

Contributed Article

Efficiency in Agro-Based Consumer Goods Industries of Tamil Nadu

M. Manonmani & K.T. Geetha

Studies indicate a long run decline in efficiency in Indian Industry as reflected by total factor productivity. Any fall in efficiency lowers the marginal productivity of labour and pulls down employment. Declining productive efficiency could well have kept the growth of employment down in Indian manufacturing. To reverse this process, the production structure should be made flexible and enable easy substitutability between labour and capital, argues the paper.

M. Manonmani & K.T. Geetha are Reader & Professor respectively in the Dept. of Economics, Avinashilingam University for Women, Coimbatore-641 043.

The competitiveness of a firm can be enhanced either by adopting better technology or by increasing efficiency in the use of existing technology, i.e. through technical progress and changes in technical efficiency (Rashmi Banga 2004). Since the cost of developing or acquiring better technology is usually prohibitively high for a firm in a developing country, the major thrust in increasing competitiveness has to take the route of increasing efficiency. Tybout (2000) reported that the mean technical efficiency level is 60-70 per cent of the best practice frontier in LDCs. Srivastava (2001) estimated the technical efficiency of Indian manufacturing firms and found that the mean technical efficiency declined in the 1990s compared to in the 1980s. Saon Ray (2004) found that ownership of domestic firms by multi-national enterprises has clearly helped in enhancing the efficiency of these firms. This seems to indicate that Indian firms are relying more on acquiring best practice knowledge from foreign firms rather than developing it indigenously. Aggregate studies indicated a long run decline in efficiency in Indian industry as reflected by the negative growth of

total factor productivity (Goldar 1986, Ahluwalia 1991). This decline in productive efficiency could have been general or 'disembodied' and / or input-specific or 'embodied'. Any fall in efficiency, whether general or labour-specific, lowers the marginal productivity of labour and, ceteris paribus, pulls down the employment. Thus, declining productive efficiency could well have kept the growth of employment down in Indian manufacturing sector. To reverse the process, the production structure should be made flexible and enable easy substitutability between labour and capital (Lakhwinder Singh & Sigal 1985).

Indian firms are relying more on acquiring best practice knowledge from foreign firms rather than developing it indigenously.

In his pioneering work, Farrell (1957) introduced three major efficiency concepts, two at the firm level and one at industry level viz., technical efficiency, price efficiency and structural efficiency. The estimation of Farrell's efficiency is known as deterministic frontier production function based on inter-firm differences. The work of Farrell was extended by Kopp (1981), which is known as the scale efficiency. This work was followed by Aigner and Chu (1968), Timmer (1971), Arfiat (1972), Richmond (1974) and Schmidt (1976). Followed by Farrell, the stochastic frontier production function (SFPF) was developed by Aigner et al., (1977) independently to measure mean

efficiency of the firm. Meesusem and Vanden Broeck (1977) and Battese and Coeli (1992) have directly applied this model. This was followed by DEA models (1978) to measure technical, scale, cost and allocative efficiencies.

There have been visible changes in the overall economic and industrial climate of the state of Tamil Nadu. Coinciding with the new economic and industrial policy of the Government of India, the state government too has announced its own policy, which outlines the main objectives and strategies to achieve them. The state government is concentrating on promoting the development of industries in which the state has a competitive edge. The agro-based industries have been identified as thrust sector for further industrial growth.

Selection of Industries

From the list of two-digit manufacturing industries (table 1) we have selected groups 15,16,17,19, 20 and 21 except 18 which did not match with earlier years' classification of NIC. To bring comparability and uniformity in data product groups 15 and 16 were merged and classified under one heading as 'Food Products, Beverages and Tobacco. Similarly till 1997-98, product group 17 was split into manufacture of Cotton Textiles, Wool, Silk and Man-made Fibre Textiles, Jute and Other Vegetable Fibre Textiles. The data relating to these product groups were aggregated into one category as manufacture of Textiles in order to

match with the classification given in NIC 98. For the other product groups relating to manufacture Wood and Wood products and Paper and Paper Products, no aggregation was done since there was no problem of comparability with preceding years’.

