991-92	0.989	1.000	0.957	0.980	0.878	0.974	0.969	1.000	0.977
1992-93	1.000	1.000	1.000	1.000	0.944	1.000	1.000	1.000	1.000
Average	0.884	0.949	0.906	0.957	0.917	0.969	0.928	0.927	0.936

contd.

Note: Plant capacity utilization rates estimated with variable returns to scale as given in chapter 4 and based on ASI data

Table 7.13 (contd.)

Trends in Plant Capacity Utilization Rates for Two Digit Industries (PCUVRS) Variable Returns to Scale (1960-61 to 1992-93)

	Industry Group								
Tear	30	31	32	33	34	35	36	37	38
1960-61	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1961-62	1.000	0.811	0.999	1.000	0.900	0.896	0.992	1.000	0.826
1962-63	0.845	0.883	1.000	0.968	0.989	0.931	0.909	0.969	1.000
1963-64	0.934	0.855	1.000	0.995	1.000	1.000	0.888	0.957	1.000
1964-65	0.919	0.856	1.000	0.977	1.000	0.976	0.894	0.969	0.955
1965-66	0.662	0.871	1.000	0.953	1.000	0.963	0.918	1.000	0.902
1966-67	0.761	0.761	1.000	0.898	0.957	0.919	0.819	0.962	0.839
1967-68	0.772	0.781	0.999	0.867	0.957	0.930	0.853	0.931	0.930
1968-69	0.884	0.762	0.999	0.926	0.917	0.992	0.815	0.962	0.936
1969-70	0.891	0.755	1.000	0.967	0.972	0.994	0.865	0.955	1.000
1970-71	0.914	0.795	0.999	0.969	0.995	1.000	0.930	0.922	0.939
1971-72	0.928	0.824	0.999	0.989	0.993	1.000	0.892	0.940	0.750
1972-73	0.927	0.822	0.999	0.994	0.998	0.964	0.888	0.967	0.634
1973-74	0.799	0.799	0.962	0.957	0.947	0.969	0.956	0.956	0.548
1974-75	0.917	0.715	0.844	0.877	0.879	0.943	0.744	0.882	0.495
1975-76	0.933	0.731	0.956	1.000	0.862	0.952	0.839	0.854	0.533
1976-77	0.920	0.802	0.994	1.000	0.932	0.977	0.921	0.894	0.603
1977-78	0.956	0.815	1.000	0.907	1.000	0.977	0.914	0.876	0.694
1978-79	0.888	0.800	0.996	1.000	0.939	1.000	0.894	0.785	0.729
1979-80	0.880	0.770	0.937	1.000	1.000	0.993	0.919	0.847	0.679
1980-81	0.869	0.734	0.904	0.985	1.000	1.000	0.912	0.864	0.672
1981-82	0.919	0.765	0.923	1.000	0.970	0.992	0.861	0.912	0.584
1982-83	1.000	0.769	0.951	0.972	0.930	0.994	0.878	0.887	0.693
1983-84	0.919	0.735	0.953	0.960	0.885	0.982	0.774	0.870	0.697
1984-85	0.929	0.761	0.979	0.960	0.946	0.948	0.811	1.000	0.703
1985-86	1.000	0.762	0.965	0.948	0.913	0.903	0.840	0.830	0.788
1986-87	0.994	0.780	0.960	0.999	0.862	0.915	0.824	0.872	0.766
1987-88	0.994	0.822	0.933	1.000	1.000	0.972	0.886	0.874	0.833
1988-89	0.977	0.880	0.973	0.999	1.000	0.963	0.870	0.949	0.782
1989-90	0.992	0.808	0.976	0.989	1.000	1.000	0.925	0.965	0.870
1990-91	0.956	1.000	0.970	0.948	1.000	1.000	1.000	1.000	0.880
1991-92	0.999	0.742	1.000	0.890	1.000	0.991	0.967	0.900	0.885
1992-93	1.000	0.869	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Average	0.917	0.807	0.975	0.966	0.962	0.971	0.891	0.926	0.792

Petroleum and Coal Products (30). PCUVRS was 100% after 1987-88 in Metal Products (34) while in industry group 32 (Non Metallic Minerals), it was very high till 1972-73. In Electrical Machinery (36) low utilization levels in the 1980's can be seen.

From Table 7.14 which gives average PCUVRS for three distinct time periods-1960-61 to 1965-66, 1966-67 to 1979-80 and 1980-81 to 1992-93 it can be seen that in thirteen of the eighteen industries, average PCUVRS rates were lowest in the period from 1966-67 to 1979-80. In these industries from fairly high levels of average utilization between 1960-61 and 1965-66 there was a decline in the average utilization rates in the subsequent period. This was then followed by an increase in PCUVRS levels during the period from 1980-81 to 1992-93. In two industries, Textile Products (26) and Wood and Wood Products (27), PCUVRS was highest in the intermediate period from 1966-67 to 1979-80 and declined in the last period between 1980-81 to 1992-93. In three other industries, Paper and Printing and Publishing (28), Leather and Leather Products (29) and Non Metallic Minerals (32), average utilization levels declined over the three decades.

From the decade wise breakup of average PCUVRS rates in Table 7.15 it is found that thirteen of the eighteen industries had highest average plant capacity utilization rates with VRTS in the early 1990's i.e. during the period from 1990-91 to 1992-93. Except for Chemicals (31) all industry groups had average utilization rates of over 90% in the early 1990's. Also, seven industries had lowest average PCUVRS during the 1970's while another eight industries had lowest averages during the 1980's as compared to the other

Table 7.14

Period wise Average Plant Capacity Utilization Rates
(Variable Returns to Scale)
(PCUVRS)

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1965-66	0.951	0.947	0.991	0.984	0.959	0.975	0.930	0.970	0.961
1966-67-1979-80	0.849	0.938	0.871	0.928	0.888	0.985	0.933	0.921	0.950
1980-81-1992-93	0.890	0.963	0.905	0.975	0.930	0.949	0.920	0.914	0.909

contd.

Table 7.15

Decade wise Average Plant Capacity Utilization Rates
(Variable Returns to Scale)
(PCUVRS)

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1969-70	0.908	0.968	0.971	0.968	0.936	0.977	0.948	0.946	0.973
1970-71-1979-80	0.852	0.913	0.844	0.922	0.882	0.987	0.917	0.926	0.933
1980-81-1989-90	0.861	0.953	0.885	0.970	0.929	0.937	0.900	0.888	0.886
1990-91-1992-93	0.989	0.996	0.974	0.993	0.935	0.990	0.986	1.000	0.988

contd.

Table 7.14 (contd.)

Period wise Average Plant Capacity Utilization Rates
(Variable Returns to Scale)
(PCUVRS)

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61-1965-66	0.893	0.879	1.000	0.982	0.981	0.961	0.934	0.982	0.947
1966-67-1979-80	0.884	0.781	0.977	0.954	0.953	0.972	0.875	0.910	0.736
1980-81-1992-93	0.965	0.802	0.960	0.973	0.962	0.974	0.888	0.917	0.781

Table 7.15 (contd.)

Decade wise Average Plant Capacity Utilization Rates
(Variable Returns to Scale)
(PCUVRS)

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61-1969-70	0.867	0.834	1.000	0.955	0.969	0.960	0.895	0.970	0.939
1970-71-1979-80	0.906	0.787	0.968	0.969	0.954	0.978	0.890	0.892	0.660
1980-81-1989-90	0.959	0.782	0.952	0.981	0.950	0.967	0.858	0.902	0.739
1990-91-1992-93	0.985	0.870	0.990	0.946	1.000	0.997	0.989	0.967	0.922

periods. Only Basic Metals (33) had lowest average PCUVRS during the 1990's and highest utilization levels during the 1980's.

Table 7.16 gives average PCUVRS levels for two industry groups - namely Process or Input Based and Use Based classifications.

From Table 7.16, according to Process Based classification it can be seen that all six industry groups showed improved performance in the early 1990's with respect to PCUVRS. Agro-based industries showed a sharp decline in 1970's and then marginal increase in 1980's followed by a sharp increase in 1990's. This industry group showed steepest fall in PCUVRS in 1970's. On the other hand, Metal-based industries had consistent performance with respect to average utilization rates (of 96.2%) in the first three decades and then showed improved performance (to 97.3%) in the last period i.e. early 1990's. Chemical -based industries started with average PCUVRS levels of 85.1% in 1960's registered a marginal decline to 84.7% in 1970's but increased to 87.1% in 1980's and further to 92.8% in the early 1990's. Machinery-based industries on the other hand showed lowest average PCUVRS levels during 1980's but its performance improved and this industry group had utilization levels of 98.4% in the early 1990's. Mineral-based industries started with highest utilization rates (100%) in 1960's but showed a decline in the next two decades with 95.2% utilization in 1980's. This industry however showed much higher utilization of 99.0% in early 1990's.

The Use based classification of industries in Table 7.16 again shows highest average PCUVRS levels during the early 1990's for the various industry groups. Basic and Intermediate Goods and Consumer

Table 7.16

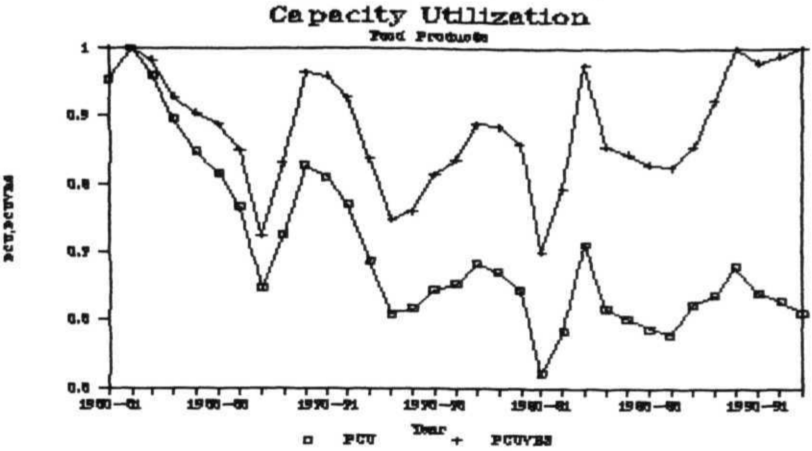
Decade wise Average Plant Capacity Utilization (PCUVRS) Rates by Process and Use Based Classification (Variable Returns to Scale)

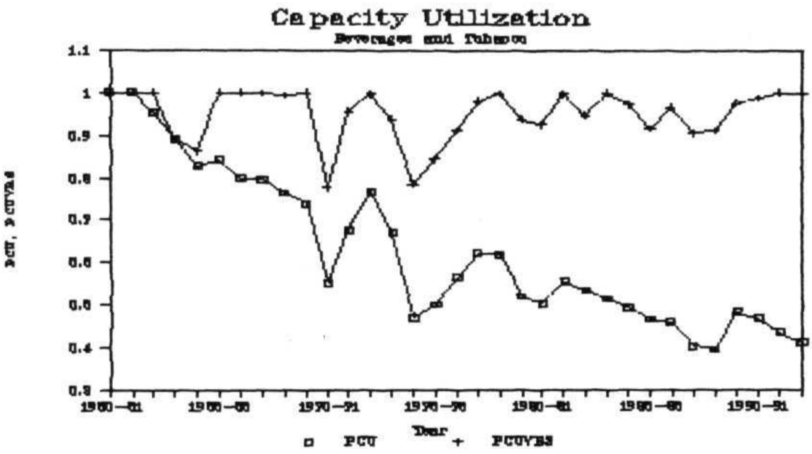
Process Based **Classification**

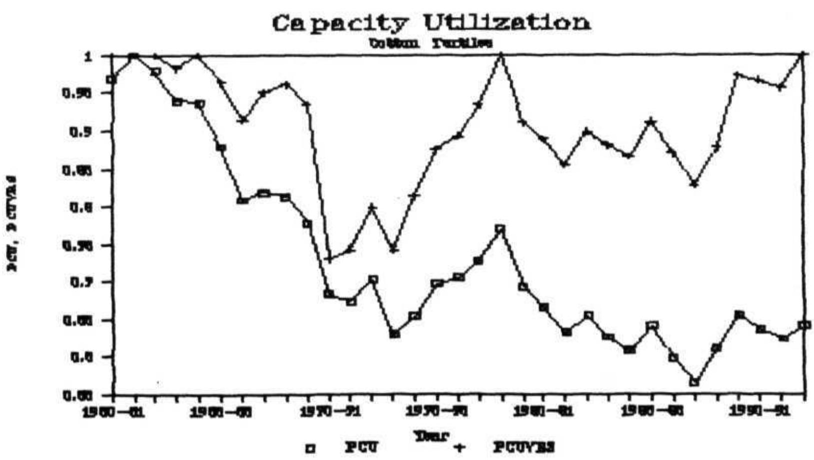
Industry group	1960-61-1969-70	1970-72-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	0.953	0.905	0.915	0.983
2. Mineral based	1.000	0.968	0.952	0.990
3. Metal based	0.962	0.962	0.966	0.973
4. Chemical based	0.851	0.847	0.871	0.928
5.Machinery based	0.942	0.920	0.909	0.984
6.Misc. industries	0.956	0.797	0.813	0.955
Total	0.944	0.900	0.904	0.969

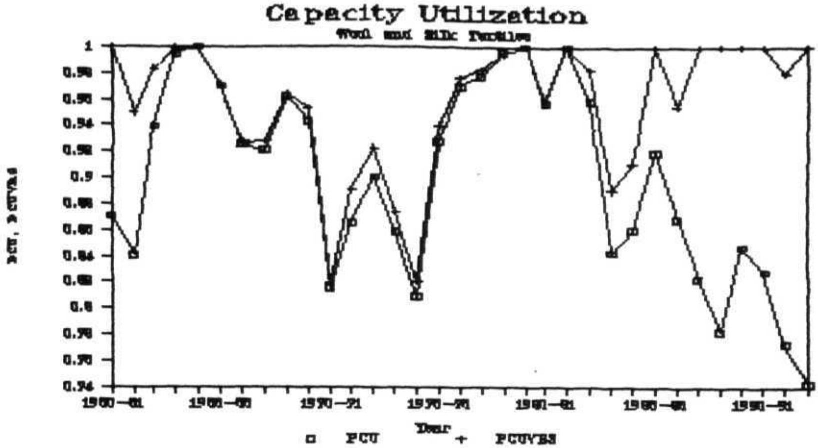
Use Based Classification

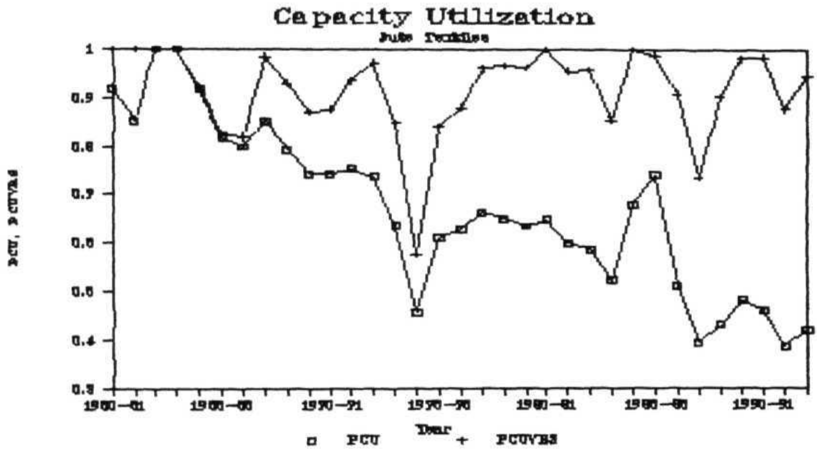
Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1.Basic and **intermediate** goods	0.942	0.909	0.918	0.968
2. Capital goods	0.942	0.920	0.909	0.984
3. **Consumer** goods	0.948	0.866	0.878	0.977
(a)Durables	0.944	0.789	0.820	0.954
(b) Non - Durables	0.951	0.917	0.917	0.992

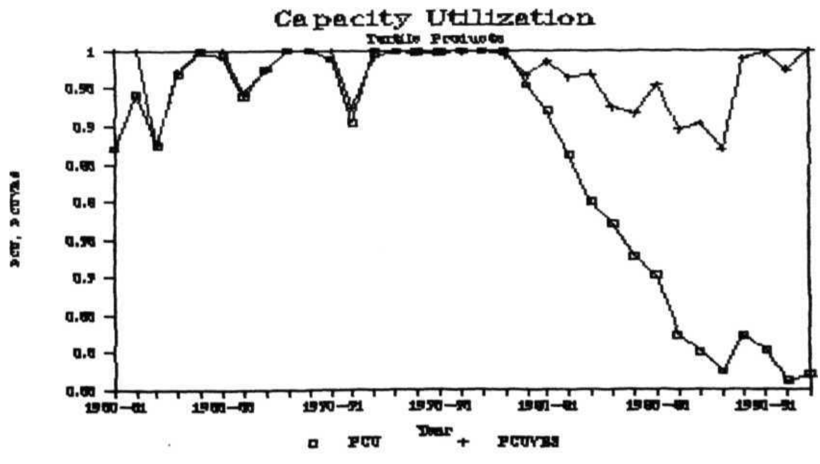

Capacity Utilization
Food Products
PCU,PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS

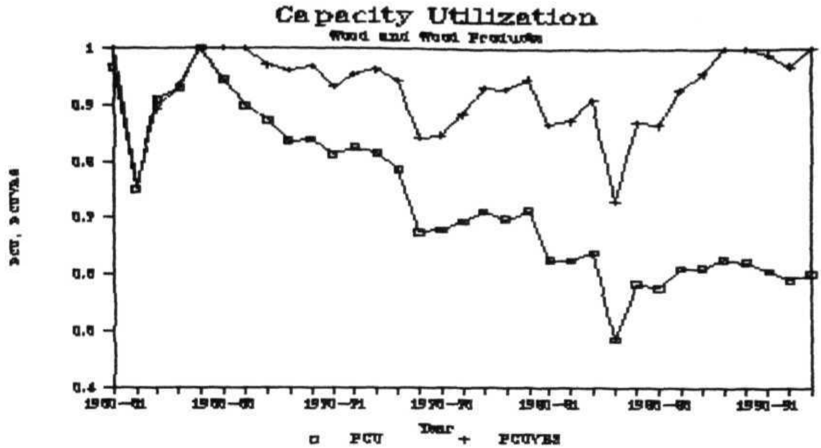

Capacity Utilization
Beverages and Tobacco
PCU, PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS

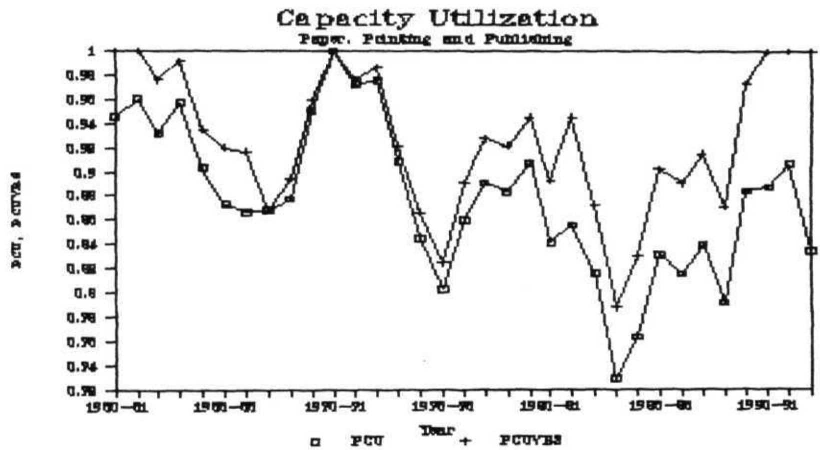

Capacity Utilization
Cotton Textiles
PCU, PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS

