CHAPTER – II
DATA-BASE & METHODOLOGY
2.1 DATABASE

The basic data for the present study entitled "Some aspects of productivity trends in manufacturing industries of Andhra Pradesh" are extracted from the Annual Survey of Industries – Summary Results for Factory sector. The present study covers the period from 1979-80 to 1997-98. Keeping in view of the objectives of the study the Time series data on Fixed capital, Number of employees, Number of workers, Total persons engaged, Wages to workers, Total emoluments, Gross value added and Managerial resources for the selected industry groups of Andhra Pradesh are employed for the analysis.

Number of Factories

Registered Factory is one which is registered under sections 2m(I) and 2m(ii) of the Factories Act, 1948. The sections 2m(I) and 2m(ii) refer to any premises including the precincts there of (a) whereon ten or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on with the aid of power, or is ordinarily carried on so; or (b) whereon twenty or more workers are working or were working on any day of the preceding twelve months and in any part of which a manufacturing process is being carried on without the aid of power, or ordinary carried on so.

Fixed Capital

Fixed capital represents the depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. Fixed assets are those which have a normal productive life of more than one year. Fixed capital covers all types of assets, new or used or own constructed, deployed for production, transportation,
living or recreational facilities, hospitals, schools, etc., for factory personnel. It includes the fixed assets of the head office allocable to the factory and also the full value of assets taken on hire-purchase basis (whether fully paid or not) excluding interest element. It excluded intangible assets and assets solely used for the post manufacturing activities such as sale, storage, distribution, etc.

Workers

Workers are defined to include all persons employed directly or through any agency whether for wages or not, and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process or in any other kind of work incidental to or connected with the manufacturing process or subject of the manufacturing process. Labor engaged in the repair and maintenance or production of fixed assets for factory's own use or labor employed for generating electricity or producing coal, gas etc. is included. However, persons holding positions of supervision or management or employed in administrative office, store keeping section and welfare section, sales department as also those engaged in the purchase of raw-materials etc., and in production of the fixed assets for the factory and watch and ward staff are excluded.

Employees

Employees include all workers defined above and persons receiving wages and holding clerical or supervisory or managerial positions or engaged in administrative office, store keeping section and welfare section, sales department as also those engaged in purchase or raw-materials etc. or production of fixed assets for the factory and watch and ward staff.
The number of workers or employees is an average number per working day (days on which the manufacturing process was carried on). It is calculated by adding, for each category, persons attending and on leave with pay (including those on strike but excluding those on unlimited leave, leave without pay) in each shift over all the shifts worked on all days (working and non-working) and dividing the result by the number of days on which the manufacturing process was carried on.

**Total persons engaged**

Total persons engaged relate to all persons engaged by the factory whether for wages or not, in work connected directly or indirectly with the manufacturing process and include all administrative, technical, clerical staff as also labour engaged in production of capital assets for factory’s own use. This is inclusive of persons holding supervisory or managerial positions or engaged in administrative office, store keeping section and welfare section, sales department as also those engaged in the purchase of raw materials etc., and production of fixed assets for the factory and watch and ward staff. It also includes all working proprietors and their family members who are actively engaged in the work of the factory even without any pay and the unpaid members of the co-operative societies who worked in or for the factory in any direct and productive capacity.

**Wages**

Wages are defined to include all remuneration capable of being expressed in monetary terms and also payable more or less regularly in each pay period to workers (defined above) as compensation for work done during the accounting year. It includes (a) direct wages and salary (i.e., basic wages / salaries, payment of
overtime, dearness, compensatory, house rent and other allowances): (b) remuneration for the period not worked (i.e., basic wages, salaries and allowance payable for leave period, paid holiday, lay-off payments and compensation for unemployment, if not paid from sources other than employers): (c) bonuses and ex-gratia payment paid both at regular and less frequent intervals (i.e., incentive bonuses, good attendance bonuses, productive bonuses, profit sharing bonuses, festival or year-end bonuses etc.). It excludes lay-off payments, which are made from trust, or other special funds set up explicitly for this purpose i.e., payments not made by the employer. It also excludes imputed value of benefits in kind, employer contribution to old age benefits and other social security charges, direct expenditure on maternity benefits and crèches and other group benefits. Travelling and other expenditure incurred for business purposes and reimbursed by the employer are excluded. The wages are expressed in terms of gross value i.e., before deduction for fines, damages, taxes provident fund, employee's state insurance contribution etc.