Variables & Data

1. Gross Value Added (GVA) was taken as output, since trends are not affected significantly by the use of gross value added. Kendrick (1973) based his estimates of factor productivity growth on gross value added. Also ambiguity in the calculation of depreciation can be overcome if gross value added is taken as a measure of output.
2. Labour input consisted of both workers directly involved in production and persons other than workers like supervisors, technicians, managers, clerks and similar type of employees. It was noted by Sinha and Sawhney (1971) that the services of non-workers are as important for the execution of work in the factory as the operators who are directly engaged in the various stages of production process.
3. In productivity measurement, fixed capital was taken into account in calculating capital inputs. Sinha and Sawhney (1971) remarked “while the importance of working capital to industrial productivity cannot be denied, the inventory and cash holdings are more often determined by supply and market expectations

than technological pipeline requirements and have therefore, far less bearing on productivity than fixed investment. It is for this reason fixed capital was taken as capital input for the study.

4. Wages included remuneration paid to both workers and non-workers.

The data source of the study was Annual Survey of Industries (ASI) published by Central Statistical Organisation (CSO) covering the period from 1979-80 to 2002-03. The period was consciously chosen for the reason that the data was available for Tamil Nadu only from 1979 - 80 and the latest data available at the time of study being 2002-03.

Since the time period involved in the study was fairly long (24 years), the need to normalise the data has been recognised. All the referred variables were normalised by applying Net State Domestic Product (NSDP) deflator. The NSDP at current and constant prices were obtained by referring to internet web site [w.w.w. tn.govt.in](http://w.w.w.tn.govt.in), Economic Survey, published by Government of India, Ministry of Finance and Economic Division, New Delhi, Tamil Nadu - An Economic Appraisal, published by Evaluation and Applied Research Department, Government of Tamil Nadu.

DEA Model

There are two approaches for estimation of efficiency, viz., the Stochastic Frontier Approach (SFA) and Data Envelopment Approach

The main advantage of DEA is that unlike SFA, it does not require apriori assumption about the analytical form of the production function.

(DEA). While the stochastic frontier approach (econometric approach) arrives at the efficiency of firms by estimating the production function, the DEA technique involves the use of mathematical programming. DEA is a non-parametric, deterministic methodology for determining relatively efficient production frontier, based on the empirical data on chosen inputs and outputs of a number of entities called Decision Making Units (DMUs). From the set of available data, DEA identifies reference points (relatively efficient DMUs) that define efficient frontier (as the best practice production technology) and evaluate the inefficiency of other interior points (relatively inefficient DMUs) that are below the frontier (Saon Ray 2004).

The DEA provides a measure of efficiency that allows intra-firm comparison, as the efficiency measure is a pure number. The main advantage of DEA is that unlike SFA, it does not require apriori assumption about the analytical form of the production function. Instead, it constructs the best practice production solely on the basis of observed data and therefore the possibility of misspecification of the production technology is minimised. In the case of SFA, the parameter estimates are sensitive to the choice of the

probability distribution specified for the disturbance term.

The two approaches to estimating the efficiency of the firm in the DEA are the output-oriented type and the input-oriented kind. In the output oriented approach, efficiency is determined by maximum output that can be produced from an input bundle. In the input-based measure, the technical efficiency of the firm is evaluated by the extent to which all inputs could be proportionally reduced without a reduction in the output. Among number of DEA models, the two most frequently used ones (input oriented) are, CCR model (after Charnes, Cooper, Rhodes 1978) and BCC model (after Banker, Charnes and Cooper 1984), both of which are used in the study. The DEA model is used to estimate the technical, scale, cost and allocative efficiency of the industries under study.

The efficiency measure is then a function of weights of the “virtual” input-output combination.

CCR Model

Charnes, Cooper and Rhodes introduced a measure of efficiency for each DMU that is obtained as a maximum ratio of weighted outputs to weighted inputs. The weights for the ratio are determined by a restriction that the similar ratios for every DMU have to be less than or equal to unity, thus reducing multiple inputs and outputs to single “virtual” output without requiring

pre-assigned weights. The efficiency measure is then a function of weights of the “virtual” input-output combination. Formally, the efficiency measure for the DMU can be calculated by solving the following mathematical programming problem:

$$\max h_0(u, v) = \sum u_r y_{r0} \quad \dots(1)$$

$$s \quad v_i x_{i0}$$

Subject to

$$u_r \geq 0, r = 1, 2, \dots, s \quad \dots(2)$$

$$v_i \geq 0, i = 1, 2, \dots, m \quad \dots(3)$$

where x_{ij} is the observed amount of input of the i th type of the DMU ($x_{ij} > 0, i = 1, 2, \dots, n, j = 1, 2, \dots, n$) and y_{rj} is the observed amount of output of the r th type for the j th DMU ($y_{rj} > 0, r = 1, 2, \dots, s, j = 1, 2, \dots, n$).