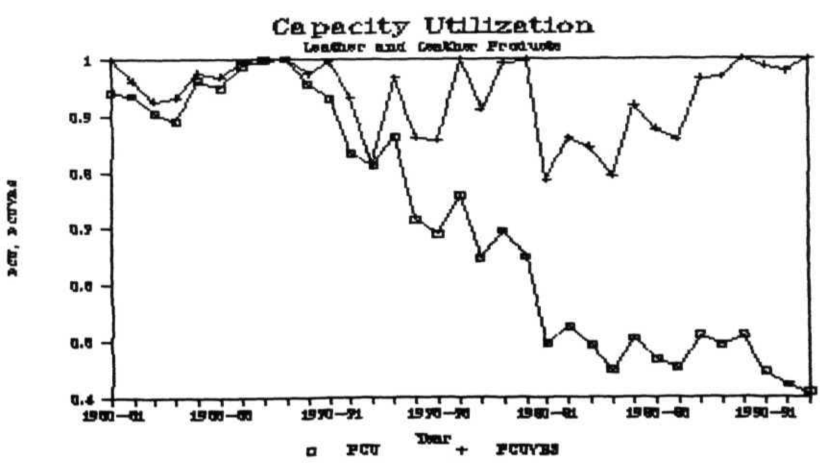

Capacity Utilization
Year
PCU

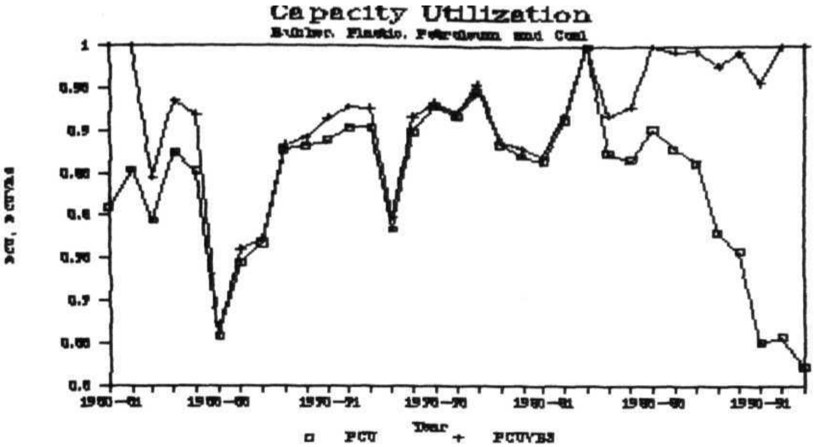

Capacity Utilization
Jute Textiles
Year
PCU

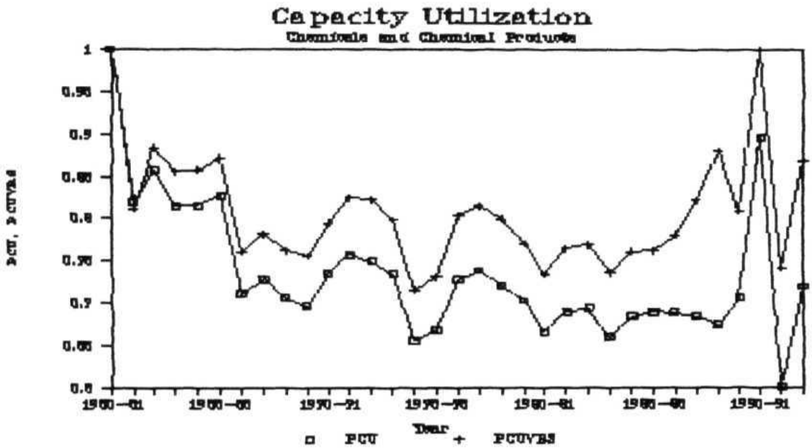

Capacity Utilization
Textile Products
Year
PCU

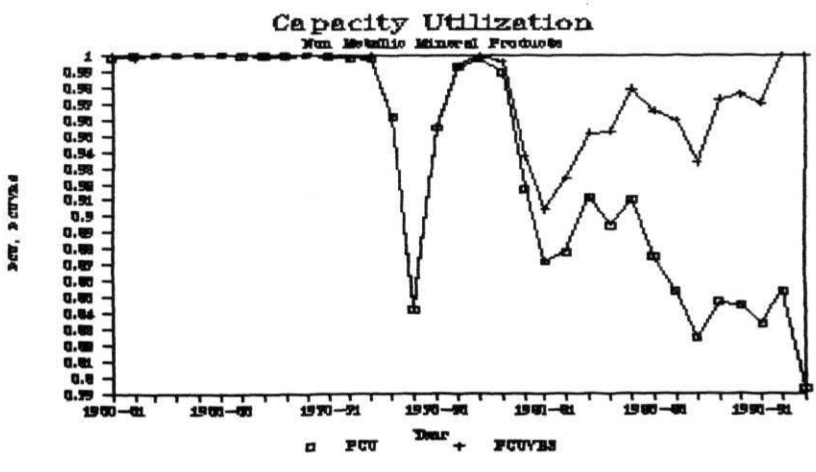

Capacity Utilization
Wood and Wood Products
Year
PCU
PCUVBS

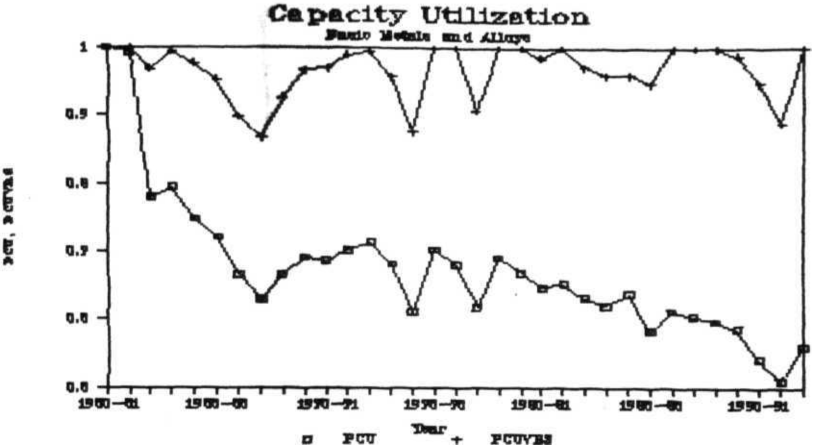

Capacity Utilization
Year
PCU
PCUVBS


Capacity Utilization
Leather and Leather Products
Year
PCU
PCUVBS

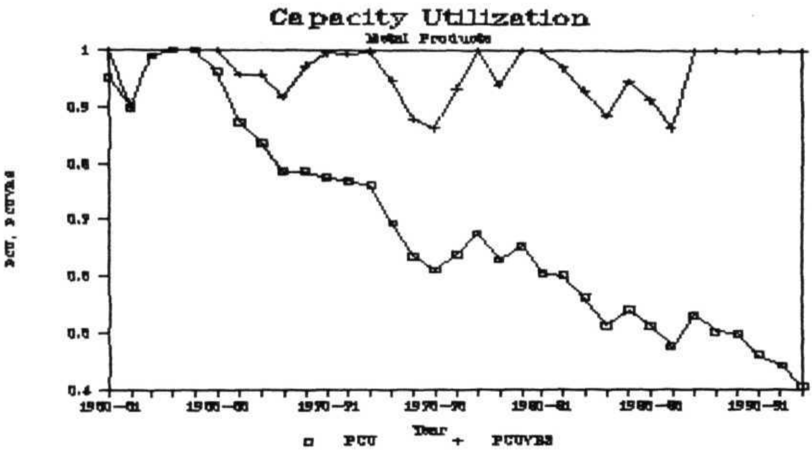

Capacity Utilization
Rubber, Plastic, Petroleum and Coal
PCU, PCUVBS
Year
PCU
PCUVBS


Capacity Utilization
Chemicals and Chemical Products
PCU, PCUVBS
Year
PCU
PCUVBS

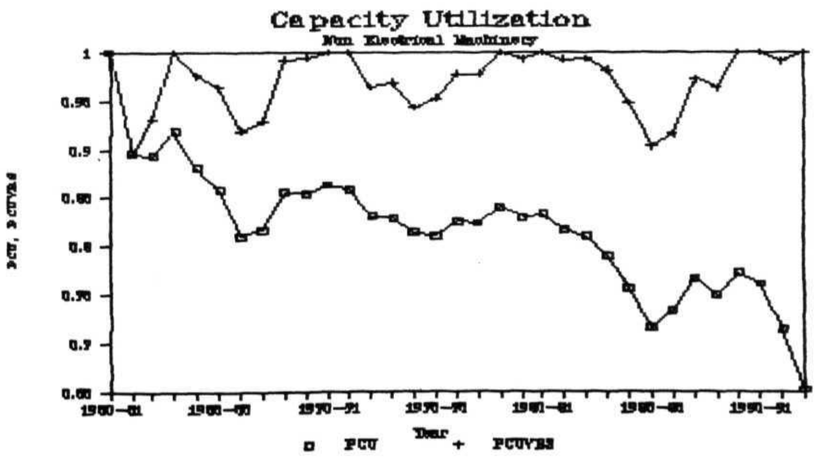

Capacity Utilization
Non Metallic Mineral Products
PCU, PCUVBS
Year
PCU
PCUVBS



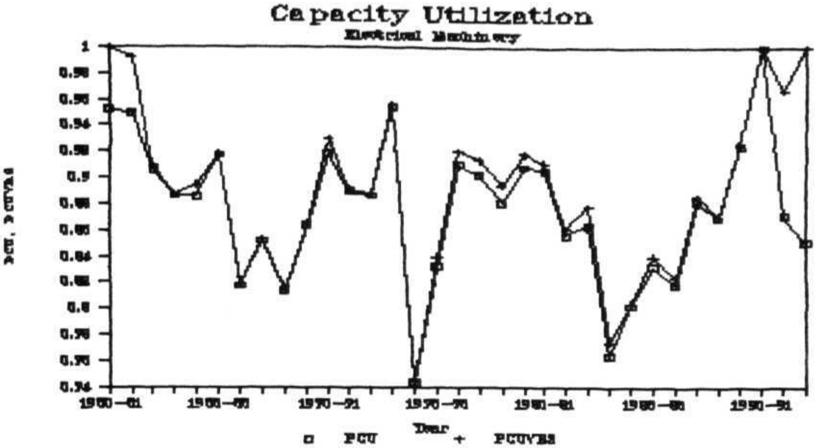
Capacity Utilization
Basic Metals and Alloys
1
0.9
0.8
0.7
0.6
0.5
PCU, PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS

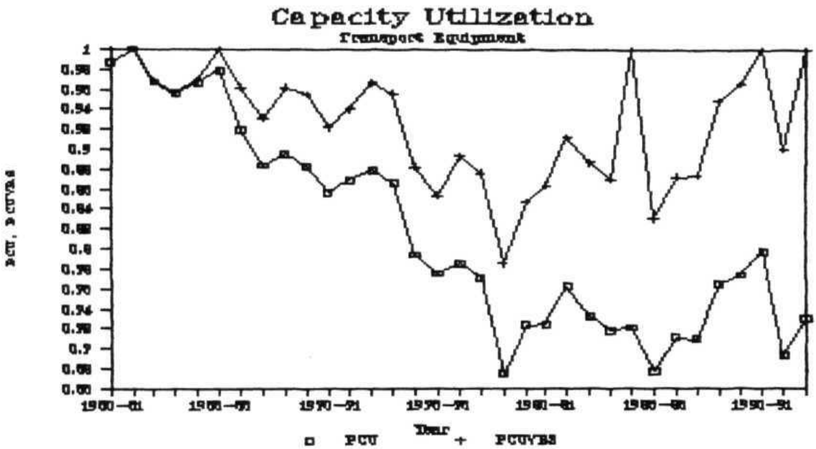


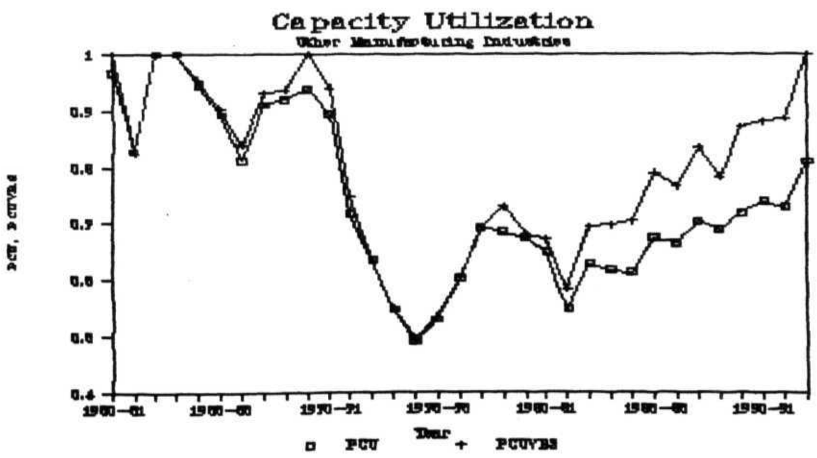
Capacity Utilization
Metal Products
1
0.9
0.8
0.7
0.6
0.5
0.4
PCU, PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS



Capacity Utilization
Non Electrical Machinery
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
PCU, PCUVBS
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
Year
PCU
PCUVBS


Capacity Utilization
Electrical Machinery
Year
PCU
PCUVBS


Capacity Utilization
Transport Equipment
Year
PCU
PCUVBS


Capacity Utilization
Other Manufacturing Industries
Year
PCU
PCUVBS

Goods had lowest utilization levels in 1970's. Capital Goods industries recorded lowest utilization levels in 1980's. Consumer Durables showed a sharp decline in utilization levels in 1970's, a marginal increase in 1980's but rose to the highest levels in the early 1990's. Consumer Non-durables also had lower utilization rates in the 1970's although this decline was not so significant. Consumer Non-durables maintained the same utilization levels of 91.7% in 1980's but showed much better rates of 99.2% in early 1990's.

7.7 A Comparison of Capacity Utilization Estimates:

In this section a comparison of the three measures of capacity utilization given in the preceding sections is attempted. Plant Capacity Utilization (PCU) is the ratio of maximum potential output when inputs are given as observed to maximum potential plant capacity output. The other measure of capacity utilization (CAPUT) is obtained as the ratio of actual output to maximum potential plant capacity output. This measure is unadjusted for inefficiency and is therefore lower than a measure of PCU. The third measure of capacity utilization (PCUVRS) is the plant capacity utilization rate obtained under the assumption of variable returns to scale. The measure of plant capacity utilization rates obtained under the assumption of CRS will be lower than the plant capacity utilization rates obtained under the less restrictive assumption of variable returns to scale. In the analysis below a comparison of the three different measures of capacity utilization obtained in this study is given. The graphical representation of the three measures brings out clearly the nature of the relationship between them.

From Tables 7.5 and 7.9 and the trends of the two series- CAPUT and PCU depicted graphically it can be seen that CAPUT rates are lower than PCU rates. Also, in a few industry groups like Wool and Silk Textiles (24), Paper and Printing and Publishing (28), Rubber, Plastic, Petroleum and Coal (30), Non Metallic Mineral Products (32), Non Electrical Machinery (35) and Electrical Machinery (36) there is considerable divergence in the behaviour of the two series. In the case of Paper, Printing and Publishing this is particularly so until the mid-1960 's,in Non Metallic Minerals until early 1970's and in Non Electrical Machinery until the mid-1970's.

In the case of Food Products (20-21), Cotton Textiles (23), Wood and Wood Products (27), Leather and Leather Products (29), Metal Products (34) and Transport Equipment (37) the two series (PCU and CAPUT) moved very closely togeather. In the remaining industries like Bevarages and Tobacco (23), Jute Textiles (25), Chemicals (31), and Miscellaneous Industries (38), there is a slight difference in the two series.

From Tables 7.8 and 7.12, it can be noted that Chemical-based industries had much higher PCU rates in the 1960's and 1970's as compared to CAPUT rates. The difference in the two average utilization rates for this industry group is particularly marked. This is also the case for Machinery-based industries. On the other hand the difference is not so significant in the case of Mineral-based industries.

From a comparison of the tables it is also observed that in the Use based classification, CAPUT rates in Basic and Intermediate

Goods are much lower than PCU rates in the 1960's and 1970's. Similarly there is considerable divergence in Capital Goods utilization rates as given by the two measures. Average PCU rates in the 1960's at 90.7% being much higher than CAPUT rates of 76.7%. The difference is significant in the 1970's also with average PCU being 83.8% while average CAPUT was only 74.4%.

Again a comparison of PCU rates obtained with constant returns to scale (CRS) assumption with those obtained with variable returns to scale (VRTS) assumption shows that PCU rates are lower with the more restricitve assumption of CRS. This is clear from a comparison of Tables 7.9 and 7.13 as also from the graphical representation of the two series - PCU and PCUVRS.

From a comparison of the Tables it can be seen that until the early 1980's the two series were nearly the same in the case of Wool and Silk Textiles (24), Rubber, Plastic, Petroleum and Coal (30), Non Metallic Minerals (32), and Other Manufacturing Industries (38). In Textile Products (26) the two series were nearly the same until 1977-78, in Paper (28) between 1965 to 1975, in Wood and Wood Products till 1970 and in Electrical Machinery the two measure were the same except for the last two years of the study. In the remaining two digit industry groups however divergent behaviour of the two series is observed.

From Tables 7.12 and 7.16 it is seen that the Process Based classification shows differences in average utilization rates of PCU and PCUVRS. Only for **Mineral-based industries, while** PCU **and** PCUVRS rates are the same in 1960's and 1970's; in the **1980's and** early 1990's PCU rates are much lower than PCUVRS. In this industry group average PCU rate is 87.1% as compared to average PCUVRS of 95.2% in 1980's and 82.7% as compared to 99.0% in early 1990's. All other categories of industries show wide differences in average utilization levels. For Other Manufacturing Industries, the difference in the two rates is especially marked in the 1980's and early 1990's.

A comparison of average utilization levels according to Use Based classification also shows that while average PCUVRS rates are much higher average PCU rates are very low particularly in Consumer Goods industries. The difference is particularly significant.

6.9 Summary and Conclusions:

This chapter contains estimates of capacity utilization for eighteen two digit industry groups in the factory sector of the organized manufacturing sector of India. The estimates based primarily on ASI data have been obtained for a period of thirtythree years- from 1960-61 to 1992-93. Three alternative measures of capacity utilization have been obtained based on production data from ASI and the use of a nonparametric production frontier. The study demonstrates the use of linear programming techniques and is meant as an alternative to the commonly used parametric cost function approach.

The results obtained in this study demonstrate the importance of estimating capacity utilization series based on an economic notion of capacity. As pointed out earlier while in developed countries a number of studies have used the parametric cost function or the nonparametric production frontier to obtain thereotically superior measures of capacity utilization , in India there is a paucity of research in this sphere. Statistical constructs of capacity utilization are not very useful in explaining trends in capacity utilization.

A comparison of the estimates of CU with other estimates is difficult given the lack of comprehensive studies and also given that the approach to estimation of CU is different. Many of the earlier studies on CU for India are for aggregate manufacturing sector. The study by Nayar and Kanbur (1976) for 1949-65 based on production function method gives very high capacity utilization estimates of between 97-99%. Similarly NCAER (1966) study shows utilization levels of 85-89% during 1955-65. RBI studies based on trend-through-peaks method shows lower utilization levels in the early 1970's. Paul's (1974) study for the period 1961-71 shows low utilization levels when adjusted for number of shifts actually worked. Economic measures of CU based on the cost function approach have been obtained for four two digit industries corresponding to the enginereering group (inds. no's 34,35,36 and 37) for the period 1960-61 to 1982-83 in an earlier study (Padma Suresh,1991). This study shows that unlike traditional measures which reveal low CU economic CU levels are closer to unity indicating that producers choose output levels based on cost considerations. The study by Burange (1992) is comprehensive in terms of coverage of industries as well as time period but is based on constructed measures using data from MSP. The study for two digit industry groups for **the period 1951 to 1986-87** shows significant year to year fluctuations. Particularly significant are the fluctuations in Non Electrical Machinery. CU in Rubber, *Paper*

and Printing, Tobacco was higher **on** an average among all industry groups over the period. CU in Chemicals and Leather was lower over the entire period. A classification by Consumer goods, Intermediate goods and Capital goods shows utilization in consumer goods at a steady 70% while wide fluctuations are noticed in Capital goods. Intermediate goods showed an increasing trend between 1951-64 and then declined to 55.98% in 1983-84.