**Total emoluments**

Total emoluments can be defined in the same way as wages as defined above, but paid to all employees plus imputed value of benefits in kind i.e., the net cost to the employer on those goods and services provided to employees free of charge or at markedly reduced cost which are clearly and primarily of benefits to the employees as consumers.

**Managerial resources**

Managerial resources is estimated as 'the persons who perform and primarily involved in managing risk and uncertainty bearing, planning and innovation,
coordination, administration and control and routine supervision of an enterprise'.

The other people employed in the enterprise, who do not perform these functions, will be referred as labor resources.

REFERENCE : Annual Survey of Industries reports published by CSO of various issues.

2.2 DEFLATORS

Since the data collected are at current prices, the estimates at constant prices (1981-82 prices) are derived as fixed capital is deflated by the composite price index of machinery (electrical and non-electrical) and transport equipments. Gross value added and output is deflated by whole sale price index of industrial production, wages and total emoluments to employees are deflated by consumer price index of industrial workers.

The price indices are taken from the various issues of Reserve Bank of India (RBI) Bulletins.

The consumer price index (General) for industrial workers are collected from http://labourbureau.nic.in/indtab.html

2.3 METHODOLOGY

Commonly the term productivity is confused with the term production. Most of the people think that if the production is more the productivity is also more. This is not necessarily true. Production is concerned with the activity of producing goods/or services, where as productivity is concerned with the efficient utilization of resources (inputs) in producing goods and/or services.
Whatever the concept may be, the production function is central to all discussions of productivity. Although some studies in productivity do not make an explicit use of it, the conceptual link between productivity and production function can not be over-emphasized (Lakshmana Rao V, 1985).

2.3.1 The production function

A production function is a highly abstract concept that has been developed to deal with the technological aspect of the theory of production. It is an embodiment of the technology which yields maximum output from the given set of inputs or specifies the way in which the inputs cooperate with each other to produce a given level of output. Symbolically, it can be expressed as

\[ Q = f(X_1, X_2, \ldots, X_n) \]

where \( Q \) is flow of output in physical terms and \( X_1, X_2, \ldots, X_n \) are quantities of different inputs for a given time period.

Production function may take many specific algebraic forms. Typically, economists, works with homogeneous production function. A production function is homogeneous of degree ‘n’ if when inputs are multiplied by some constant, say ‘k’ the resulting output is ‘k’ times the original output.

In the present analysis various forms of production functions i.e., Cobb-Douglas production function, Constant Elasticity of Substitution production function and Variable Elasticity of Substitution production function have been tried to examine the production performance and factor substitution among the factors of production.
Cobb-Douglas Production Function

The most widely used production function for empirical estimation is the Cobb-Douglas production function and it is very handy. The form of C-D production function is

\[ V = AK^\alpha L^\beta e^u \]  

(2.1)

where \( V \) = Value added

\( K \) = Capital input

\( L \) = Labour input

\( \alpha, \beta \) = Output elasticity with respect of capital and labour.

\( u \) = Stochastic disturbance term.

For economic relevance, Douglas stipulated \( A > 0 \) and \( \alpha \) and \( \beta \) between zero and unity. \( 'A' \) is called efficiency parameter.

