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 unambiguous 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
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 twenty-three 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.