In the present study, to summarize, a declining trend in capacity utilization measure (CAPUT) in many industries (Food Products (20-21), Beverages and Tobacco (22), Cotton Textiles (23), Jute Textiles (25), Leather and Leather Products (29), Chemicals (31), Non Metallic Minerals (32), Basic Metals (33), Metal Products (34), Non Electrical Machinery (35), Transport Equipment (37) can be observed. In Wool and Silk Textiles (24), Paper, Printing and Publidshing (28) and Other Manufacturing Industries (38) there is no significant trend. Industries 27, 28 and 38 (i.e. Wood and Wood Products, Paper, Printing and Publishing and Other Manufacturing Industries) show improved capacity utilization rates since the early 1990's. Industry group 36 i.e. Electrical Machinery shows an increasing trend in CAPUT rate. From fairly high levels of capacity utilization in 1960-61 a number of industries (eight of them) had low capacity utilization rates of less than 60% in 1992-93. Beverages and Tobacco, Jute Textiles, Textile Products, Leather and Leather Products and Rubber, Plastic, Petroleum and Coal had low capacity utilization rates of 35% **or so** in **a number** of **years.** On an **average, Paper,** Printing **and** Publishing and Non Metallic Mineral Products had higher utilization levels, while Electrical Machinery shows an increasing trend in utilization rates. The Process and Use based classification of CAPUT rates shows that Metal-based and Agro-based industries had low average utilization rates by the early 1990's of 48.3% and 59.2% respectively. Mineral-based industries had higher average utilization rate of 82.5% in the 1990's although a decreasing trend is clear. Chemical-based induatries on the other hand had low average utilization of 60% in the 1960's and higher utilization of 74.9% in the 1980's although even in this category it declined to 65.7% in the 1990's. From the Use based classification we see that Consumer goods had higher average utilization levels in the 1960's (82.7%) but lower rates in the 1990's (57%). Consumer Durables had higher average utilization (67.2%) than Consumer Non-durables (50.2%) in the early 1990's. Capital goods average utilization rates in the 1960's was 76.7% and in the early 1990's it was 77.6%. Basic and Intermediate goods average CAPUT rates was 78.3% in the 1960s and 61.4% in the 1990's.

PCU rates are higher than CAPUT rates although the trend in many industries are the same. For the whole period, average utilization rate of over 90% is seen in Wool and Silk Textiles and Non Metallic Mineral Products. Lowest average utilization is observed in Beverages and Tobacco. This industry had a low PCU average of slightly over 40% in the early 1990's. PCU rates by Process and Use based classification shows that Metal-based industries had low average utilization of 48.8% in the early 1990's. Miscellaneous Industries show a decline in average utilization rates from 93.7% in 1960's to 59.1% in 1990's. Agro-based induatries show a decline from 89.6% in 1960's to 62% in 1990's. Mineral-based industries had highest average utilization rates in the different decades although a declining trend is obvious. From the Use based classification it can be seen that Consumer goods utilization rates declined from 89.6% in 1960's to 60.1% in the 1990's. Capital good show a drop from 90.2% to 78.5% in the same period. During this period, Basic and Intermediate goods show a decline from 88.5% to 62.9%. Consumer Non-durables show lower average utilization rates as compared to Consumer Durables.

In the current study, PCU rates with the assumption of variable returns to scale (PCUVRS) show higher utilization rates as compared to CAPUT and PCU rates. Fourteen of the eighteen industries in the study had high average utilization rates of over 90%. Other Manufacturing Industries had lowest average of 79.2%. In the Process and Use based classification of the industries, Mineral-based industries had highest average utilization rates of 99% in the early 1990's. Chemical-based industries had lowest average utilization rate of 85.1% in 1960's although it was higher at 92.8% in the early 1990's. This was still the lowest utilization rate among all Process based industries. Consumer goods had marginally higher average utilization rates in the 1960's as compared to Capital goods and Basic and Intermediate goods. In the early 1990's, however Capital goods had higher average utilization of 98.4%. Consumer goods showed a low utilization rate in 1970's and again increased utilization in the 1980's and early 1990's. Consumer Durables showed lower average utilization rates than Consumer Non-Durables.

CHAPTER 8

INPUT UTILIZATION RATES, SCALE EFFICIENCY AND RETURNS TO SCALE IN INDIAN INDUSTRIES

8.1 Introduction:

In this chapter, the nonparametric linear programming methodology is used to obtain some further results on input utilization rates, scale efficiency and returns to scale. The framework and the methodology described in Chapter 4 is used here to extend the model to obtain optimal utilization rates for the variable inputs – labor, energy and intermediate inputs or materials. These input utilization rates reveal whether the actual inputs used are over- or underutilized with respect to the usage required to produce optimal output. Clearly if the industry is operating at less than full capacity then it would imply that the inputs are being underutilized. Again the trends in utilization rates reveal whether and to what extent these inputs were being under or overutilized.

The nonparametric linear programming framework is also used to obtain measures of returns to scale. This would reveal interesting facts relating to whether inefficiency is due to increasing or decreasing returns to scale and the framework also enablesthe estimation of a measure of the extent of inefficiency due to such scale economies.

In Section 8.2 the results on input utilization rates are given and discussed. Section 8.3 is a disussion of the results on scale efficiency and the nature of returns to scale in Indian industries while a brief conclusion follows in Section 8.4.

8.2 Trends in Input Utilization Rates for Indian Industries:

In this section the results obtained in the present study on the input utilization rates are given. The nonparametric linear programming framework based on input-output observations is used to obtain the utilization rates of variable inputs - labor, energy and intermediate inputs for each observation (year) for all the two digit industries.

The derivation of the input utilization rate is as given in Chapter 4. Input utilization rate for each variable input (INUT) are obtained as the ratio of actual input used to that needed to produce optimal plant capacity output. Thus, if this rate is greater than unity then it implies that the input is overutilized relative to that needed for optimal capacity output. If on the other hand, this rate is less than unity, then it implies that the input is underutilized relative to the usage for optimal output.

Thus, it is possible to obtain the input utilization rates for the three variable inputs- namely labor, energy and materials or intermediate inputs. These rates are denoted respectively by INUTL, INUTE and INUTM. For each of the eighteen two digit industries, estimates of the three input utilization rates for each year or observation are obtained. Thus, it is possible to obtain trends in the input utilization rates for the three inputs over the period from 1960-61 to 1992-93. A comparison of the input utilization rates for the three inputs can be made. Such a comparison would also reveal the extent of the differences in under or over utilization among the inputs. Given the scarcity of inputs especially fuel and intermediate inputs in the Indian economy, the trends in input utilization rates would reveal the fluctuations in actual utilization of these inputs relative to that needed for optimal utilization of capacity. The estimated input utilization rates are given in Tables 8.1 to 8.3.

Tables 8.1, 8.2 and 8.3 give the input utilization rates for labor, energy and materials respectively for each year for the two digit industry groups over the period from 1960-61 to 1992-93. In Tables 8.4 to 8.9 the average input utilization rates according to two classifications of the time period- one corresponding to the debate on industrial deceleration and the other a decade wise average of utilization rates of the inputs are given. Tables 8.10 to 8.12 give the decade wise input utilization rates according to the process – based and use – based classification. The graphs given in the following pages bring out clearly the trend in the input utilization rates for labor, energy and materials for the eighteen industry groups.

From Tables 8.1 to 8.3 and the average utilization levels given at the bottom of each table it can be seen that in eleven of the eighteen industries average input utilization rates for energy (INUTE) is higher than average INUTL and INUTM for the entire period. In Wool and Silk Textiles (24), Jute Textiles (25) and Electrical Machinery (36) INUTL has a higher average over the period as compared to INUTE and INUTM. The average for the period from 1960-61 to 1992-93 is

Table 8.1

Trends in Input Utilization Rates for Labor for Two Digit Industries (1960-61 to 1992-93)

Tear	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61	1.000	1.000	1.017	2.709	1.022	1.198	1.087	1.382	1.326
1961-62	1.000	1.048	1.000	2.180	1.084	1.347	0.769	1.354	1.167
1962-63	0.980	0.902	0.926	2.181	1.072	1.370	0.997	1.306	1.228
1963-64	0.953	0.749	0.812	2.003	1.000	1.486	1.015	1.295	1.193
1964-65	0.928	0.687	0.777	2.077	1.009	1.542	1.000	1.245	1.217
1965-66	0.890	0.613	0.723	1.932	0.923	1.389	0.933	1.154	1.143
1966-67	0.851	0.506	0.677	1.681	0.843	1.217	0.874	1.134	1.135
1967-68	0.766	0.546	0.647	1.614	0.852	1.139	0.830	1.075	1.092
1968-69	0.755	0.511	0.568	1.526	0.892	1.086	0.792	1.014	1.000
1969-70	0.725	0.477	0.543	1.504	0.964	1.000	0.750	1.010	0.811
1970-71	0.753	0.349	0.444	1.395	1.208	1.048	0.714	1.000	0.873
1971-72	0.756	0.429	0.443	1.312	1.361	0.954	0.699	0.971	0.824
1972-73	0.823	0.486	0.438	1.309	1.401	1.189	0.673	0.931	0.868
1973-74	0.886	0.500	0.433	1.280	1.456	1.239	0.658	0.890	0.972
1974-75	0.918	0.453	0.454	1.108	1.296	1.253	0.609	0.809	0.854
1975-76	0.930	0.423	0.445	1.171	1.375	1.182	0.596	0.742	0.770
1976-77	0.957	0.562	0.429	1.188	1.273	1.266	0.550	0.736	0.738
1977-78	0.940	0.614	0.421	1.211	1.330	1.227	0.548	0.739	0.667
1978-79	0.836	0.628	0.425	1.094	1.301	1.061	0.537	0.717	0.737
1979-80	0.828	0.614	0.417	1.176	1.394	1.047	0.561	0.711	0.620
1980-81	0.873	0.571	0.378	1.020	1.275	0.936	0.489	0.639	0.559
1981-82	0.844	0.591	0.348	1.000	1.107	0.880	0.463	0.627	0.544
1982-83	0.761	0.598	0.341	0.916	1.154	0.794	0.449	0.602	0.498
1983-84	0.569	0.498	0.315	0.802	0.970	0.763	0.363	0.529	0.455
1984-85	0.537	0.391	0.280	0.798	1.198	0.714	0.375	0.466	0.470
1985-86	0.494	0.332	0.251	0.722	0.868	0.672	0.361	0.466	0.441
1986-87	0.455	0.345	0.246	0.674	0.865	0.584	0.327	0.409	0.419
1987-88	0.459	0.348	0.225	0.692	0.768	0.538	0.306	0.415	0.415
1988-89	0.429	0.297	0.207	0.588	0.726	0.532	0.287	0.354	0.429
1989-90	0.417	0.348	0.212	0.533	0.735	0.556	0.275	0.352	0.438
1990-91	0.391	0.297	0.195	0.485	0.664	0.523	0.244	0.334	0.364
1991-92	0.367	0.294	0.179	0.420	0.643	0.478	0.233	0.350	0.355
1992-93	0.366	0.272	0.172	0.391	0.667	0.484	0.238	0.316	0.323
Average	0.741	0.524	0.466	1.233	1.051	0.991	0.594	0.790	0.756

contd.

Note: Input utilization rates estimated as the ratio of actual to optimal input usage as given in chapter 4.

Table 8.1 (contd.)

Trends in Input Utilization Rates for Labor for Two Digit Industries (1960-61 to 1992-93)

Tear	Industry Group 30	31	32	33	34	35	36	37	38
1960-61	2.020	1.000	1.334	1.000	0.950	1.000	3.682	1.121	1.044
1961-62	2.006	0.745	1.262	0.980	0.872	0.772	3.584	1.000	0.900
1962-63	1.609	0.726	1.312	0.690	0.950	0.727	3.336	0.999	1.066
1963-64	1.594	0.656	1.304	0.659	0.998	0.722	3.032	0.965	1.000
1964-65	1.531	0.623	1.235	0.679	1.000	0.629	2.970	0.903	0.983
1965-66	1.281	0.609	1.166	0.627	0.822	0.561	2.789	0.909	0.939
1966-67	1.168	0.515	1.153	0.586	0.764	0.471	2.320	0.846	0.822
1967-68	1.042	0.476	1.087	0.519	0.694	0.443	2.178	0.627	0.781
1968-69	1.127	0.420	0.981	0.532	0.648	0.429	2.017	0.738	0.789
1969-70	1.175	0.387	1.000	0.548	0.627	0.418	2.059	0.743	0.747
1970-71	1.286	0.406	0.946	0.522	0.604	0.405	2.100	0.598	0.656
1971-72	1.264	0.392	0.912	0.540	0.579	0.384	1.939	0.575	0.506
1972-73	1.239	0.354	0.912	0.533	0.575	0.371	1.790	0.576	0.488
1973-74	1.231	0.345	0.906	0.533	0.564	0.359	2.036	0.517	0.473
1974-75	1.179	0.322	0.868	0.485	0.523	0.335	1.819	0.498	0.445
1975-76	1.155	0.311	0.863	0.535	0.504	0.329	1.783	0.432	0.395
1976-77	1.022	0.313	0.827	0.449	0.485	0.305	1.737	0.388	0.379
1977-78	1.066	0.318	0.829	0.445	0.502	0.313	1.687	0.390	0.404
1978-79	1.258	0.304	0.869	0.465	0.462	0.302	1.676	0.323	0.393
1979-80	1.113	0.309	0.832	0.437	0.471	0.308	1.731	0.374	0.397
1980-81	1.016	0.285	0.787	0.426	0.414	0.282	1.644	0.361	0.358
1981-82	1.001	0.265	0.763	0.403	0.397	0.270	1.529	0.348	0.333
1982-83	1.000	0.263	0.766	0.386	0.382	0.261	1.503	0.332	0.336
1983-84	0.789	0.239	0.692	0.367	0.323	0.239	1.388	0.310	0.313
1984-85	0.755	0.232	0.627	0.369	0.330	0.218	1.352	0.295	0.287
1985-86	0.683	0.222	0.555	0.319	0.299	0.198	1.264	0.255	0.283
1986-87	0.666	0.201	0.483	0.318	0.264	0.184	1.142	0.246	0.279
1987-88	0.653	0.201	0.445	0.297	0.276	0.186	1.124	0.229	0.265
1988-89	0.591	0.191	0.402	0.279	0.259	0.172	1.003	0.226	0.269
1989-90	0.860	0.090	0.379	0.253	0.255	0.159	0.948	0.201	0.250
1990-91	0.816	0.098	0.353	0.221	0.229	0.149	1.000	0.193	0.243
1991-92	0.676	0.090	0.337	0.195	0.216	0.140	0.865	0.187	0.236
1992-93	0.627	0.101	0.313	0.208	0.202	0.128	0.827	0.175	0.222
Average	1.106	0.364	0.833	0.479	0.528	0.369	1.874	0.512	0.524

Table 8.2

Trends in Input Utilization Rates for Energy for Two Digit Industries (1960-61 to 1992-93)

	Industry' Group								
Tear	20-21	22	23	24	25	26	27	28	29
1960-61	0.992	1.000	0.983	0.756	0.917	0.721	0.946	0.968	0.815
1961-62	1..000	1.009	1.000	0.756	0.853	0.784	0.643	1.016	0.880
1962-63	0.990	1.137	1.035	0.901	1.007	0.726	1.038	0.969	1.061
1963-64	0.896	0.969	0.950	0.991	1.000	0.939	0.887	0.979	0.875
1964-65	0.876	1.007	0.989	1.175	1.004	0.977	1.000	0.925	1.042
1965-66	0.860	0.973	0.937	1.113	1.009	0.876	0.910	0.954	0.987
1966-67	0.849	0.956	0.880	1.245	0.906	0.778	0.847	0.960	0.962
1967-68	0.821	0.932	0.841	1.276	0.901	0.876	0.820	0.878	1.038
1968-69	0.842	0.901	0.876	1.113	0.922	0.966	0.749	0.872	1.000
1969-70	0.847	0.880	0.841	1.036	0.802	1.000	0.753	0.995	0.875
1970-71	0.903	0.774	0.674	0.985	0.902	0.848	0.734	1.000	0.946
1971-72	0.890	0.869	0.649	0.917	0.911	0.779	0.750	1.027	0.883
1972-73	0.905	0.943	0.695	0.984	0.857	1.004	0.741	1.004	0.995
1973-74	0.803	0.835	0.643	0.907	0.750	1.079	0.678	0.882	1.009
1974-75	0.775	0.724	0.614	0.863	0.567	0.968	0.586	0.799	0.855
1975-76	0.806	0.743	0.684	0.923	0.718	0.966	0.596	0.848	0.971
1976-77	0.845	0.809	0.729	1.073	0.741	1.026	0.635	0.871	0.988
1977-78	0.862	0.896	0.741	1.098	0.804	1.039	0.681	1.012	0.924
1978-79	0.867	0.942	0.810	1.047	0.768	0.993	0.659	0.950	0.898
1979-80	0.854	0.940	0.785	1.048	0.953	0.875	0.689	1.027	0.997
1980-81	0.791	0.873	0.728	1.006	0.882	0.880	0.579	0.950	0.835
1981-82	0.752	0.925	0.615	1.000	0.768	0.811	0.563	0.944	0.784
1982-83	0.798	0.857	0.667	1.044	0.829	0.804	0.659	0.923	0.830
1983-84	0.765	0.927	0.743	1.039	0.697	0.778	0.503	0.896	0.843
1984-85	0.786	0.945	0.689	1.085	0.917	0.754	0.552	0.962	0.901
1985-86	0.758	0.843	0.739	0.926	0.791	0.763	0.564	0.967	0.930
1986-87	0.746	0.897	0.714	0.950	0.785	0.702	0.525	0.966	0.798
1987-88	0.789	0.817	0.673	0.973	0.651	0.797	0.503	0.998	0.873
1988-89	0.783	0.843	0.642	0.982	0.728	0.669	0.524	0.965	0.847
1989-90	0.931	0.822	0.728	1.057	0.794	0.768	0.564	1.145	0.854
1990-91	0.844	0.887	0.718	1.029	0.750	0.788	0.513	1.047	0.847
1991-92	0.842	0.889	0.652	0.940	0.681	0.751	0.458	1.192	0.759
1992-93	0.839	0.796	0.682	0.921	0.737	0.765	0.481	1.045	0.692
Average	0.846	0.896	0.768	1.005	0.827	0.856	0.677	0.968	0.903

contd.

Note: Input Utilization rates estimated as the ratio of actual to optimal input usage as given in chapter 4.

Table 8.2 (contd.)