A natural logarithmic transformation of Cobb-Douglas production function is given by

\[ \log V = \log A + \alpha \log K + \beta \log L + u \]  

(2.2)

The often used method of OLS has been used to estimate this equation and compute estimates of \( \alpha \) and \( \beta \). The sum of \( \alpha \) and \( \beta \) is a measure of returns to scale, if

\( \alpha + \beta > 1 \) : Increasing returns to scale

\( \alpha + \beta = 1 \) : Constant returns to scale

\( \alpha + \beta < 1 \) : Decreasing returns to scale
**Constant Elasticity of substitution Production Function**

The Constant Elasticity of Substitution production function permits elasticity of substitution to take any value from zero to infinity. The form of the CES production function is as follows.

\[ V = A \left[ \delta K^{\rho^*} + (1-\delta)L^{\rho^*} \right]^{\frac{1}{\rho}} \]  

(2.3)

where \( V = \text{Value added} \)

\( K = \text{Capital input} \)

\( L = \text{Labour input} \)

\( A = \text{Efficiency parameter} \)

\( \delta = \text{Distribution parameter} \)

\( \rho = \text{Substitution parameter} \) and

\( \sigma = \text{Elasticity of substitution} = \frac{1}{1+\rho} \)

The CES production is not readily transformable into linear functional form and this requires a non-linear estimation. Accordingly, several alternative methods for estimation have been proposed.

The following two derived relations from the CES function have been used to estimate the elasticity of substitution.

**Model – I:** Assuming constant returns scale

\[ \log (V/L) = A + \sigma \log (W/L) \]  

(2.4)

**Model – II:** No restrictions on returns to scale

\[ \log (V/L) = A + \sigma \log (W/L) + b \log L \]  

(2.5)

where \( V/L = \text{Labour productivity} \)
\[
\frac{W}{L} = \text{Wage rate} \\
L = \text{Labour input} \\
\sigma = \text{Elasticity of substitution} \\
b = \sigma \left( 1 - \frac{1}{\nu} \right) \\
\rho = \text{Substitution parameter; } \sigma \frac{1}{1 + \rho} \\
\nu = \frac{\sigma \rho}{\sigma \rho - b}
\]

Variable Elasticity of Substitution Production function

Hildebrand and Lu (1965), Lu and Fletcher (1968), Young and Tsang (1972) and others developed the VES production function which permits the elasticity of substitutions to vary with changes in the capital labour ratio. The following functional form suggested by Hilderbrand and Lu (1965) has been used in the present study.

\[
V = A \left[ (1-\delta)K^n + \delta K^{mn} L^{(1-m)\epsilon} \right]^{1/n} \quad \ldots \quad (2.6)
\]

where \( V \) is Value added, \( K \) is capital input and \( L \) is labour input. It reduces to CES form for \( m=0 \). This function is homogeneous of degree one and has variable elasticity of substitution.

An important implication of this functional form is that, under the condition of perfect competition, labour productivity becomes a log-linear function of wage rate and capital labour ratio

\[
\log(V/L) = \log A + A_1 \log(W/L) + A_2 \log(K/L) \quad \ldots \quad (2.7)
\]
Using the parameters of the above equation, elasticity of substitution may be obtained as

\[ \sigma = \frac{A_1}{1 - \frac{A_2}{S_k}} \]  

where \( S_k \) is the income share of capital.

If the coefficient \( A_2 \) is significantly different from zero, then VES is suitable functional form. Otherwise (i.e., \( A_2 = 0 \) then \( \sigma = A_1 \) ) CES is a suitable form. Further if \( A_2 = 0 \) and \( A_1 = 1 \) then C-D is a specific case.

2.3.2 Analysis of Productivity trends

Industrial performance has been a subject of debate in India since the advent in the early 1950s of import substitution and industrialisation based on the public sector as the engine of growth (Deb Kusum Das, 2004). In the era of liberalisation India’s economic policies are geared towards economic growth. Rise in productivity in all the sectors is essential to put the country on the growth path (Jeemol Unni, 2001).

