Chapter 1

Statement of the Problem

1.1 Introduction

Most of the business units today face an irritatingly limited supply of resources and face persistent competition. This has led to a significant emphasis on the efficient utilization and allocation of on-hand resources in a unit. Productivity generally indicates a unit's efficiency in converting physical inputs to physical outputs and is an important index of its performance. Enhancing productivity is an effective means for a firm to survive and prosper in a competitive economy.

From the standpoint of planning the utilization of resources, productivity management based on an inter-period comparison of productivity is considered to be an important tool [230]. Similarly, a unit's relative productivity in the industry is a significant determinant of its competitive position. The firm's management, therefore, needs to not only know its productivity *per se*, but also understand the properties of interfirm differences in productivity so as to appraise its competitive position in the industry and to appreciate its weakness in utilizing and allocating resources. The comprehension of this weakness can help the management to correctly guide the firm towards the best

utilization of resources. This thesis is devoted to estimating productive performance of decision making units (DMUs) in the manufacturing sector, using the technique of Data Envelopment Analysis (DEA).

In a competitive environment industrial firms must continuously improve their productivity to sustain their long-term growth and productivity. The information content of direct measures of productivity is valuable partly because productivity performance cannot be unambiguously inferred from financial results. For example, favourable measures of financial performance can obscure lags in productivity. Economic enterprises may temporarily survive, even prosper, through clever marketing, financial manipulations, or due to favourable external conditions. For the longer term, however, continuous improvements in productivity are essential for the firms' financial viability and success. This is particularly true in industrial operations, where important technical changes are frequent, and competition is intense. Productivity measurement and analysis can thus play an important role in strategic planning and competitive analysis [221].

Productivity change encompasses the effect of technical change, efficiency change, and scale change. Measurement of contributions of these components to total productivity changes is very useful for production management, for example, for decision makers to estimate productivity improvement achievable solely through reduction in wastefulness (technical efficiency) without resorting to new technology or large scale of production. Estimates of productivity improvements attributable to technical change are useful in assessing the maximum benefits derivable from introducing new technologies. Likewise, measurements of the productivity effects of changes in the scale of manufacturing are helpful in planning plant size.

Estimation of productivity and its individual components - technical change, technical efficiency, and scale efficiency - is a subject today of interest and is important to both the economic theorists and the economic policy makers. The basis and the underlying the-

oretical arguments for increasing the relative productivity of different Decision Making Units (DMUs) are being increasingly subjected to questions and to empirical tests. It is, therefore, essential to be able to make an accurate measurement of productivity and its components. Such measures help the industries to attempt to exploit the advantage of scale economies, achieve efficiency, and to strengthen their competitive positions.

1.2 Importance and Motivation of Using DEA

Evaluation of productivity/efficiency of production units using cross-sectional data and frontier methods is becoming a major managerial activity. Managers directing or carrying out this work are faced with a choice between two major approaches to frontier estimation. These approaches are (1) econometric methods and (2) Farrell frontier methodology (or Data Envelopment Analysis) and among several variations of each. The econometric approach to estimating efficiency frontiers assumes, for the underlying production technology, an explicit functional form along with a two-part error term. One part is the noise that is generally assumed to follow a normal distribution, and the other part represents inefficiency which is assumed to follow a one-sided distribution such as half-normal, exponential, truncated normal, or gamma distribution [3, 4, 114, 218]. The parameters of the production frontier are estimated using regression techniques, and the residuals are decomposed into a random component and an inefficiency component. In contrast, DEA, originally pioneered by Charnes *et al.* [52], does not require any underlying assumptions for the functional form of the production technology, but it enables one to obtain extremal relations such as the production functions and/or efficient production possibility surfaces. The advantage of DEA lies in its approach. DEA optimises for each individual observation whereas a single optimisation is performed in a statistical regression for the whole set of observations. Instead of trying to fit a regression plane through the centre of the data, DEA floats piecewise linear/Cobb-Douglas (log-linear) surface to rest on the top of the observations due to which it is able to uncover such