Trends in Input Utilization Rates for Energy for Two Digit Industries (1960-61 to 1992-93)

	Industry Group								
Year	30	31	32	33	34	35	36	37	**38**
1960-61	1.078	1.000	0.950	1.000	1.034	1.000	1.212	0.935	1.645
1961-62	0.956	0.954	1.041	1.069	0.972	0.938	1.209	1.000	0.998
1962-63	1.085	1.049	1.118	0.863	1.119	0.891	1.164	0.896	1.213
1963-64	0.888	0.930	1.011	0.898	1.106	0.790	1.057	0.817	1.000
1964-65	0.877	0.907	1.019	0.789	1.000	0.743	1.042	0.836	1.295
1965-66	0.747	0.971	1.033	0.789	1.048	0.710	1.046	0.857	1.262
1966-67	0.766	0.880	1.023	0.721	1.058	0.608	0.911	0.859	0.906
1967-68	0.828	0.871	0.969	0.709	1.007	0.588	0.916	0.753	1.071
1968-69	0.828	0.867	0.956	0.764	0.843	0.614	0.870	0.771	1.022
1969-70	0.830	0.854	1.000	0.796	0.987	0.640	0.964	0.825	0.963
1970-71	1.083	0.921	0.963	0.810	1.005	0.650	1.329	0.745	0.829
1971-72	1.216	0.957	0.906	0.823	0.978	0.602	0.973	0.803	0.655
1972-73	1.197	0.965	0.899	0.851	0.992	0.619	1.007	0.833	0.598
1973-74	1.082	0.844	0.842	0.792	0.841	0.609	1.019	0.719	0.481
1974-75	0.939	0.779	0.721	0.747	0.743	0.493	0.862	0.602	0.361
1975-76	0.830	0.841	0.844	0.936	0.698	0.535	1.030	0.589	0.343
1976-77	0.826	0.971	0.895	0.870	0.777	0.516	1.038	0.576	0.410
1977-78	0.904	0.993	0.878	0.752	0.821	0.548	1.064	0.609	0.446
1978-79	1.258	1.032	0.911	1.107	0.775	0.555	1.083	0.539	0.462
1979-80	1.144	0.958	0.876	1.043	0.801	0.544	1.085	0.636	0.407
1980-81	0.719	0.908	0.777	0.940	0.699	0.484	0.996	0.526	0.386
1981-82	0.789	0.979	0.786	0.849	0.674	0.446	0.945	0.571	0.346
1982-83	1.000	0.982	0.853	0.864	0.637	0.481	1.039	0.541	0.376
1983-84	1.174	1.020	0.832	0.912	0.599	0.471	0.920	0.542	0.396
1984-85	0.855	1.056	0.924	0.953	0.716	0.453	1.166	0.534	0.395
1985-86	0.870	0.937	0.849	0.890	0.616	0.412	0.991	0.494	0.405
1986-87	0.941	1.062	0.852	0.881	0.565	0.404	0.904	0.534	0.439
1987-88	1.320	1.080	0.815	0.884	0.705	0.419	1.037	0.521	0.435
1988-89	1.073	0.940	0.867	0.919	0.705	0.424	0.849	0.543	0.476
1989-90	3.061	0.269	0.897	1.008	0.806	0.443	0.962	0.551	0.398
1990-91	2.999	0.348	0.871	0.861	0.831	0.415	1.000	0.554	0.485
1991-92	2.435	0.230	0.884	0.814	0.796	0.391	0.876	0.536	0.430
1992-93	2.341	0.286	0.857	0.860	0.770	0.373	0.843	0.565	0.531
Average	1.180	0.868	0.907	0.872	0.840	0.570	1.012	0.673	0.663

Table 8.3

Trends in Input Utilization Rates for Materials for Two Digit Industries (1960-61 to 1992-93)

	Industry Group								
Tear	20-21	22	23	24	25	26	27	28	29
1960-61	0.946	1.000	0.946	1.028	0.918	0.721	0.922	0.934	1.002
1961-62	1.000	1.057	1.000	1.016	1.135	0.754	0.662	0.947	0.893
1962-63	0.958	0.942	0.969	0.993	1.001	0.706	0.808	0.914	0.754
1963-64	1.000	0.918	0.953	1.063	1.000	0.795	0.892	0.946	0.713
1964-65	0.840	0.780	0.875	1.042	0.889	0.971	1.000	0.893	0.900
1965-66	0.805	0.826	0.784	0.950	0.788	0.887	0.846	0.833	0.868
1966-67	0.756	0.742	0.675	0.875	0.785	0.685	0.811	0.820	1.226
1967-68	0.637	0.873	0.645	0.868	0.853	1.010	0.781	0.863	0.995
1968-69	0.717	0.866	0.688	0.937	0.763	1.060	0.836	0.880	1.000
1969-70	0.785	0.952	0.628	0.905	0.688	1.000	0.823	0.939	0.977
1970-71	0..810	0.617	0.527	0.754	0.647	1.704	0.742	1.000	0.889
1971-72	0..765	0.807	0.573	0.818	0.662	1.608	0.792	0.970	0.773
1972-73	0.,677	0.761	0.590	0.833	0.637	1.618	0.813	0.981	0.717
1973-74	0..600	0.616	0.450	0.813	0.535	1.244	0.793	0.974	0.755
1974-75	0..608	0.411	0.502	0.765	0.359	1.063	0.590	0.868	0.589
1975-76	0,.634	0.447	0.562	0.933	0.513	1.132	0.589	0.806	0.584
1976-77	0..643	0.506	0.544	0.950	0.529	1.186	0.601	0.889	0.688
1977-78	0.672	0.563	0.598	0.963	0.537	1.173	0.634	0.902	0.558
1978-79	0.660	0.559	0.634	0.992	0.543	1.091	0.617	0.897	0.602
1979-80	0.634	0.460	0.514	1.026	0.497	1.050	0.629	0.929	0.577
1980-81	0.513	0.445	0.478	0.946	0.516	1.145	0.513	0.857	0.407
1981-82	0.575	0.496	0.460	1.000	0.450	1.118	0.528	0.874	0.436
1982-83	0.701	0.475	0.480	0.971	0.440	1.089	0.558	0.832	0.410
1983-84	0.613	0.455	0.426	0.854	0.391	0.944	0.404	0.736	0.373
1984-85	0.601	0.445	0.411	0.878	0.560	0.934	0.515	0.788	0.431
1985-86	0.588	0.427	0.452	1.039	0.703	1.105	0.516	0.882	0.393
1986-87	0.582	0.417	0.397	0.934	0.404	1.022	0.573	0.874	0.380
1987-88	0.630	0.359	0.357	0.861	0.294	0.850	0.589	0.919	0.463
1988-89	0.651	0.358	0.433	0.839	0.343	0.846	0.651	0.839	0.429
1989-90	0.719	0.441	0.491	0.951	0.406	1.006	0.626	1.041	0.449
1990-91	0.687	0.437	0.451	0.928	0.401	0.924	0.611	1.063	0.384
1991-92	0.662	0.400	0.448	0.879	0.310	0.904	0.594	1.153	0.358
1992-93	0.622	0.379	0.484	0.858	0.347	0.913	0.604	0.997	0.349
Average	0.706	0.613	0.589	0.923	0.601	1.038	0.681	0.910	0.646

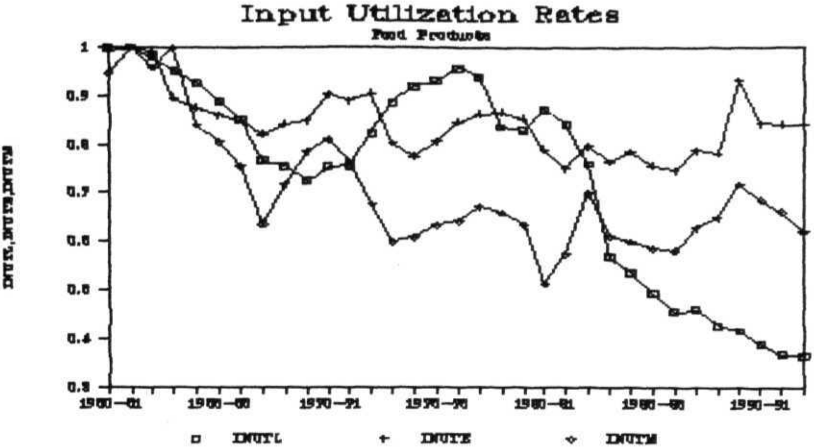
oontd.

Note: Input utilization rates estimated as the ratio of actual to optimal input usage as given in chapter 4.

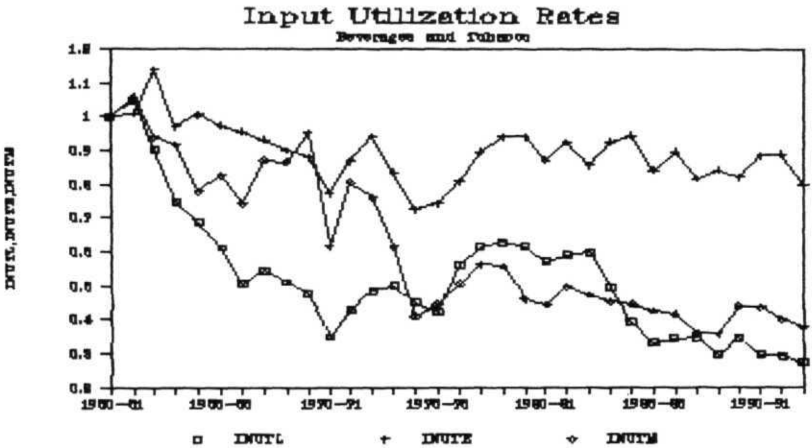
Table 8.3 (contd.)

Trends in Input Utilization Rates for Materials for Two Digit Industries (1960-61 to 1992-93)

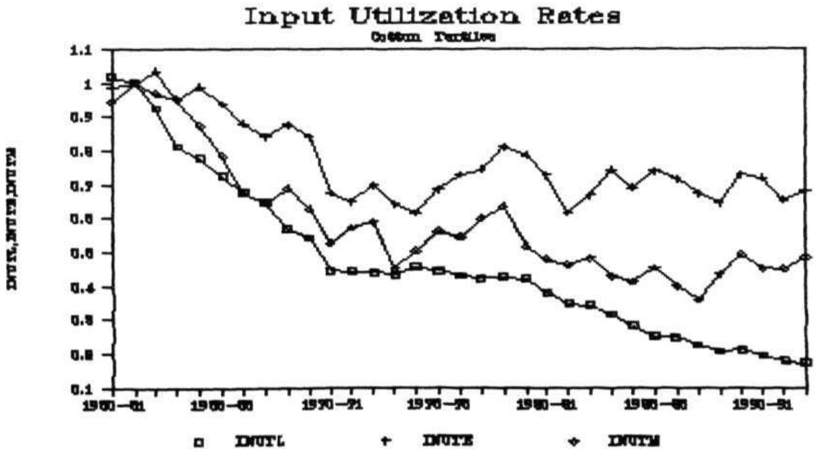
	Industry Group								
Tear	30	31	32	33	34	35	36	37	38
1960-61	0.680	1.000	0.849	1.000	0.923	1.000	0.908	0.888	0.954
1961-62	0.717	0.767	0.927	0.996	0.857	0.754	0.905	1.000	0.767
1962-63	0.667	0.818	1.012	0.652	1.003	0.750	0.820	0.807	1.098
1963-64	0.744	0.762	1.090	0.755	1.012	0.808	0.782	0.842	1.000
1964-65	0.701	0.777	1.038	0.774	1.000	0.718	0.781	0.852	0.926
1965-66	0.553	0.796	1.013	0.665	0.934	0.664	0.841	0.822	0.854
1966-67	0.626	0.658	0.982	0.641	0.824	0.574	0.742	0.745	0.745
1967-68	0.645	0.690	0.954	0.598	0.777	0.584	0.794	0.710	0.893
1968-69	0.752	0.669	0.904	0.622	0.729	0.660	0.760	0.714	0.916
1969-70	0.762	0.666	1.000	0.681	0.714	0.657	0.784	0.697	1.154
1970-71	0.774	0.700	0.987	0.710	0.699	0.692	0.842	0.665	0.928
1971-72	0.805	0.736	1.027	0.736	0.696	0.685	0.824	0.695	0.617
1972-73	0.806	0.732	0.997	0.729	0.684	0.606	0.798	0.718	0.526
1973-74	0.659	0.735	0.851	0.565	0.600	0.605	0.913	0.710	0.454
1974-75	0.795	0.643	0.600	0.404	0.528	0.579	0.653	0.585	0.407
1975-76	0.891	0.643	0.676	0.436	0.498	0.574	0.711	0.561	0.439
1976-77	0.834	0.704	0.740	0.406	0.532	0.600	0.828	0.576	0.499
1977-78	0.892	0.720	0.748	0.418	0.577	0.596	0.813	0.555	0.586
1978-79	1.258	0.683	0.735	0.467	0.520	0.623	0.773	0.457	0.573
1979-80	0.739	0.659	0.611	0.381	0.549	0.606	0.824	0.492	0.559
1980-81	0.726	0.625	0.535	0.329	0.495	0.642	0.839	0.532	0.563
1981-82	0.834	0.646	0.550	0.353	0.493	0.618	0.783	0.546	0.454
1982-83	1.000	0.652	0.614	0.353	0.436	0.573	0.739	0.506	0.525
1983-84	0.897	0.589	0.613	0.387	0.392	0.544	0.650	0.487	0.511
1984-85	0.909	0.647	0.671	0.436	0.412	0.498	0.694	0.489	0.508
1985-86	1.017	0.666	0.636	0.447	0.392	0.486	0.745	0.490	0.558
1986-87	1.005	0.687	0.626	0.534	0.359	0.514	0.756	0.528	0.552
1987-88	1.141	0.677	0.640	0.625	0.400	0.545	0.830	0.542	0.665
1988-89	1.096	0.669	0.650	0.695	0.385	0.516	0.863	0.608	0.623
1989-90	0.660	0.919	0.656	0.764	0.422	0.531	0.914	0.640	0.782
1990-91	0.686	1.204	0.645	0.645	0.405	0.538	1.000	0.674	0.787
1991-92	0.619	0.781	0.700	0.662	0.397	0.522	0.891	0.567	0.818
1992-93	0.590	0.933	0.700	0.758	0.346	0.488	0.924	0.642	0.980
Average	0.802	0.735	0.787	0.595	0.606	0.617	0.810	0.647	0.704



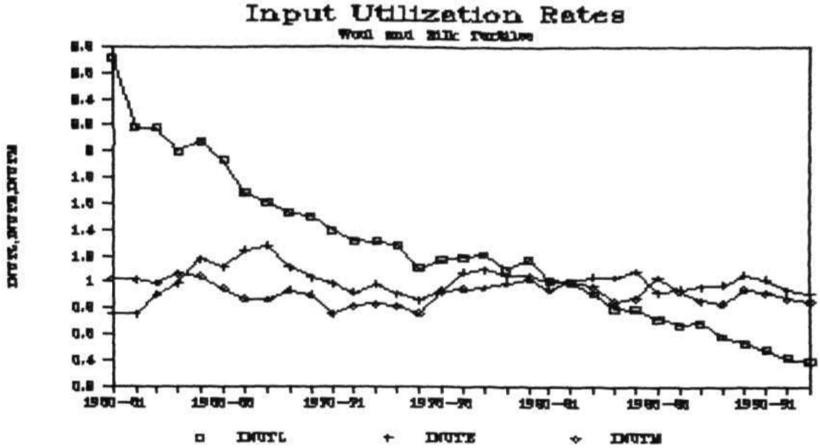
Input Utilization Rates
Food Products
INUTL
INUTE
INUTM

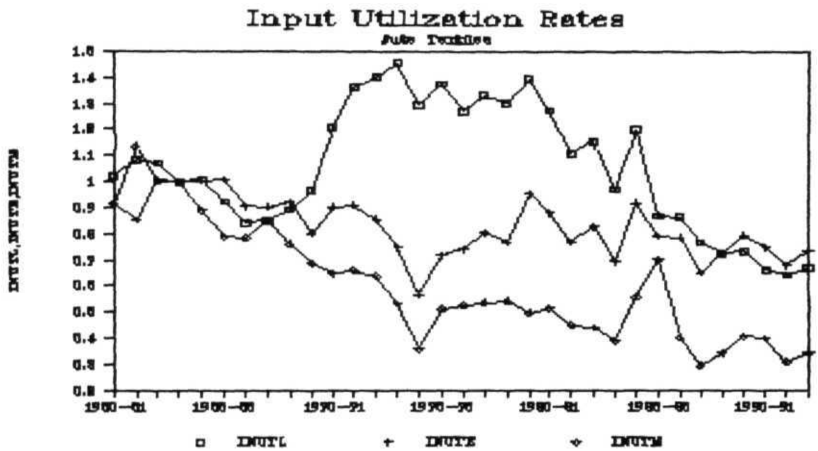


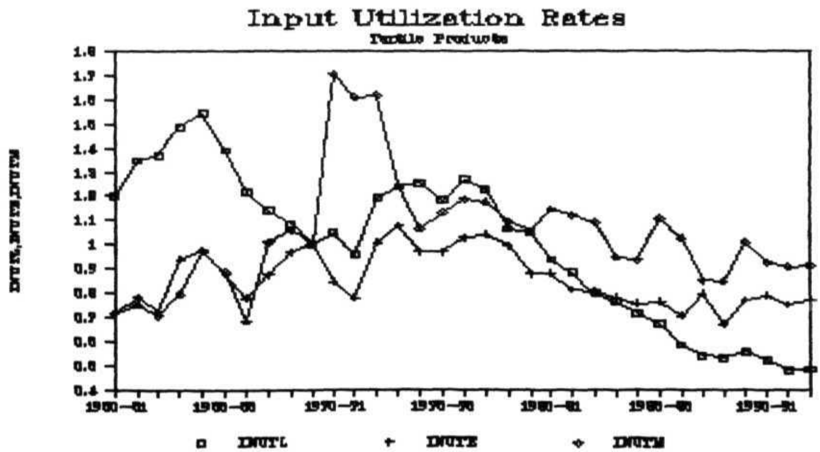
Input Utilization Rates
Beverages and Tobacco
INUTL
INUTE
INUTM



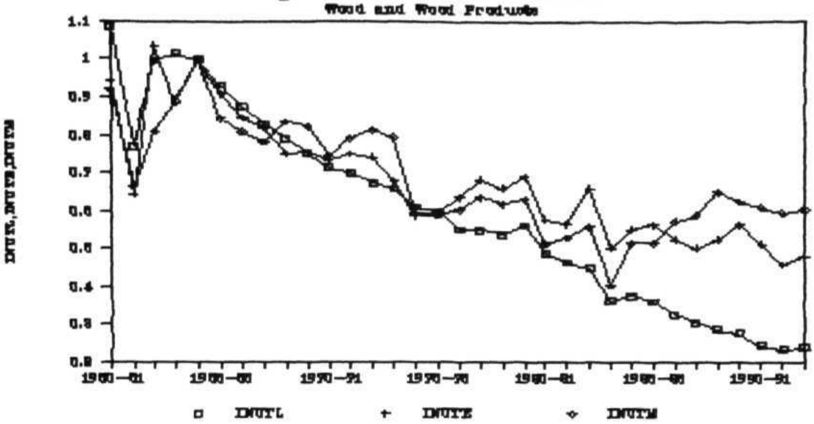
Input Utilization Rates
Cotton Textiles
INUTL
INUTE
INUTM