It is essential for every industry to grow by utilising the existing input resources in effective manner. In general the growth of an industry is very often constrained by scarce inputs and ultimately it warrants an efficient use of inputs. The ruling technology sets the limits on how much can be produced with a given amount of input. Given the level of technology there are various techniques of producing goods and services. Therefore technical progress is the improvement in the knowledge about the industrial arts and implies that either a greater output can be got
with same volume of inputs or the same output with lesser inputs. An appropriate indicator of efficiency in inputs is provided by various productivity measures.

Productivity is often measured as a ratio of output to inputs. The productivity of the industry can be measured in terms of the productivity of its constituent factors of production, such as labour and capital. However, the partial productivity measures have limitations as in situations, where capital intensity is increasing overtime, partial productivity measures such as labour productivity, may show an increasing but this would be more a reflection of raising capital labour ratio rather than pure productivity increases. This problem is resolved by analyzing, TFP growth, which encompasses the effect not only of technical progress but also of better utilisation of capacity, learning by doing, and improved skills of labour (Ahluwalia, 1991). Therefore, to assess the performance of an industry, TFP ratios are better than partial factor productivity indices. Hence, an attempt has been made to examine the trends in partial and total factor productivities, and the functional relationship between labor productivity and capital intensity in the selected manufacturing industry groups of Andhra Pradesh.

In the general parlance, the productivity is defined as output per unit of input. This definition is too narrow to define the concept of productivity which influences the decisions of planners regarding the economic planning in general and industrial planning in particular. Specifically the productivity can be either measured by using narrow measures like partial productivity indices or a more comprehensive measure entitled Total Factor Productivity (Sunil Kumar 2001).
Partial Productivity

Partial productivity indices/measures can be computed as the ratio of output to factor input. The partial productivity indices has been computed as

\[ P_L = \frac{V}{L}, \quad P_K = \frac{V}{K} \]  \hspace{1cm} (2.9)

where \( P_L \) and \( P_K \) are the partial productivities of labour and capital respectively, and \( V \) is the value added, \( L \) is the labour and \( K \) is capital. We have also computed the Capital intensity as

\[ KI = \frac{K}{L} \]  \hspace{1cm} (2.10)

Total Factor Productivity

Total factor productivity can be a more comprehensive measure of technical change which sums up the partial productivity of all inputs in a production process, so that the efficiency with which all inputs are utilised. Thus, it is a composite index which captures the contribution of individual inputs which have been combined in some composite fashion. Moreover, TFP is a broad measure of economic and technical efficiency reflecting a diversity of factors including managerial efficiency, human capital utilisation, economies of scale, R & D, market structure etc (Denison 1962, 1967).

Several methods have been suggested for estimation of TFP. Here three methods of measuring TFP namely, Solow, Kendrick and Divisia index which differ from one another with regard to weighting scheme have been used.

Solow Index of TFP assumes constant returns to scale and Hicksian neutral technological progress. It is based on rate of change and it is obtained as
where $\Delta V_t$, $\Delta K_t$ and $\Delta L_t$ are real gross value added, capital and labour respectively and $r_t$ and $w_t$ are income share of capital and labour.

TFP (s) can be derived as

$$TFP_s = \frac{A_t}{A_t} = \Delta V_t - \left[ w_t \Delta L_t + r_t \Delta K_t \right]$$

(2.11)

where $A_t$, $V_t$, $L_t$ and $K_t$ are indices of real gross value added, labour and capital; and $w_t$ and $r_t$ are the income share of labour and capital respectively in base year.

Solow’s Index of TFP is considered to be superior to the Index based on Kendrick’s methodology, because it does not assume the production function to be linear in inputs (Solow, 1957).

Kendrick index of TFP is based on linear production function and assumption of perfect competition. TFP (k) is defined as

$$TFP_k = \frac{V_t}{w_0 L_t + r_0 K_t}$$

(2.13)

where $V_t$, $L_t$ and $K_t$ are indices of real gross value added, labour and capital; and $w_0$ and $r_0$ are the income share of labour and capital respectively in base year.