Input Utilization Rates
Wool and Silk Textiles
INUTL
INUTE
INUTM

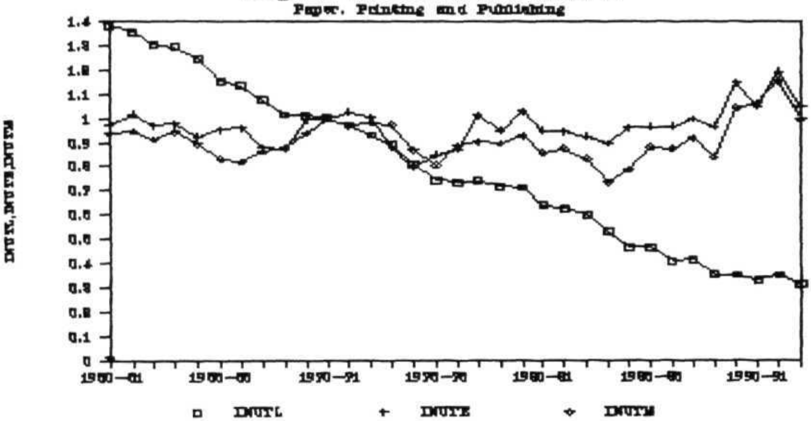

Input Utilization Rates
Jute Textiles
INUTL
INUTE
INUTM


Input Utilization Rates
Textile Products
INUTL
INUTE
INUTM

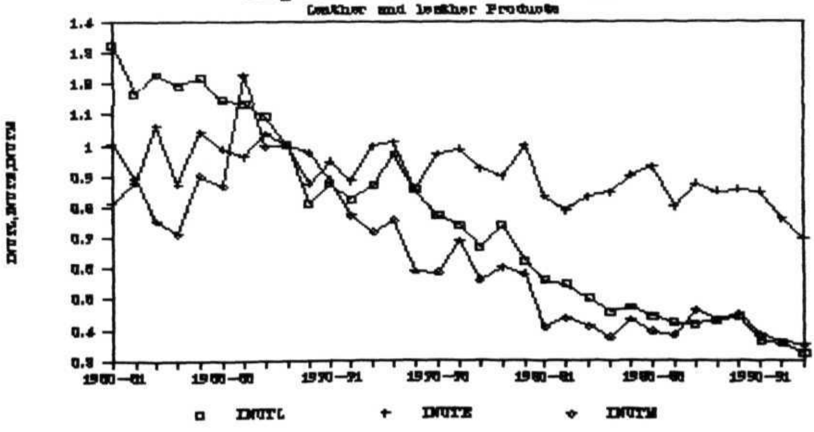
Input Utilization Rates
Wood and Wood Products

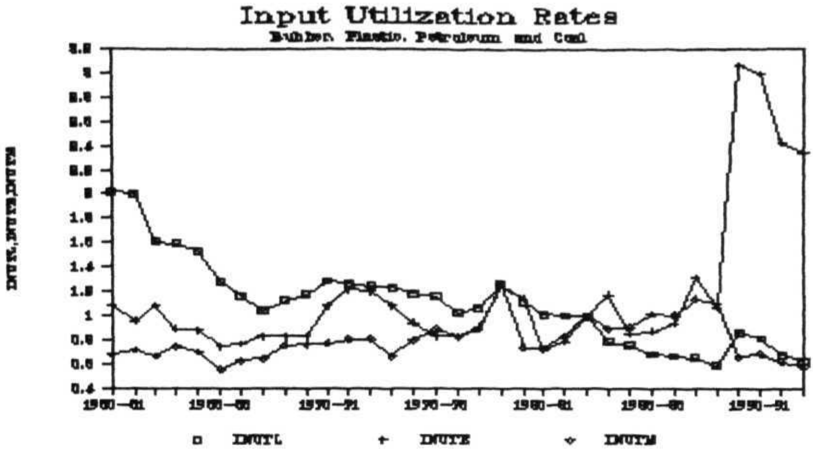


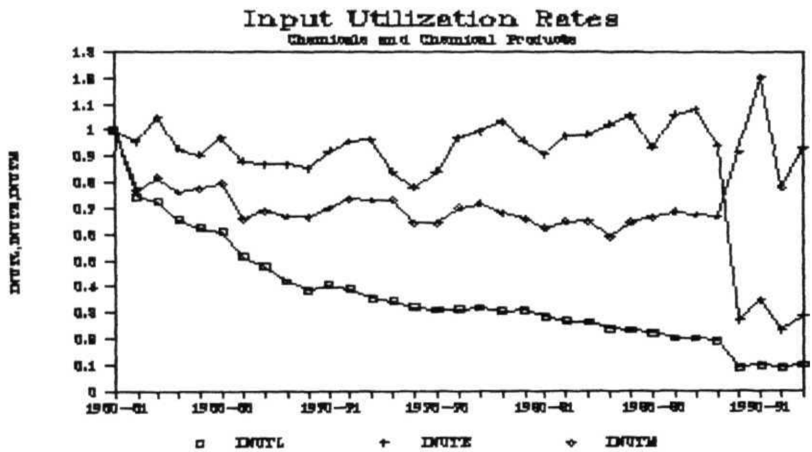
Input Utilization Rates
Paper, Printing and Publishing

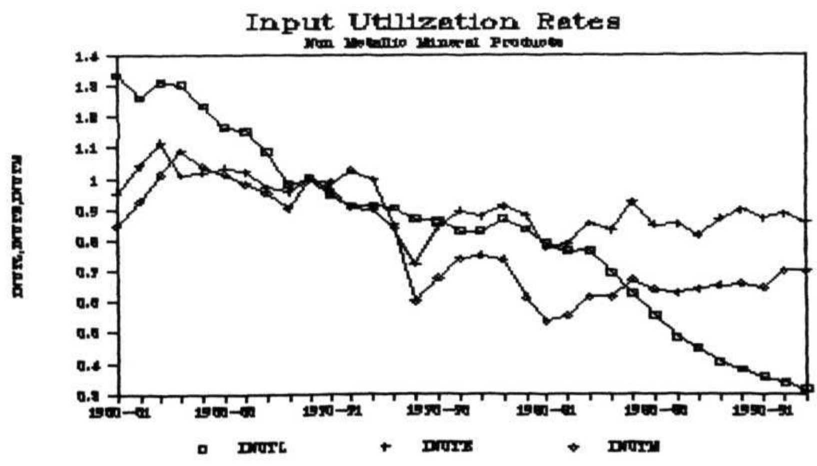


Input Utilization Rates
Leather and leather Products

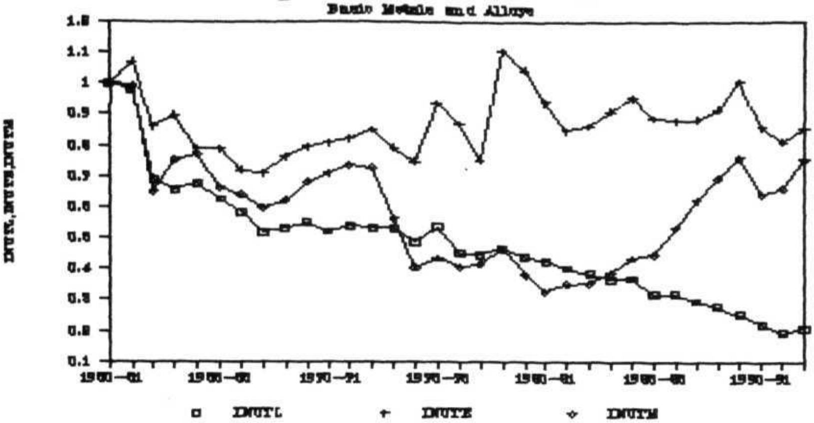



Input Utilization Rates
Rubber, Plastic, Petroleum and Coal
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
INUTL
INUTE
INUTM

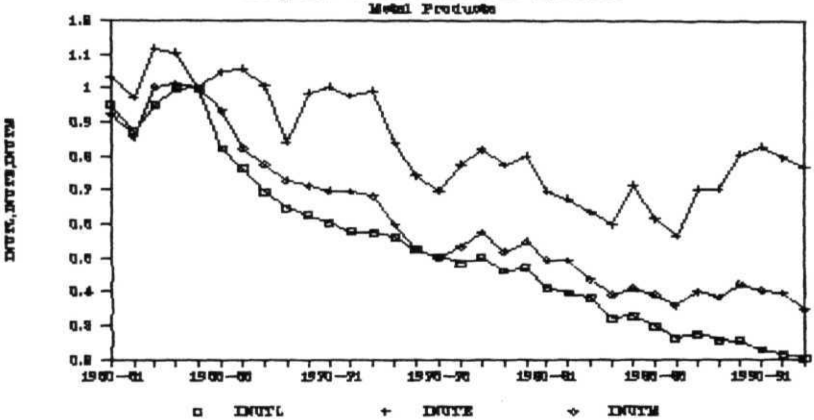

Input Utilization Rates
Chemicals and Chemical Products
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
INUTL
INUTE
INUTM


Input Utilization Rates
Non Metallic Mineral Products
1960-61
1965-66
1970-71
1975-76
1980-81
1985-86
1990-91
INUTL
INUTE
INUTM

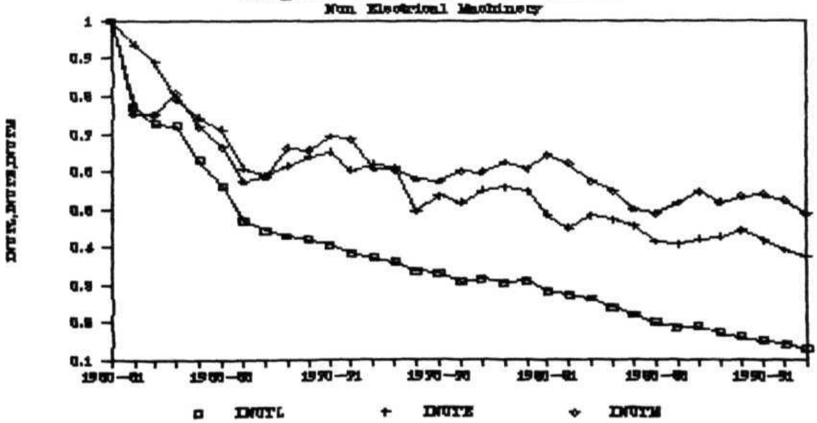
Input Utilization Rates
Basic Metals and Alloys



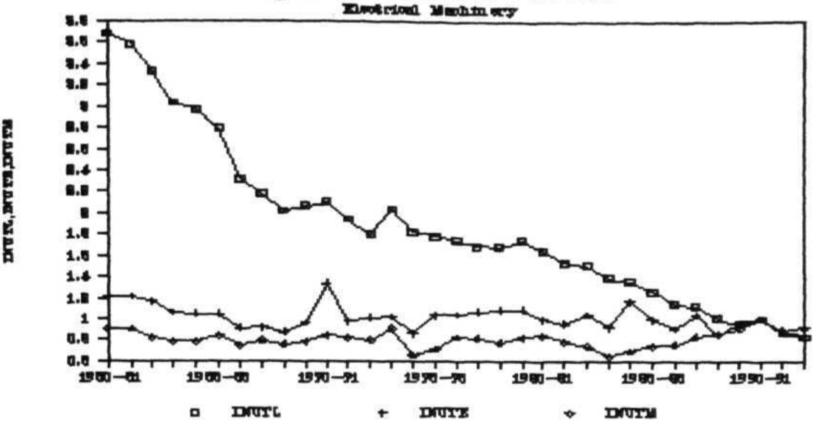
Input Utilization Rates
Metal Products



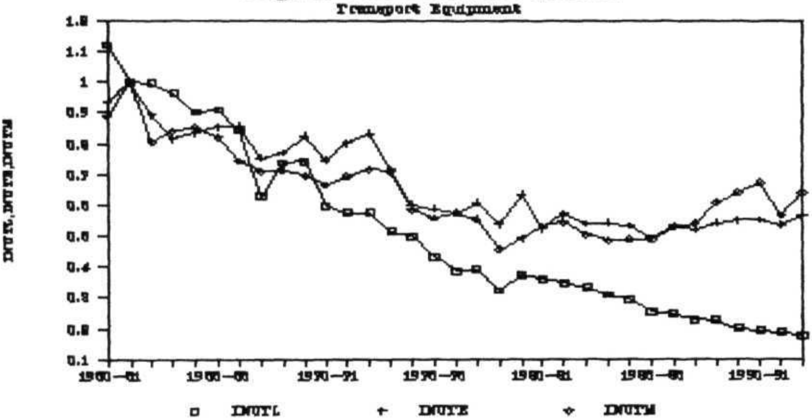
Input Utilization Rates
Non Electrical Machinery



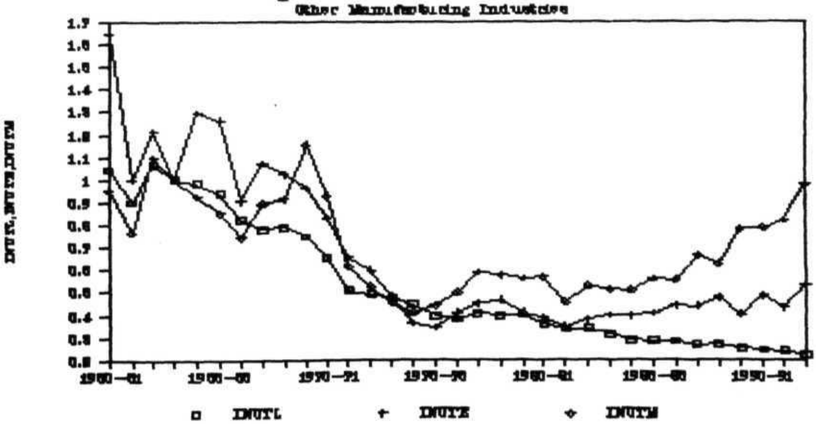
Input Utilization Rates
Electrical Machinery



Input Utilization Rates
Transport Equipment



Input Utilization Rates
Other Manufacturing Industries



also greater than unity indicating actual usage of labor input which is more than the optimal level. Industry 36 i.e Electrical Machinery in particular has a very high average level of INUTL and although it shows a declining trend, only in the last years of the study is the value less than unity. In Textile Products (26), Wood and Wood Products (27), Non Electrical Machinery (35) and Other Manufacturing Industries (38) average INUTM is highest as compared to average levels of INUTL and INUTE.

The tables as well as the graphs also reveal that INUTL has fallen very sharply in Beverages and Tobacco (22), Cotton Textiles (23), Wood and Wood Products (27), Chemicals (31), Basic Metals and Alloys (33),Non Electrical Machinery (35), Transport Equipment (37) and Other Manufacturing Industries (38). The actual utilization of labor input is very much less than the level required for optimal utilization. Rubber, Plastic, Petroleum and Coal (30) had high levels of INUTL till 1981-82 while Electrical Machinery (36) had high levels till the early 1990's. Food Products (20-21) shows fluctuations in INUTL with a decrease during 1960-61 to 1969-70 and an increase till 1976-77 and a steady decline after 1980-81. While Beverages and Tobacco (22) shows a sharp decrease till 1970-71 and a marginal increase till 1982-83. Thereafter INUTL fell sharply throughout the 1980's. Jute Textiles (25) shows a decline till 1966-67 and a continuos increase till 1973-74. INUTL in this industry remained high and was over unity till 1982-83. Textile Products (26) shows a decline from mid-60's till 1971-72. Thereafter it increased till 1976-77 and INUTL was greater than unity till 1979-80. But fell sharply during the 1980's and early 1990's. In all other industries a more or less continuous declining trend in INUTL is evident. Thus it can be seen that INUTL levels declined in many industries from high levels of over unity in 1960's to very low levels by the early 90's. Only Chemicals (31) and Non Electrical Machinery (35) started with relatively low levels of INUTL.

On an average INUTE is higher in eleven of the eighteen industries with the average INUTE being greater than unity in Wool and Silk Textiles (24), Rubber, Plastic, Petroleum and Coal (30) and Electrical Machinery (36). Wood and Wood Products (27) and Non Electrical Machinery (35) show a declining trend in INUTE. Rubber, Plastic, Petroleum and Coal (30) shows a sharp increase in 1989-90 while Chemicals (31) shows a very sharp decline in 1989-90. Paper, Printing and Publishing (28) shows a decline in the mid- 1970's and an increase in the 1990's. Other Manufacturing Industries (38) shows a sharp decline in INUTE after 1970-71. INUTE figures are neither too high nor too low as compared to INUTL indicating neither too much of an excess use of energy nor too less of it compared to optimal levels.

For the period 1960-61 to 1992-93 average INUTM levels are less than unity for all industries except Textile Products (26). In Wool and Silk Textiles (24) and Paper, Printing and Publishing (28) average INUTM is high with levels of 0.923 and 0.910 respectively. Jute Textiles (25) and Leather and Leather Products (29) show very low INUTM towards the mid-1980's and more or less a declining trend over the period. Paper, Printing and Publishing (28) and Rubber, Plastic, Petroleum and Coal (30) show an increase in INUTM towards the early 1990's and also show less fluctuations. Leather and Leather

Products (29) also shows a declining trend with low INUTM towards the 1990's. Basic Metals and Alloys (33) shows an increase in INUTM from 1980-81 to 1992-93. Metal Products (34) and Non Electrical Machinery (35) also show a steady decline to low levels of INUTM towards the terminal years of the study. Electrical Machinery (36) shows lower levels of INUTM as compared to INUTL and INUTE throughout the period but INUTM also shows less fluctuations. Other Manufacturing Industries (38) shows higher levels of INUTM in early 1980's as compared to sharp decline during 1970-71 to 1976-77.

From Tables 8.4 and 8.5 it is seen that INUTL shows a declining trend over the different time period irrespective of whether it is the first classification according to the debate on industrial deceleration or whether it is a decade wise classification. Only in Jute Textiles (25) INUTL shows an increase in the second time period in both the tables 7.4 and 7.5 before declining again. Electrical Machinery (36) had the highest levels of INUTL in all time periods. Cotton Textiles (23), Chemicals (31) and Non Electrical Machinery (35) had lowest levels of INUTL by the 1990's.

From Table 8.6,in eleven of the eighteen industries, the trend in INUTE shows a decline. In three industry groups namely, Jute Textiles (24), Textile Products (26) and Leather and Leather Products (29) average INUTE was higher during 1966-67 to 1979-80. While in Paper, Printing and Publishing (28) and Rubber, Plastic, Petroleum and Coal (30) average INUTE was highest during 1980-81 to 1992-93. In Beverages and Tobacco (22) and Basic Metals and Alloys (33) also average INUTE levels increased during the third period after the

Table 8.4

Period wise Average Input Utilization Rates for Labor for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1965-66	0.958	0.833	0.876	2.180	1.018	1.389	0.967	1.289	1.213
1966-67-1979-80	0.837	0.507	0.485	1.326	1.210	1.136	0.671	0.891	0.854
1980-81-1992-93	0.536	0.399	0.258	0.696	0.895	0.650	0.339	0.451	0.439

oontd.

Table 8.5

Decade wise Average Input Utilization Rates for Labor for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1969-70	0.885	0.704	0.769	1.941	0.966	1.277	0.905	1.197	1.131
1970-71-1979-80	0.863	0.506	0.435	1.224	1.340	1.147	0.614	0.825	0.792
1980-81-1989-90	0.584	0.432	0.280	0.775	0.967	0.697	0.370	0.486	0.467
1990-91-1992-93	0.375	0.288	0.182	0.432	0.658	0.495	0.238	0.333	0.347

contd.

Table 8.4 (contd.)

Period wise Average Input Utilization Rates for Labor for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61-1965-66	1.674	0.726	1.269	0.772	0.932	0.735	3.232	0.983	0.989
1966-67-1979-80	1.166	0.369	0.928	0.509	0.572	0.369	1.919	0.545	0.548
1980-81-1992-93	0.779	0.191	0.531	0.311	0.296	0.199	1.199	0.258	0.283

Table 8.5 (contd.)

Decade wise Average Input Utilization Rates for Labor for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61-1969-70	1.455	0.616	1.183	0.682	0.833	0.617	2.797	0.885	0.907
1970-71-1979-80	1.181	0.337	0.876	0.494	0.527	0.341	1.830	0.467	0.453
1980-81-1989-90	0.801	0.219	0.590	0.342	0.320	0.217	1.290	0.280	0.297
1990-91-1992-93	0.706	0.096	0.334	0.208	0.216	0.139	0.897	0.185	0.234

Table 8.6

Period wise Average Input Utilization Rates for Energy for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61- 1965-66	0.936	1.016	0.982	0.949	0.965	0.837	0.904	0.968	0.943
1966-67- 1979-80	0.848	0.867	0.747	1.037	0.822	0.943	0.708	0.937	0.953
1980-81- 1992-93	0.802	0.871	0.691	0.996	0.770	0.772	0.537	1.000	0.830

contd.

Table 8.7

Decade wise Average Input Utilization Rates for Energy for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61- 1969-70	0.897	0.977	0.933	1.036	0.932	0.864	0.859	0.951	0.954
1970-71- 1979-80	0.851	0.847	0.702	0.984	0.797	0.958	0.675	0.942	0.947
1980-81- 1989-90	0.790	0.875	0.694	1.006	0.784	0.773	0.554	0.972	0.850
1990-91- 1992-93	0.842	0.858	0.684	0.964	0.722	0.768	0.484	1.095	0.766

contd.

Table 8.6 (contd.)

Period wise Average Input Utilization Rates for Energy for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	30
1960-61-1965-66	0.939	0.968	1.029	0.901	1.047	0.845	1.122	0.890	1.235
1966-67-1979-80	0.981	0.909	0.906	0.837	0.880	0.580	1.011	0.704	0.640
1980-81-1992-93	1.506	0.777	0.851	0.895	0.701	0.432	0.964	0.539	0.423

Table 8.7 (contd.)

Decade wise Average Input Utilization Rates for Energy for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61-1969-70	0.888	0.928	1.012	0.840	1.017	0.752	1.039	0.855	1.138
1970-71-1979-80	1.048	0.926	0.873	0.873	0.843	0.567	1.049	0.665	0.499
1980-81-1989-90	1.180	0.923	0.845	0.910	0.672	0.444	0.981	0.536	0.405
1990-91-1992-93	2.592	0.288	0.871	0.845	0.799	0.393	0.906	0.552	0.482

Table 8.8

Period wise Average Input Utilization Rates for Materials for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1965-66	0.925	0.920	0.921	1.015	0.955	1.389	0.855	0.911	0.855
1966-67-1979-80	0.686	0.656	0.581	0.888	0.611	1.136	0.718	0.908	0.781
1980-81-1992-93	0.627	0.426	0.444	0.918	0.428	0.650	0.560	0.912	0.405

contd.

Table 8.9

Decade wise Average Input Utilization Rates for Materials for Two Digit Industries

Period	Industry Group 20-21	22	23	24	25	26	27	28	29
1960-61-1969-70	0.845	0.896	0.816	0.968	0.882	1.277	0.838	0.897	0.933
1970-71-1979-80	0.670	0.575	0.549	0.885	0.546	1.147	0.680	0.921	0.673
1980-81-1989-90	0.617	0.432	0.439	0.927	0.451	0.697	0.547	0.864	0.417
1990-91-1992-93	0.657	0.406	0.461	0.888	0.352	0.495	0.603	1.071	0.364

contd.

Table 8.8 (contd.)

Period wise Average Input Utilization Rates for Materials for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61- 1965-66	0.677	0.820	0.988	0.807	0.955	0.782	0.840	0.869	0.933
1966-67- 1979-80	0.803	0.688	0.844	0.557	0.638	0.617	0.790	0.634	0.664
1980-81- 1992-93	0.860	0.746	0.633	0.538	0.410	0.540	0.818	0.558	0.641

Table 8.9 (contd.)

Decade wise Average Input Utilization Rates for Materials for Two Digit Industries

	Industry Group								
Period	30	31	32	33	34	35	36	37	38
1960-61- 1969-70	0.685	0.760	0.977	0.738	0.877	0.717	0.812	0.808	0.931
1970-71- 1979-80	0.845	0.695	0.797	0.525	0.588	0.617	0.798	0.602	0.559
1980-81- 1989-90	0.929	0.678	0.619	0.492	0.419	0.547	0.781	0.537	0.574
1990-91- 1992-93	0.632	0.973	0.681	0.688	0.382	0.516	0.938	0.628	0.862

decline in the second period. Wool and Silk Textiles (24), Paper, Printing and Publishing (28), Rubber, Plastic, Petroleum and Coal (30) and Electrical Machinery (36) had high levels of average INUTE in all periods. From Table 8.7 it is clear that in eight of the eighteen industries INUTE levels increased in the 1990's. The decline in industry group Chemicals (31) is significant while so is the increase in Rubber, Plastic, Petroleum and Coal (30).

From Tables 8.8 and 8.9 the decline in INUTM levels in many industries is sharp. Only in Rubber, Plastic, Petroleum and Coal (30) there is an increase in INUTM over the different time periods. However from Table 8.9, a sharp decrease in INUTM in the early 1990's is noticed. Also in three industries, namely Textile Products (26), Paper, Printing and Publishing (28) and Electrical Machinery (36) the INUTM levels did not decrease so sharply and in Paper, Printing and Publishing (28) and Electrical Machinery (36) INUTM increased again in the last period after the decline in the second period. From Table 7.9 we also see that in ten of the eighteen industries INUTM increased again during early 1990's.

In Tables 8.10 to 8.15 the decade wise average input utilization rates by the Process and Use –based classification are given. From Tables 8.10, 8.12 and 8.14 which give INUTL, INUTE and INUTM according to the Process-based classification brings out clearly the continuous decline in INUTL levels over time irrespective of the category of industries under consideration. Only Metal-based industries had a low INUTL of less than unity in the decade of the 1960's. All other industry groups had an average INUTL more than unity. Table 8.12 shows that in two categories, namely Mineral-based and Metal-based industries INUTE increased in the early 1990's after declining in the two earlier decades of the 1970's and 1980's. In case of Chemical-based industries INUTE shows a consistent increase over the four time periods with average INUTE levels greater than unity in the decade of the 1980's and the early 1990's. In Agro-based and Machinery -based industries as well as Miscellaneous Industries INUTE declined continuously with the drop being very sharp for Miscellaneous Industries in the 1970's. Also average INUTE is greater than average INUTM for all time periods and for all industry groups in the Process-based classification. Again, in case of INUTM in five of the six industry groups INUTM increased in the early 1990's after declining continuously in the 1970's and and 1980's. Only Chemical-based industries show an increase in INUTM during the 1970's and 1980's and about the same level in the early 1990's.

From the Use-based classification of INUT levels given in Tables 8.11, 8.13 and 8.15 it can be seen that INUTL levels show a continuous decline with Capital goods having highest input utilization levels in all time periods. During 1960-61 to 1969-70 INUTL was more than unity for Basic and Intermediate goods as well as capital goods. By the early 1990's input utilization levels for labor declined very low levels. The input utilization rates for energy showed an increase in the early 1990's after declining throughout in Basic and Intermediate goods and Consumer goods while it fell throughout in the case of Capital goods. The decline in INUTE for Consumer goods is mainly because of a sharp decline in INUTE for Consumer Durables. All three industry groups - Basic and Intermediate goods, Capital goods as well as Consumer goods show an increase in

Decade wise Average Input Utilization Rates for Labor by Process and Use Based Classification

Table 8.10

Process Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	1.081	0.869	0.574	0.375
2. Mineral based	1.183	0.876	0.590	0.334
3. Metal based	0.758	0.511	0.331	0.212
4. Chemical based	1.036	0.759	0.510	0.401
5. Machinery based	1.433	0.879	0.596	0.407
6. Misc. industries	1.019	0.623	0.382	0.291
Total	1.085	0.753	0.497	0.337

Table 8.11

Use Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Basic and intermediate goods	1.077	0.803	0.525	0.351
2. Capital goods	1.433	0.879	0.596	0.407
3. Consumer goods	0.936	0.717	0.476	0.326
(a) Durables	0.906	0.534	0.334	0.236
(b) Non - Durables	0.955	0.839	0.571	0.386

Decade wise Average Input Utilization Rates for Energy by Process and Use Based Classification

Table 8.12

Process Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	0.931	0.845	0.806	0.802
2. Mineral based	1.012	0.873	0.845	0.871
3. Metal based	0.929	0.858	0.791	0.822
4. Chemical based	0.908	0.987	1.052	1.440
5.Machinery based	0.882	0.760	0.654	0.617
6. Misc. industries	1.046	0.723	0.628	0.624
Total	0.951	0.841	0.796	0.863

Table 8.13

Use Based Classification

Industry **group**	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1.Basic and intermediate goods	0.949	0.894	0.884	0.963
2. Capital goods	0.882	0.760	0.654	0.617
3. **Consumer** goods	**0.947**	0.766	**0.679**	**0.687**
(a)Durables	**0.999**	**0.587**	**0.480**	**0.483**
(b) Non - Durables	**0.913**	**0.885**	**0.813**	**0.823**

Decade wise Average Input Utilization Rates for **Materials** by Process and Use **Based** Classification

Table 8.14

Process Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. Agro based	0.875	0.764	0.660	0.669
2. Mineral based	0.977	0.797	0.619	0.681
3. Metal based	0.808	0.557	0.456	0.535
4. Chemical based	0.723	0.770	0.804	0.803
5. **Machinery** based	0.779	0.672	0.622	0.694
6. Misc. industries	0.932	0.616	0.496	0.613
Total	0.849	0.696	0.610	0.666

Table 8.15

Use Based Classification

Industry group	1960-61-1969-70	1970-71-1979-80	1980-81-1989-90	1990-91-1992-93
1. **Basic** and **intermediate** goods	0.853	0.702	0.624	0.649
2. Capital goods	0.779	0.672	0.622	0.694
3. **Consumer** goods	**0.874**	0.754	0.635	0.688
(a) Durables	0.885	0.620	0.561	0.733
(b) Non - **Durables**	**0.867**	**0.844**	0.685	0.659

INUTM in the early 1990's after declining through in the 1970's and the 1980's. Consumer Durables too follows this same pattern. However, Consumer Non-durables show high INUTM levels in the 1970's and show a sharp decline in the 1980's and in the early 1990's as well.

8.3 Scale Efficiency and Returns to Scale in Indian Industries:

In this section the results on scale efficiency and returns to scale are given. In Chapter 4 the methodology for derivation of technical or productive efficiency was given. In Chapter 7 the results on productive or technical efficiency for the eighteen two digit industries for the period from 1960-61 to 1992-93 were presented. In this section, the linear programming model is extended to enable the determination of scale efficiency and the determination of the nature of returns to scale. The procedure to determine the nature of scale economies has been outlined in Chapter 4. From the linear programming solutions, the measure of scale efficiency is thus obtained (S_o^t).

If $S_o^t = 1$, the technology exhibits constant returns to scale at the observed input-output combination. The percent of potential output lost due to scale inefficiency is then (1 - S_o^t). Thus it is possible to obtain an estimate of lost output due to scale inefficiency in this manner for all the eighteen two digit industry groups for each year.

Also, given that S_o^t captures output loss due to deviations from optimal scale it can be determined if if scale inefficiency is due to increasing returns to scale (IRS) or decreasing returns to scale (DRS).

By imposing a different restriction for non-increasing returns to scale and solving the LP, output levels under this assumption can be obtained. Thus, as given in Chapter 4, by a three step procedure it can be determined whether increasing, decreasing or constant returns to scale prevails.

The results on productive/technical efficiency given in Chapter 7 are reproduced here. In addition the estimates of scale efficiency and the nature of returns to scale for all the eighteen industry groups industries for the period from 1960-61 to 1992-93 is given in Table 8.16. Column TE is the measure of productive or technical efficiency as given in Table 7.1 of Chapter 7, column SE refers to scale efficiency and RTS gives the nature of returns to scale prevailing i.e. increasing returns to scale (IRS), decreasing returns to scale (DRS) or constant returns to scale (CRS).

From the table it can be seen that in Food Products (20-21), average TE for the study period is quite high- 94.8 per cent. Except in 3 years when there is DRS, in all other years there is inefficiency of IRS type. CRS prevails from 1988-89 to 1992-93 as well as 1960-61 to 1961-62, 1965-66 and 1982-83. Low TE exists in 1967-68, 1968-69 and 1971-72 and 1980-81. There is IRS during these periods. Yet, however scale inefficiency is not significant.

On the other hand in Beverages and Tobacco (22) there is low average TE and particularly so in the early 1990's. Efficient production was achieved in only 3 years. Increasing returns to scale (IRS) is evident only in 3 years. In the remaining years this industry is characterized by DRS. About 8.64 per cent of lost output on an average is due to scale inefficiency. In the decade of the 1980's and particularly since 1988-89 prevalence of DRS was the major source of scale inefficiency and accounted for most of the lost output due to inefficiency.

In Cotton Textiles (23), in fifteen of the thirtythree years under consideration, production was efficient and average TE was high at 97.9%. In four years this industry faced DRS. In the remaining fourteen years IRS characterized this industry. Also, in many years when the loss of output due to technical or productive efficiency was relatively higher it was due to the presence of IRS type of scale inefficiency.

In Wool and Silk Textiles (24), in seven years production was efficient. Average TE for the study period was lower at 89.5%. After 1980-81, this industry was characterized by DRS when production was not efficient while before 1980-81, IRS was the cause of inefficiency. TE between 1962-63 to 1969-70 was very low with average technical efficiency between 1965-66 to 1969-70 being only 62.26%. Increasing returns to scale prevailed but scale inefficiency was not very significant in accounting for this output loss. And accounted for only a small part of loss in potential output during this period.

Industry group 25 i.e. Jute Textiles had average TE of only 86.8% with efficient production in only 3 years. This industry faced IRS till 1978-79. Thereafter, in seven years decreasing returns, in five years increasing returns and in two years constant returns to scale is observed. Scale inefficiency was due to IRS, a major cause for inefficiency during early 1960's. Again, the sharp decline in TE in mid- 1980's was accounted for by scale inefficiency of DRS variety particularly in 1984-85 and 1985-86. On an average however only 4.43 % of lost output can be attributed to scale inefficiency.

IRS characterized Textile Products (26) till 1968-69 and again in 1991-92. In the remaining years, inefficient production was due to DRS. In six years, production was efficient. Low TE was a feature of this industry. In the initial years, low TE was due to scale inefficiency of IRS kind. Again, after 1971-72, the sharp decline in TE was accounted for in many years by scale inefficiency of DRS. Between 1975-76 to 1985-86 about 10-22% of potential output loss is due to scale inefficiency.

Industry group 27 i.e. Wood and Wood Products had full efficient production in eight years. Average technical efficiency for the entire period was (95.6%). Low TE between 1981-82 to 1986-87 was due to DRS as well as IRS. Scale inefficiency however was not the major reason for technical inefficiency.

Paper, Printing and Publishing (28) had technically efficient production in eight years. Average TE for this industry group is high (95.9%). But TE is low between 1960-61 to 1964-65 and again in 1992-93. Scale inefficiency is the major cause of technical inefficiency in this industry. In this industry group, until 1970-71 eithe IRS or CRS is observed. After 1980-81, except for three years between 1971-72 to 1973-74, when there is evidence of DRS, IRS prevails. On an average, about 50% of potential output loss can be attributed due to scale inefficiency.

In Leather and Leather Products (29), except for five years in the initial period, DRS characterize this industry. The sharp decline in TE in two years 1962-63 and 1966-67 was not characterized by major scale inefficiency. After 1972-73 and till 1982-83 TE was higher (over 90%). DRS prevailed and scale inefficiency was also prevalent. But the sharp decline in TE again in 1985-86 and 1986-87 cannot be attributed by scale inefficiency.

Industry group 30 i.e. Rubber, Plastic, Petroleum and Coal was charachterized by increasing returns between 1960-61 to 1979-80. In the subsequent period between 1980-81 to 1992-93, TE is much higher with efficient production in four years. Inefficient production in later years is due to decreasing returns. Very low TE till mid-1970's is also clear. In initial two years scale inefficiency due to IRS accounted for loss in potential output. Thereafter while TE fell, scale inefficiency accounted for a smaller proportion of output loss. Again, DRS charachterized this industry after 1983-84 and after 1988-89 scale inefficiency was a major cause of output loss.

In Chemicals (31), average TE is 95.2%. There is not much fluctuations in efficiency levels with efficient production observed in seven years. Lowest TE of 88.1% is seen in 1975-76. Except for 1961-62, 1962-63 and 1991-92, DRS prevails in this industry. During years in which TE declined, scale inefficiency does not seem to account for the loss in output.

Till 1981-82 there is IRS and thereafter DRS prevails in Non Metallic Minerals (32). Average TE is high at 96%. Low TE in initial years is due to IRS and scale inefficiency accounts for lost output. In later years, however scale inefficiency does not account for much of lost output and after 1982-83, DRS prevails in this industry.

Increasing returns to scale is observed in six years, constant returns in seven years and decreasing returns in the remaining 20 for industry group 33 i.e. Basic Metals and Alloys. Average TE is 92.4% for the thirtythree year period. The decline in TE between 1967-68 to 1976-77 is not accounted for by scale inefficiency. The decline between 1983-84 to 1987-88 is mainly due to DRS. In 1984-85 for example, TE is 84.7% and lost output due to scale inefficiency is 6.6%.

After 1984-85, decreasing returns prevails in Metal Products (34) with efficient production in four of the seven years. Before 1984-85,decreasing returns is seen during 1971-72 and 1972-73. In the remaining years, this industry faced IRS. In the initial 3 years, and in the terminal years technical inefficiency was due to scale inefficiency.

In Non Electrical Machinery (35), there is decreasing returns in six years, increasing returns in seven years and in the remaining twenty years there is CRS. Average TE for the period of study is high at 94.3%. Between 1966-67 to 1973-74 TE was lower. After 1977-78, TE was higher. Scale efficiency measure however does not capture the lost output between 1966-67 and 1973-74.

Electrical Machinery (36) is characterized by low average TE of 82.1%. After 1980-81 TE is higher with efficient production in seven years. In the first two years, when TE was 70.8 and 71.6%, the loss in output is due to scale inefficiency of IRS variety. But after this, while scale inefficiency does not contribute to loss in potential output, its share declines. On an average about 5.7% of potential output loss is due to scale inefficiency.

Industry group 37 i.e. Transport Equipment had high TE of 97.1%. In six years production is senn to be efficient. Except in 1981-

Table 8.16

Scale Efficiency and Returns to Scale In Two Digit Industries

(1960-61 to 1992-93)

Tear	Industry Group 20-21 TE	RTS	SE	22 TE	RTS	SE	23 TE	RTS	SE
1960-61	1.000	CRS	1.000	1.000	CRS	1.000	0.959	IRS	0.959
1961-62	1.000	CRS	1.000	0.961	DRS	0.969	1.000	CRS	1.000
1962-63	0.979	IRS	1.000	0.844	DRS	0.965	0.989	DRS	0.999
1963-64	0.901	IRS	0.997	0.826	IRS	0.826	1.000	CRS	1.000
1964-65	0.964	IRS	1.000	0.901	IRS	0.901	1.000	CRS	1.000
1965-66	1.000	CRS	1.000	0.985	DRS	0.990	0.983	IRS	0.997
1966-67	0.992	IRS	0.999	1.000	CRS	1.000	0.994	IRS	0.994
1967-68	0.857	IRS	0.993	0.944	DRS	0.985	1.000	CRS	1.000
1968-69	0.860	IRS	0.996	0.890	DRS	0.978	0.986	IRS	0.998
1969-70	0.981	DRS	1.000	0.991	DRS	0.991	1.000	CRS	1.000
1970-71	0.954	DRS	1.000	0.954	IRS	0.954	0.904	IRS	0.904
1971-72	0.847	DRS	1.000	0.898	DRS	0.949	0.919	IRS	0.919
1972-73	0.790	IRS	0.999	0.737	DRS	0.845	0.911	IRS	0.937
1973-74	0.818	IRS	0.998	0.775	DRS	0.876	0.961	IRS	0.961
1974-75	0.955	IRS	0.998	1.000	CRS	1.000	1.000	CRS	1.000
1975-76	0.953	IRS	0.999	0.820	DRS	0.973	0.970	IRS	1.000
1976-77	0.922	IRS	0.999	0.886	DRS	0.910	0.998	IRS	0.998
1977-78	0.996	IRS	0.999	0.842	DRS	0.878	1.000	CRS	1.000
1978-79	0.962	IRS	0.999	0.829	DRS	0.881	1.000	CRS	1.000
1979-80	0.964	IRS	0.999	0.877	DRS	0.966	0.976	DRS	0.999
1980-81	0.848	IRS	0.999	0.813	DRS	0.965	1.000	CRS	1.000
1981-82	0.909	IRS	0.999	0.837	DRS	0.929	1.000	CRS	1.000
1982-83	1.000	CRS	1.000	0.884	DRS	0.913	0.972	DRS	0.999
1983-84	0.997	IRS	0.999	0.950	DRS	0.950	1.000	CRS	1.000
1984-85	0.968	IRS	0.999	0.952	DRS	0.952	0.932	DRS	1.000
1985-86	0.964	IRS	0.999	0.805	DRS	0.869	0.917	IRS	0.988
1986-87	0.948	IRS	0.999	0.753	DRS	0.898	0.998	IRS	0.999
1987-88	0.939	DRS	1.000	0.845	DRS	0.905	1.000	CRS	1.000
1988-89	1.000	CRS	1.000	0.868	DRS	0.868	0.970	IRS	0.970
1989-90	1.000	CRS	1.000	0.737	DRS	0.749	0.979	IRS	0.990
1990-91	1.000	CRS	1.000	0.742	DRS	0.747	1.000	CRS	1.000
1991-92	1.000	CRS	1.000	0.793	DRS	0.793	1.000	CRS	1.000
1992-93	1.000	CRS	1.000	0.773	DRS	0.773	1.000	CRS	1.000
Average	0.948		0.999	0.870		0.914	0.979		0.988

contd.