The Divisia index of technological change is based on translog production function which as a ‘priori’ does not restrict the input substitutability to any particular value. It allows for Variable Elasticity of Substitution and does not require the assumption of Hicks neutrality (Christemen and Jorgenson, 1969).
Divisia index of TFP is also based on the rate of productivity change which is expressed as follows

\[ TFP_{(D)} = \frac{\Delta A_t}{A_t} = \frac{\Delta K_t}{K_t} \left[ w_t \frac{\Delta L_t}{L_t} + r_t \frac{\Delta K_t}{K_t} \right] \]  

(2.14)

where \( \Delta V_t, \Delta K_t, \) and \( \Delta L_t \) are in log of real value added, capital and labour respectively.

\[ w_t = \frac{1}{2} [w_{t-1} + w_t], \quad r_t = \frac{1}{2} [r_{t-1} + r_t] \]

w and r are the share of the labour and capital in total income. Then TFP(D) is derived as

\[ A_{t+1} = A_t \left[ 1 + \frac{\Delta A_t}{A_t} \right] \]  

(2.15)

where base year \( A_t = 1. \)

The calculation of the above three indices required time series data on:

a) Gross value added or net value added at constant prices

b) Fixed capital at constant prices

c) Number of employees (or) total persons engaged

d) Share of labour and capital in total income.

2.3.3 Capital Intensity and Labour Productivity

To assess the changes in labour productivity consequent upon unit change in capital intensity the following relation has been used.

\[ \frac{V}{L} = \lambda \left( \frac{K}{L} \right)^\beta \]  

(2.16)

where \( \beta \) indicates the changes in labour productivity with the unit change in capital intensity. If we isolate the rate of increase in labour productivity due to residual
factors including technical change. To assess the effect of technical change in labour productivity the time-parameter is added and the following function has also been used.

\[
\frac{V}{L} = A \left( \frac{K}{L} \right)^a e^u 
\]  

\[ (2.17) \]

2.3.4 Factors affecting Total factor productivity

In an attempt to identify the factors influencing the TFP, the following function in log linear form has been estimated.

Productivity = \( f(X_1, X_2, X_3, X_4) \)

where

\( X_1 = \) Gross value added
\( X_2 = \) Capital intensity
\( X_3 = \) Average wage rate of productive workers
\( X_4 = \) Average wage rate all employees.

The Divisia index of productivity is used as dependent variable. The variable Capital intensity \((X_2)\) reflects growth in the capital accumulation per employee. It is a measure of a relative degree of the mechanisation of the production process, the variable average wage rate of productive workers \((X_3)\) reflects the average skill level of productive workers and the variable average wage rate of all employees \((X_4)\) reflects the skill level of all employees.

2.3.5. Productivity and Managerial Resources

Concept of Managerial resources

Harbison found identification of entrepreneur with an individual person in the context of industry as neither possible nor reasonable. For a modern large scale
manufacturing there will be a number of individuals who perform entrepreneurial functions. He suggest the use of the concept of Managerial Resources in the place of an entrepreneur.

He defined managerial resources as 'The persons who perform and primarily involved in managing risk and uncertainty bearing, planning and innovation, coordination, administration and control and routine supervision of an enterprise'. The other people employed in the enterprise, who do not perform these functions will be referred as labour resources.

In our empirical analysis the ratio between 'persons other than workers' to 'workers' as a measure of managerial resources. Thus we used the ratio as proxy for entrepreneurial organisation in studying the large scale manufacturing industries.

**Inter-relations between managerial resources and productivity**

Regression analysis has been used to relate trends in Managerial resources to trends in productivity. Further regression analysis is also used for disclosing interrelationships among the indices of managerial resources and different measures of productivity. We have tried four variables viz., fixed capital, labor productivity, capital productivity and total factor productivity (Divisia index) as dependent variables and managerial resources as independent variable in regression analysis.