Note: TE = Technical Efficiency
RTS = Returns to Scale
SE = Scale Efficiency
Estimated as given in Chapter 4 and based on ASI data.

Table 8.16 (contd.)

Scale Efficiency and Returns to Scale in Two Digit Industries

(1960-61 to 1992-93)

Industry Group

Tear	24			25			26		
	TE	RTS	SE	TE	RTS	SE	TE	RTS	SE
1960-61	1.000	CRS	1.000	0.750	IRS	0.750	0.545	IRS	0.545
1961-62	0.997	IRS	0.997	0.944	IRS	0.944	0.643	IRS	0.643
1962-63	0.877	IRS	0.951	0.901	IRS	0.901	0.656	IRS	0.738
1963-64	0.757	IRS	0.928	1.000	CRS	1.000	0.750	IRS	0.815
1964-65	0.786	IRS	0.932	0.947	IRS	0.963	0.941	IRS	0.941
1965-66	0.607	IRS	0.942	0.822	IRS	0.915	1.000	CRS	1.000
1966-67	0.608	IRS	0.949	0.829	IRS	0.898	1.000	CRS	1.000
1967-68	0.605	IRS	0.961	0.914	IRS	0.992	0.841	IRS	0.997
1968-69	0.649	IRS	0.960	0.812	IRS	0.985	0.916	IRS	0.998
1969-70	0.644	IRS	0.971	0.780	IRS	0.959	1.000	CRS	1.000
1970-71	0.907	IRS	0.958	0.727	IRS	0.952	1.000	CRS	1.000
1971-72	1.000	CRS	1.000	0.781	IRS	0.981	1.000	CRS	1.000
1972-73	1.000	CRS	1.000	0.800	IRS	0.999	0.876	DRS	0.966
1973-74	0.807	IRS	0.998	0.844	IRS	0.980	0.971	DRS	0.971
1974-75	0.932	IRS	0.998	0.912	IRS	0.912	0.775	DRS	0.941
1975-76	0.896	IRS	0.999	0.952	IRS	0.979	0.767	DRS	0.882
1976-77	0.876	IRS	0.994	0.963	IRS	0.986	0.832	DRS	0.862
1977-78	0.925	IRS	0.996	0.906	IRS	0.999	0.828	DRS	0.828
1978-79	0.934	IRS	0.992	0.846	IRS	0.998	0.695	DRS	0.779
1979-80	0.963	IRS	0.994	0.853	DRS	0.999	0.613	DRS	0.772
1980-81	0.965	IRS	0.999	0.986	DRS	0.986	0.702	DRS	0.803
1981-82	1.000	CRS	1.000	1.000	CRS	1.000	0.804	DRS	0.822
1982-83	0.979	DRS	0.992	0.925	DRS	0.994	0.864	DRS	0.864
1983-84	0.992	DRS	0.992	0.792	IRS	0.975	0.722	DRS	0.829
1984-85	0.983	DRS	0.985	0.651	DRS	0.823	0.707	DRS	0.848
1985-86	1.000	CRS	1.000	0.732	DRS	0.743	0.627	DRS	0.898
1986-87	0.994	DRS	0.994	0.992	IRS	0.997	0.678	DRS	0.935
1987-88	0.969	DRS	0.974	1.000	CRS	1.00C	0.701	DRS	0.924
1988-89	0.940	DRS	0.998	0.898	IRS	0.996	0.816	DRS	0.922
1989-90	0.948	DRS	0.999	0.791	DRS	0.967	0.904	DRS	0.948
1990-91	1.000	CRS	1.000	0.793	DRS	0.966	0.855	DRS	0.970
1991-92	1.000	CRS	1.000	0.886	IRS	0.994	0.962	IRS	1.000
1992-93	1.000	CRS	1.000	0.931	IRS	0.999	1.000	CRS	1.000
Average	0.895		0.983	0.868		0.955	0.818		0.892

contd.

Table 8.16 (contd.)

Scale Efficiency and Returns to Scale in Two Digit Industries

(1960-61 to 1992-93)

Industry Group

	27			28			29		
Tear	TE	**RTS**	SE	TE	RTS	SE	TE	RTS	SE
1960-61	0.992	IRS	0.992	0.836	IRS	0.836	1.000	CRS	1.000
1961-62	1.000	CRS	1.000	0.850	IRS	0.850	0.916	IRS	0.971
1962-63	0.932	IRS	0.970	0.851	IRS	0.894	0.837	IRS	0.968
1963-64	0.968	IRS	0.995	0.865	IRS	0.910	1.000	CRS	1.000
1964-65	1.000	CRS	1.000	0.878	IRS	0.940	0.934	IRS	0.979
1965-66	1.000	CRS	1.000	0.980	IRS	0.980	0.910	IRS	0.995
1966-67	0.951	DRS	0.989	1.000	CRS	1.000	0.871	DRS	0.999
1967-68	0.894	DRS	0.997	0.992	CRS	1.000	0.984	IRS	0.988
1968-69	0.987	IRS	1.000	0.993	IRS	0.993	1.000	CRS	1.000
1969-70	0.984	DRS	0.997	0.961	IRS	0.998	1.000	CRS	1.000
1970-71	0.896	DRS	0.999	1.000	CRS	1.000	1.000	CRS	1.000
1971-72	0.993	IRS	0.996	0.936	DRS	0.999	0.940	DRS	0.995
1972-73	0.980	IRS	0.999	0.954	DRS	0.998	0.921	DRS	0.996
1973-74	1.000	CRS	1.000	0.991	DRS	0.995	0.901	DRS	0.955
1974-75	0.972	DRS	0.991	1.000	CRS	1.000	0.980	DRS	0.980
1975-76	0.952	DRS	0.991	0.996	IRS	0.996	0.985	DRS	0.994
1976-77	0.979	IRS	0.993	0.993	IRS	0.998	1.000	CRS	1.000
1977-78	0.975	IRS	0.998	0.997	IRS	0.999	1.000	CRS	1.000
1978-79	0.990	IRS	0.999	0.977	IRS	0.998	0.953	DRS	0.953
1979-80	0.969	DRS	0.982	0.942	DRS	0.991	0.960	DRS	0.973
1980-81	1.000	CRS	1.000	0.976	IRS	0.999	0.911	DRS	0.978
1981-82	0.897	DRS	1.000	1.000	CRS	1.000	0.931	DRS	0.981
1982-83	0.909	DRS	0.997	0.960	DRS	0.996	0.950	DRS	0.985
1983-84	0.869	IRS	0.994	1.000	CRS	1.000	0.949	DRS	0.987
1984-85	0.883	DRS	1.000	0.968	DRS	0.999	0.946	DRS	0.992
1985-86	0.858	IRS	0.998	0.931	DRS	1.000	0.894	DRS	0.988
1986-87	0.895	IRS	0.997	0.957	DRS	1.000	0.892	DRS	0.992
1987-88	0.924	IRS	1.000	0.979	DRS	0.994	0.968	DRS	0.968
1988-89	0.960	DRS	0.996	1.000	CRS	1.000	0.920	DRS	0.966
1989-90	0.924	DRS	0.990	1.000	CRS	1.000	0.944	DRS	**0.944**
1990-91	1.000	CRS	1.000	1.000	CRS	1.000	0.949	DRS	0.981
1991-92	1.000	CRS	1.000	1.000	CRS	1.000	0.978	DRS	0.992
1992-93	1.000	CRS	1.000	0.898	DRS	**0.949**	1.000	CRS	1.000
Average	0.956		0.996	**0.959**		**0.979**	**0.949**		**0.985**

contd.

Table 8.16 (contd.)

Scale Efficiency and Returns to Scale in Two Digit Industries

(1960-61 to 1992-93)

	Industry Group								
	30			31			32		
Year	TE	RTS	SE	TE	RTS	SE	TE	RTS	SE
1960-61	0.647	IRS	0.647	1.000	CRS	1.000	0.884	IRS	0.883
1961-62	0.651	IRS	0.651	0.944	IRS	0.958	0.891	IRS	0.932
1962-63	0.596	IRS	0.727	0.984	IRS	0.992	0.965	IRS	0.965
1963-64	0.547	IRS	0.774	1.000	CRS	1.000	0.973	IRS	0.973
1964-65	0.512	IRS	0.821	0.980	DRS	0.993	0.971	IRS	0.982
1965-66	0.518	IRS	0.840	0.964	DRS	0.988	0.979	IRS	0.987
1966-67	0.494	IRS	0.890	0.898	DRS	0.995	0.993	IRS	0.993
1967-68	0.490	IRS	0.889	0.876	DRS	0.992	0.961	IRS	0.996
1968-69	0.490	IRS	0.894	0.910	DRS	0.991	0.912	IRS	0.998
1969-70	0.508	IRS	0.908	0.887	DRS	0.991	1.000	CRS	1.000
1970-71	0.541	IRS	0.933	0.909	DRS	0.985	0.961	IRS	0.999
1971-72	0.594	IRS	0.939	0.923	DRS	0.991	0.944	IRS	1.000
1972-73	0.601	IRS	0.946	0.936	DRS	0.996	0.937	IRS	1.000
1973-74	0.716	IRS	0.947	0.906	DRS	0.986	0.967	IRS	0.998
1974-75	0.871	IRS	0.958	0.916	DRS	0.987	1.000	CRS	1.000
1975-76	0.867	IRS	0.953	0.881	DRS	0.989	0.906	IRS	0.999
1976-77	0.859	IRS	0.971	0.899	DRS	0.995	0.939	IRS	0.999
1977-78	0.916	IRS	0.985	0.945	DRS	0.995	1.000	CRS	1.000
1978-79	0.825	IRS	0.988	1.000	CRS	1.000	0.949	DRS	0.992
1979-80	0.899	IRS	0.997	0.973	DRS	0.986	0.969	IRS	0.999
1980-81	1.000	CRS	1.000	0.924	DRS	0.990	1.000	CRS	1.000
1981-82	1.000	CRS	1.000	0.946	DRS	0.995	1.000	CRS	1.000
1982-83	1.000	CRS	1.000	0.983	DRS	0.996	0.962	DRS	0.977
1983-84	0.913	DRS	1.000	1.000	CRS	1.000	0.907	DRS	0.977
1984-85	0.935	DRS	0.998	0.999	DRS	0.999	0.957	DRS	0.979
1985-86	1.000	CRS	1.000	0.972	DRS	0.991	0.947	DRS	0.986
1986-87	0.931	DRS	0.989	0.971	DRS	0.999	0.925	DRS	0.994
1987-88	0.918	DRS	0.969	0.977	DRS	0.997	0.937	DRS	0.992
1988-89	0.982	DRS	0.982	1.000	CRS	1.000	0.962	DRS	0.997
1989-90	0.825	DRS	0.857	1.000	CRS	1.000	0.983	DRS	0.997
1990-91	0.886	DRS	0.921	1.000	CRS	1.000	1.000	CRS	1.000
1991-92	0.924	DRS	0.933	0.955	IRS	0.994	1.000	CRS	1.000
1992-93	0.960	DRS	0.960	0.953	DRS	0.990	0.994	DRS	0.996
Average	0.770		0.917	0.952		0.993	0.960		0.988

contd.

Table 8.16 (contd.)

Scale Efficiency and Returns to Scale In Two Digit Industries

(1960-61 to 1992-93)

Industry Group

	33			34			35		
Tear	TE	RTS	SE	TE	RTS	SE	TE	RTS	SE
1960-61	1.000	CRS	1.000	0.942	IRS	0.942	1.000	CRS	1.000
1961-62	1.000	CRS	1.000	0.942	IRS	0.956	0.946	IRS	0.946
1962-63	0.864	DRS	0.988	0.970	IRS	0.979	0.931	IRS	0.967
1963-64	0.927	DRS	0.974	0.997	IRS	0.999	0.982	DRS	0.996
1964-65	1.000	CRS	1.000	1.000	CRS	1.000	0.964	IRS	0.991
1965-66	0.900	DRS	0.993	1.000	CRS	1.000	0.930	IRS	0.985
1966-67	0.933	DRS	0.996	0.965	IRS	0.996	0.845	IRS	0.980
1967-68	0.861	IRS	0.998	0.973	IRS	0.997	0.812	IRS	0.979
1968-69	0.841	IRS	0.999	0.976	IRS	0.989	0.803	IRS	0.997
1969-70	0.859	IRS	1.000	0.979	IRS	0.999	0.898	IRS	0.998
1970-71	0.875	IRS	0.999	0.944	IRS	1.000	0.898	DRS	0.991
1971-72	0.889	DRS	0.993	0.922	DRS	0.983	0.891	DRS	0.993
1972-73	0.898	DRS	0.977	0.936	DRS	0.981	0.800	IRS	0.990
1973-74	0.823	DRS	0.976	0.970	IRS	0.999	0.897	IRS	0.992
1974-75	0.964	DRS	0.997	0.967	IRS	0.992	0.956	IRS	0.981
1975-76	0.898	DRS	0.980	0.953	IRS	0.990	0.897	IRS	0.992
1976-77	0.867	DRS	0.992	0.964	IRS	0.999	0.987	IRS	0.998
1977-78	0.952	DRS	0.986	0.939	IRS	0.999	0.991	IRS	0.998
1978-79	0.946	DRS	0.966	0.968	IRS	0.999	1.000	CRS	1.000
1979-80	0.914	DRS	0.989	1.000	CRS	1.000	0.975	IRS	1.000
1980-81	1.000	CRS	1.000	0.955	DRS	1.000	1.000	CRS	1.000
1981-82	1.000	CRS	1.000	1.000	CRS	1.000	1.000	CRS	1.000
1982-83	0.988	DRS	0.988	1.000	CRS	1.000	1.000	CRS	1.000
1983-84	0.874	DRS	0.974	0.968	IRS	0.997	0.946	DRS	0.999
1984-85	0.847	DRS	0.934	0.996	IRS	0.996	1.000	CRS	1.000
1985-86	0.874	IRS	0.999	0.972	DRS	0.996	0.983	IRS	0.995
1986-87	0.888	DRS	0.997	1.000	CRS	1.000	0.942	IRS	0.985
1987-88	0.880	DRS	0.996	1.000	CRS	1.000	0.950	IRS	0.993
1988-89	0.954	DRS	0.995	1.000	CRS	1.000	0.964	DRS	1.000
1989-90	0.988	DRS	0.995	0.969	DRS	0.992	1.000	CRS	1.000
1990-91	1.000	CRS	1.000	0.970	DRS	0.986	1.000	CRS	1.000
1991-92	0.981	IRS	0.987	1.000	CRS	1.000	0.968	IRS	1.000
1992-93	1.000	CRS	1.000	0.984	DRS	0.984	0.976	DRS	0.976
Average	0.924		0.990	0.973		0.992	0.943		0.992

contd.

Table 8.16 (contd.)

Scale Efficiency and Returns to Scale in Two Digit Industries

(1960-61 to 1992-93)

Industry Group

Tear	36			37			38		
	TE	RT8	SE	TE	RTS	SE	TE	RTS	SE
1960-61	0.708	IRS	0.708	0.957	IRS	0.957	0.902	IRS	0.902
1961-62	0.716	IRS	0.734	1.000	CRS	1.000	0.915	IRS	0.987
1962-63	0.669	IRS	0.779	0.961	IRS	0.996	0.998	IRS	0.998
1963-64	0.666	IRS	0.823	0.961	IRS	0.992	1.000	CRS	1.000
1964-65	0.634	IRS	0.864	0.986	IRS	0.986	0.917	IRS	0.997
1965-66	0.651	IRS	0.877	1.000	CRS	1.000	0.915	IRS	0.989
1966-67	0.627	IRS	0.911	0.974	IRS	0.997	0.931	IRS	0.986
1967-68	0.629	IRS	0.921	0.938	IRS	0.989	0.848	DRS	0.965
1968-69	0.642	IRS	0.928	0.930	IRS	0.999	0.840	DRS	0.954
1969-70	0.664	IRS	0.935	0.975	IRS	0.999	0.994	DRS	0.994
1970-71	0.686	IRS	0.952	0.970	IRS	0.995	0.872	DRS	0.982
1971-72	0.692	IRS	0.952	0.981	IRS	0.994	0.806	IRS	0.975
1972-73	0.729	IRS	0.953	0.968	IRS	0.997	0.790	IRS	0.929
1973-74	0.760	IRS	0.956	0.975	IRS	0.992	0.776	IRS	0.928
1974-75	0.792	IRS	0.963	0.973	IRS	0.991	0.862	IRS	0.937
1975-76	0.763	IRS	0.972	0.930	IRS	0.976	0.847	IRS	0.925
1976-77	0.794	IRS	0.978	1.000	CRS	1.000	0.865	IRS	0.915
1977-78	0.818	IRS	0.982	0.993	IRS	0.993	0.826	IRS	0.905
1978-79	0.854	IRS	0.987	0.982	IRS	0.982	0.937	IRS	0.957
1979-80	0.851	IRS	0.987	0.915	IRS	0.981	0.897	IRS	0.899
1980-81	0.932	IRS	0.984	0.929	IRS	0.996	0.897	IRS	0.916
1981-82	0.959	IRS	0.986	0.923	DRS	0.994	0.933	IRS	0.937
1982-83	1.000	CRS	1.000	0.976	IRS	1.000	0.968	IRS	0.968
1983-84	1.000	CRS	1.000	0.993	IRS	0.995	0.950	IRS	0.979
1984-85	0.986	DRS	0.992	1.000	CRS	1.000	0.944	IRS	0.986
1985-86	0.940	IRS	1.000	0.962	IRS	0.996	1.000	CRS	1.000
1986-87	0.953	IRS	1.000	0.985	IRS	0.991	0.892	DRS	0.976
1987-88	1.000	CRS	1.000	0.979	IRS	0.993	0.939	DRS	0.994
1988-89	1.000	CRS	1.000	0.969	IRS	0.994	0.884	DRS	0.947
1989-90	1.000	CRS	1.000	0.984	IRS	0.997	1.000	CRS	1.000
1990-91	1.000	CRS	1.000	1.000	CRS	1.000	0.944	DRS	0.980
1991-92	0.969	IRS	1.000	0.966	DRS	0.997	0.994	DRS	0.994
1992-93	1.000	CRS	1.000	1.000	CRS	1.000	1.000	CRS	1.000
Average	0.821		0.943	0.971		0.993	0.912		0.964

82, this industry has IRS. In 1960-61 and 1964-65, scale inefficiency is a major source of inefficiency. In the remaining years, till 1979-80, when TE was low, improving scale efficiency could still lead to an increase in output although scale inefficiency as a source of output loss decreases in importance.

Average TE in Other Manufacturing Industries (38) for the entire period is 91.2%. Constant returns to scale is seen in four years. Low TE between 1967-68 to 1977-78 is also noticed. In 1960-61, scale inefficiency accounted for a major proportion of lost output. It is also important from the mid-1970's to 1983-84.

8.4 Conclusions:

This chapter has demonstrated the use of the nonparametric linear programming production frontier approach used to obtain capacity utilization estimates to the measurement of input utilization rates as well as to the measurement of scale efficiency and the determination of returns to scale. From the results on plant capacity utilization, it is possible to extend the model to include the calculation of the input utilization rates for the variable factors of production. These variable inputs are labor, energy and intermediate inputs. By a simple extension of the model, a measure of scale efficiency can be obtained and it is possible to then determine if inefficiency is due to increasing returns (IRS) or decreasing returns (DRS) or whether efficiency prevails (CRS).

Given that there is underutilization of capacity, the input utilization rates reveal the limitations imposed by variable input constraints given capital stock in achieving the maximum plant capacity output. The results on input utilization rates for the three variable inputs- labor, energy and intermediate materials input reveal a number of interesting facts. Labor utilization rates have varied in a high range. From very high levels of INUTL in the early sixties in many industries when it was greater than unity, INUTL rates declined to very low levels by the early 1990's with INUTL rates being far less unity i.e. the level required for optimal plant capacity output. However in industries like Wool and Silk Textiles, Jute Textiles, Rubber, Plastic, Petroleum and Coal and Electrical Machinery average input utilization rates for the entire period is grater than unity. INUTL rates in the early 1990's are the highest in Electrical Machinery and lowest in Chemicals.

In fact, the least fluctuation is shown by the input utilization rates for energy - INUTE. The average INUTE for the entire period is greater than unity in Wool and Silk Textiles, Rubber, Plastic, Petroleum and Coal, and Electrical Machinery. Rubber, Plastic, Petroleum and Coal shows fairly high INUTE rates particularly since 1989-90. Low INUTE is also observed in Chemicals since 1989-90. Non Electrical Machinery had among lowest INUTE rates by the early 1990's.

Materials input utilization rates shows greater fluctuation as well as wide range of variation although not as high as INUTL. Beverage and Tobacco and Cotton Textiles had the low INUTM rates by the early 1990's while average INUTM for the period of study is greater than unity only in Textile Products. A sharp drop in INUTM rates in Rubber, Plastic , Petroleum and Coal is seen after 1989-90 and a sharp increase in INUTM rates in Chemicals after 1989-90 is also clear.

Also, decreasing trend in INUTL for all Process and Use based classifications is also observed. Among Process-based industries Metal-based industries had lowest average INUTL while Consumer Durables had lowest average INUTL by early 1990's in the Use-based classification.

INUTE rates on the other hand show an increasing trend in Chemical-based industries. Mineral-based and Metal-based industries show higher average INUTE in the early 1990's as compared to 1980's. Again, in the Use-based classification, Consumer Durables show lowest INUTE in 1990's while INUTE in Consumer Non-durables is much higher. Basic and Intermediates goods had high INUTE - close to unity as compared to Capital Goods.

All industry groups in the Process and Use based categories show average INUTM less than unity pointing to the significance of intermediate materials shortages. In all industries groups average INUTM declined from the 1960's through the 1970's and 1980's but increased in the early 1990's. Chemical based industries showed increasing INUTM rates through all decades.

The estimates of technical or productive efficiency (PE/TE) show improved efficiency in a number of industries since 1980's and particularly in early 1990's near efficient production is seen in a large number of industries. Electrical Machinery shows an increasing trend in TE over the study period from low TE levels in 1960's to TE levels of nearly 100% from early 1980's. Similarly Rubber, Plastic, Petroleum and Coal shows increasing TE trend and 100% TE in early

1980's but a slight decline in late 1980's and higher levels in 1990's. Beverages and Tobacco had lowest TE levels in the early 1990's among all two digit industry groups with a steadily declining trend since the 1960's. TE in 1992-93 in this industry was only 77.3%, Scale inefficiency accounts for a major part of technical inefficiency in this industry which was charachterized by inefficiency of DRS kind for a better part of the study period. Low TE in Textile Products in early 1960's is also due to scale inefficiency of IRS type. Again, since 1974-75 this industry is charachterized by low TE but scale inefficiency of DRS is quite significant but does not account for the full amount of the loss in potential output. Low TE in Rubber, Plastic, Petroleum and Coal in the early 1960's is also noticed. Scale inefficiency accounts for a major part of this inefficiency but declining TE is also accompanied by declining scale efficency implying that sacle inefficency was decreasingly important in explaining output loss. IRS charachterized this industry until the 1980's. Since then scale inefficiency of DRS type accounted for output loss in this industry. In Electrical Machinery, low TE in the 1960's is due to scale inefficency of the IRS kind although scale inefficiency is decreasingly important in accounting for output loss. In a few industries like Food Products, Wool and Silk Textiles and Jute Textiles scale inefficiency is not very important in accounting for loss of potential output.

CHAPTER 9

SUMMARY AND CONCLUSIONS

A number of empirical studies in India have focussed on industrial growth rates, total factor productivity etc. However, a measure of the performance of the industrial sector - capacity utilization (CU), is rarely assessed. This, despite the fact that utilizing productive capacity created is of crucial concern in a capital scarce economy like India.

The overall framework of planning in India has been to stress too much on capital accumulation. Too little emphasis has been made on the efficiency with which capital is utilized. The industrial and trade policy framework as it has evolved over time has led to a number of biases in the economy. The overemphasis on capital accumulation and subsidization of capital has led to excessive investment in capital. At the same time the availability of other factors of production was restricted for a number of reasons. The result was that these biases led to an inefficient utilization of resources in the economy. The overall result has been a failure to exploit the tremendous potential for industrial development that exists in productive capacity already created. The existence and persistence of large underutilized capacity is a major problem which necessitates the serious attention of researchers.

The main reason for the relative lack of studies on capacity utilization is the serious problem that arises in defining the term 'capacity'. Capacity utilization is usually defined as the ratio of actual to potential output. But 'potential output' is an elusive concept and depending on the definition chosen, various measures of CU are available in the literature.

A review of the alternative measures of CU shows that many of the earlier measures of CU are ad hoc in nature. Statistical constructs based either on output indices or data on installed capacity and actual output have been popular in the literature. The present study shows the importance of deriving CU measures based on an explicit theory of costs or production. Such measures are closely related to an economic notion of capacity. They are thus more economically meaningful and interpretation of the movement in trends of CU can also be analyzed with respect to economic indicators. In particular, two different approaches to the measurement of CU which are theoretically superior have been used in a number of studies in recent years.

The first approach for deriving economic measures of CU involves the econometric estimation of the cost function to determine optimal capacity output. Recent developments in the theory of duality enable the specification and estimation of a cost function. Based on data on costs, output and input prices two different definitions of potential output have been suggested. These correspond to the output at which shortrun average cost curve reaches the minimum and the output at which longrun and shortrun average cost curves are tangent.

Empirical applications of these economic measures of CU is given in a number of studies by Morrison (1985,1986 etc.), Berndt and Hesse (1986), Nelson (1989) and others. These measures of CU span both sides of unity unlike traditional measures which are always less than unity. The estimates of CU obtained for the DCs proved to be very useful in capturing the effect of energy price shocks of the 1970's. In particular, the impact of the two energy price hikes of the early 1970's and late 1970's is reflected in lower CU levels during the 1970's. Also, the theoretical framework can be used to assess the impact of variable input prices and output demand on CU. Excess capacity or under utilization of capacity can be attributed to changing economic circumstances in the form of changing output demand and input prices variations.

The other approach to estimation of CU is based on the use of linear programming (LP) techniques to fit a nonparametric production frontier about input-output observations. This approach can be seen as an alternative to using econometric techniques to fit a parametric cost function between cost-output observations. The calculated production frontier reveals the relationship between efficient production and inputs and provides information on plant capacity and utilization, In recent years, this approach has been widely used in the literature by Fare (1984), Fare, Grosskopf and Grabowski (1985), Fare, Grosskopf and Kokkenlenberg (1989) and others.

The major advantage of the nonparametric linear programming approach is that it provides an alternative to the parametric cost-minimizing framework. While numerous empirical studies based on flexible functional forms have been published, a number of practical problems arise. These relate to the choice of an appropriate functional form for the cost function to describe the industry at the aggregate level, the existence of sufficient observations to enable the efficient estimation of parameters of the cost function, the availability of reliable data on input prices etc. Also numerical computation of CU estimates faced problems of convergence especially if curvature conditions are close to being violated (as in the study by Berndt and Hesse, 1986).

In the current study, the measures of capacity utilization are based on observed best practice performance in a given industry. Optimal capacity is obtained from the frontier production function. Thus, in this study, plant capacity and a measure of utilization of this capacity can be determined from data on observed inputs and output. These measures are calculated as solutions to linear programming problems and are similar to efficiency measures as given by Farrell (1957).

The notion of capacity used is the maximum amount that can be produced per unit of time with the existing plant and equipment provided that the availability of variable factors of production is not restricted. Plant capacity defined in this manner is closely related to the economists notion of a short run production function rather than the more commonly used cost framework and thus provides an alternative when information on input prices is unreliable or unavailable. Also, as the construction of frontier production function is based on the technical relationship of factor inputs and output i.e. production function and resource constraint, the optimal capacity based on this approach is realistic. A major advantage of this approach is also that it does not require the researcher to arbitrarily choose a particular functional form. Rather this method envelops the observed data points and 'reveals' the technology as practiced in the industry.

Thus, while measures of CU derived in either the theory of costs or production are superior, a review of studies on CU for Indian industry reveals the limited nature of studies. The studies which are available are traditional measures, based on data on installed capacity and actual production obtained from the Monthly Statistics of Production or are statistical constructs using data from official Index Number of Industrial Production. None of the studies use an explicit theory of costs or production to obtain CU estimates.

The study by Padma Suresh (1991) used the econometric approach to the estimation of cost function to obtain trends in CU for the engineering industry for the period 1960-61 to 1982-83. The CU measures spanned both sides of unity and low correlations between traditional measures and economic CU measures point to the importance of deriving CU measures in a meaningful manner. The fact that economic measures of CU were closer to unity suggests that actual output levels are determined by cost considerations. The traditional measures reveal significant underutilization of capacity since they do not take input prices and thus cost considerations into account.

In the present study which is based on the nonparametric linear programming approach, the basic data source is the Annual Survey of Industries (ASI). The data pertain to the two digit ASI classification of the Factory Sector for the period 1960-61 to 1992-93. Eighteen two digit industries in the registered manufacturing sector which account for over 85% of industrial sector value added are included in the study. The study excludes two digit industry groups corresponding to electricity, gas, water works, cold storage and repair works. The data base itself has a number of weaknesses as pointed out in *Chapter* 5. The long time period covered by the study poses additional problems of the consistency and comparability of the different series over time. In interpreting the results it is necessary to keep in mind the limitations posed by the data sources.

In this chapter, a summary of some of the main issues relating to the analytical framework adopted in the present study, the conclusions reached and the policy implications are now given.

(1) The analytical framework adopted in the present study is a nonparametnc one, which is based on the use of linear programming approach to construction of best practice frontier technology based on inputs and outputs.

(2) The notion of 'capacity' used in the study is an economic notion of maximum plant capacity output as given by Johansen (1968). This output is the maximum output that can be obtained from given plant and equipment provided the availability of variable factors of production is not restricted.

(3) The study thus uses an alternative framework which is based on a thereotically superior notion of capacity rather than relying on statistical constructs which have been the basis of most empirical studies on CU in India.

(4) The present study is also comprehensive in terms of coverage of industries as well as time period. Eighteen industry groups of the two digit classification of the Annual Survey of Industries are included in the study which covers the period from 1960-61 to 1992-93. In the current study, three different estimates of capacity utilization are obtained based on the linear programming solutions of

the frontier production framework. The first measure, (CAPUT) is obtained as the ratio of actual output to maximum plant capacity output. The second measure of CU (denoted by PCU) is obtained as the ratio of maximum output obtained from given factors of production to maximum plant capacity output. This measure is obtained with the assumption of CRS while the third measure, PCUVRS, is a PCU measure obtained with the assumption of variable returns to scale.

(5) From the trends in CAPUT rates, the study points to a declining trend in a majority of the industry groups. From fairly high utilization rates in the early 1960's, a number of industries had low CAPUT rates of less than 60% in 1992-93. Beverages and Tobacco (39.1%), Leather and Leather Products (44.5%) and Jute, Hemp and Mesta Textiles (45.8%) had very low utilization rates by the early 1990's. Such low utilization rates imply a significant cost to the economy in terms of a high cost of capital.

(6) The study also shows that on an average, PCU rates (the second measure of capacity utilization) were higher than CAPUT rates. Since PCU rates are adjusted for inefficiency, these estimates are higher than CAPUT rates. Beverages and Tobacco had lowest PCU (among all industry groups) of slightly over 40% in the early 1990's. Average PCU over the entire period was more than 90% in the case of Non Metallic Mineral Products and Wool and Silk Textiles.

(7) PCU rates with variable returns to scale assumption are higher than PCU and CAPUT rates. Fourteen of the eighteen industries had high average PCUVRS of over 90% while Other Manufacturing Industries had lowest average PCUVRS of 79.2%.

(8) From an analysis of the trends in CU rates according to different time periods corresponding to the debate on structural retrogression, the trends in PCUVRS in thirteen of the industry groups show a drop in utilization rates during the period of industrial retrogression (1965-66 to 1979-80) and an increase in utilization rates from the early 1980's. The second measure of capacity utilization, PCU shows that except in two industry groups (Textile Products and Rubber, Plastic and Petroleum and Coal), all other industry groups show a continuous declining trend in PCU rates till the early 1990's. But considering the 1990's separately, eight industry groups show increased utilization in PCU rates in the early 1990's. CU rates obtained from the CAPUT estimates show a continous declining trend in eleven of the eighteen industry groups in the study.

(9) A comparison from Process and Use Based classification shows that Capital Goods industries (CAPUT rates) show increasing utilization since the early 1980's. Chemical based industries also show increased utilization in the 1970's and 1980's. In the early 1990's, Metal based industries (48.3%) had lowest utilization rates. Consumer goods (57%) and particularly Consumer Non durables (50.2%) had low utilization rates in the early 1990's.

(10) In addition, the linear programming approach is also used to obtain a measure of technical or productive efficiency and to see whether technical inefficiency is due to suboptimal scale and then to determine the nature of scale economies i.e. whether decreasing or increasing or constant returns to scale prevail in the different industry groups over time. The estimates of technical efficiency show improved efficiency in a number of industries since 1980's and

particularly in the early 1990's, near efficient production is seen in a large number of industries. Beverages and Tobacco had lowest TE levels in the early 1990's among all two digit industry groups with a steadily declining trend since the 1960's. In thirteen of the eighteen industry groups, TE levels were highest in the early 1990's while seven of them had almost full or full efficient production. TE in this industry group was only 77.3% in 1992-93. Scale efficiency accounted for a major part of technical inefficiency in this industry which was charachterized by inefficiency of decreasing returns to scale kind for a better part of the study period. In a few other industry groups like Textile Products, Rubber, Plastic, Petroleum and Coal and Electrical Machinery, scale inefficiency accounted for a major part of the loss in potential output.

(11) The study also shows that since technical efficiency estimates are higher than capacity utilization estimates, this implies that existing factors of production were utilized efficiently but shortages in the availability of variable factors of production were responsible for underutilization of productive capacity. Thus capital installed could not be utilized fully due to the limitations in the availability of variable factors of production. This implies a high cost to society and to producer's, particularly in a capital scarce economy like India.

(12) In the study, trends in capacity utilization are analyzed in terms of non-availability of factors of production. The estimated input utilization (INUT) rates for the variable inputs namely, labor, energy and intermediate materials reveal interesting insights. Given that there is underutilization of capacity, the input utilization rates reveal the limitations imposed by variable input constraints in achieving

maximum plant capacity output. The study shows that labor utilization rates declined from very high levels in the early 1960's (from values greater than unity in many industries) to very low levels in the early 1990's. This means that the utilization of labor was far less than that required for optimal plant capacity output. This is in agreement with a number of studies which have highlighted the decreasing employment intensity in Indian industries. Ahluwalia (1990) also points to the fact that organized industry in India is moving towards the use of contract labor to avoid the problems of dealing with trade unions. In such a context the slow growth of employment reflects the situation where not all employment is recorded on the payroll. The least fluctuation in input utilization rates is in the case of the factor of production -energy. In the case of materials, input utilization rates show a great fluctuation and a wide range of variation pointing to significant shortages in intermediate materials in the Indian economy. All Process and Use based categories show average INUTM less than unity pointing to significance of shortages in intermediate inputs availability.

The results obtained in the present study show the importance of obtaining capacity utilization estimates in an economic theroetical framework. The methodology adopted in the study brings out the limitations in input availabilities in restricting the use of productive capacity installed in the industrial sector. But, factors other than supply bottlenecks are important in explaining the underutilization of capacity. Demand factors are also crucial in explaining why installed capacity is not fully utilized. An analysis at a more disaggregate level (e.g.plant level) would perhaps be more useful in identifying the determinants of utilization.

APPENDIX

Table 1 - Two Digit Industry Groups

NIC code	Industry Name
20-21	Manuf. of Food Products
22	Manuf. of Beverages,Tobacco and Tobacco Products
23	Manuf. of Cotton Textiles
24	Manuf. of Wool,Silk and Synthetic Fibre Textiles
25	Manuf of Jute,Hemp and Mesta Textiles
26	Manuf. of Textile Products
27	Manuf. of Wood and Wood Products,Furniture and Fixtures
28	Manuf. of Paper and Paper Products,Printing and Publishing
29	Manuf of Leather and Leather and Fur Products
30	Manuf of Rubber, Plastic, Petroleum and Coal Products
31	Manuf of Chemical and Chemical Products
32	Manuf of Non Metallic Mineral Products
33	Manuf. of Basic Metals and Alloys
34	Manuf. of Metal Products and Parts
35	Manuf. of Non Electrical Machinery
36	Manuf of Electrical Machinery
37	Manuf. of Transport Equipment
38	Other Manufacturing Industries

Table 2- Percentage Share in Net Value Added (NVA) for Major Industry Groups Arranged in Descending Order of NVA

NIC Code	Industry Name	% share in NVA
40	Electricity	13.12
31	Chemical and Chemical Products	12.48
33	Basic metals	10.13
35	Non Electrical Machinery	8.01
30	Rubber, Plastic, Petroleum and Coal	7.99
20-21	Food Products	7.63
37	Transport Equipment	6.54
36	Electrical Machinery	6.39
23	Cotton Textiles	6.28
32	Non Metallic Minerals	4.80
24	Woolen Textiles	3.51
28	Paper and Printing and Publishing	2.73
34	Metal Products	2.26
22	Beverages and Tobacco	1.94
38	Other Manuf Industries	1.66
97	Repair Services	1.33
25	Jute and Mesta Textiles	1.04
26	Textile Products	0.96
29	Leather and Leather Products	0.57
27	Wood and Wood Products	0.42
74	Cold Storage	0.12
42	Water Works	0.08
41	Gas	0.01
All Industries		100.00

Source: ASI, 1985-86

Table 3- Process and Use Based Classification of Two Digit Industry Groups

	Process Based Classification	
1.	**Agro-based industries**	**20-21,22,23,24,25,26,27,28**
2.	**Mineral-based industries**	**32**
3.	**Metal-based industries**	**33,34**
4.	**Chemical-based industries**	**30,31**
5.	**Machinery-based industries**	**35,36,37**
6.	**Miscellaneous industries**	**29,38**
	Use Based Classification	
1.	Basic and Intermediate Goods industries	23,24,25,28,29,30,31,32,33,34
2.	Capital goods industries	35,36,37
3.	Consumer goods industries	20-21,22,26,27,38
(a)	Durables	27,38
(b)	Non Durables	20-21,22,26

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