Variables u_r , and v_i are the weights to be determined by the above programming problem. However, this problem has infinite number of solutions since if (u^*, v^*) is optimal then for each positive scalar a (au^*, av^*) is also optimal. Following the Charnes - Cooper transformation (1962), one can select a representative solution (u, v) for which

$$\sum v_i x_{i0} = 1 \quad \dots (4)$$

to obtain a linear programming problem that is equivalent to the linear fractional programming problem (1) - (4). Thus, denominator in the above efficiency measure h_0 is set to equal one and the transformed linear problem for DMU can be written.

$$\text{Max } z_0 = \sum u_r y_{r0} \quad \dots (5)$$

Subject to

$$\sum u_r y_{rj} - \sum v_i x_{ij} \leq 0, j = 1, 2, \dots, n \quad \dots (6)$$

$$\sum v_i x_{i0} = 1 \quad \dots (7)$$

$$u_r \geq 0, r = 1, 2, \dots, s \quad \dots (8)$$

$$v_i \geq 0, i = 1, 2, \dots, m \quad \dots (9)$$

For the above linear programming problem, the dual can be written (for the given DMU) as:

$$\text{Min } z_0 = \Theta_0 \quad \dots (10)$$

Subject to

$$\sum \lambda_r y_{rj} \geq y_{r0}, r = 1, 2, \dots, s \quad \dots (11)$$

$$\Theta_0 x_{i0} - \sum \lambda_j x_{ij} \geq 0, i = 1, 2, \dots, m \quad \dots(12)$$

$$\lambda_j \geq 0, j = 1, 2, \dots, n \quad \dots (13)$$

Both the above linear problems yield the optimal solution Q^* , which is the efficiency score (so-called technical efficiency or CCR efficiency) for the particular DMU and repeating them for each DMU $j, j = 1, 2, \dots, n$ efficiency scores for all of them are obtained. The value of Q is always less than or equal to unity (since when tested, each particular DMU is constrained by its own virtual input-output combination too). DMUs for which $Q^* \leq 1$ are relatively inefficient and those for which $Q^* = 1$ are relatively efficient, having their virtual input-output combination points laying on the frontier. The frontier itself consists of linear facets spanned by efficient units of the data and the resulting frontier production function

(obtained with the implicit constant returns to scale assumption) has no unknown parameters.

BCC Model

No constraints for the weights λ_j , other than the positivity conditions in the problem (10) - (13) implies constant returns to scale. For allowing variable returns to scale, it is necessary to add the convexity condition for the weights, λ_j , i.e. to include in the model (10) - (13) the constraint:

$$\sum \lambda_j = 1. \quad \dots (14)$$

The resulting DEA model that exhibits variable returns to scale is called BCC model. The input-oriented BCC model for the DMU₀ can be written formally as:

$$\text{Min } z_0 = \Theta_0 \quad \dots (15)$$

Subject to

$$\sum \lambda_r y_{rj} \geq y_{r0} \quad r = 1, 2, \dots, s \quad \dots (16)$$

$$\Theta_0 x_{i0} - \sum \lambda_j x_{ij} \geq 0, \quad i = 1, 2, \dots, m \quad \dots (17)$$

$$\sum \lambda_j = 1 \quad \dots (18)$$

$$\lambda_j \geq 0, j = 1, 2, \dots, n \quad \dots (19)$$

Running the above model for each DMU, the BCC efficiency scores are obtained (with similar interpretation of its values as in the CCR model). These scores are also called “pure technical

efficiency scores”, since they are obtained from the model that allows variable returns to scale and hence eliminate the “scale part” of the efficiency from the analysis. Generally, for each DMU the CCR efficiency score will not exceed the BCC efficiency score, what is intuitively clear since in the BCC model each DMU is analyzed “locally” (i.e. compared to the subset of DMUs that operate in the same region of returns to scale) rather than “globally”,

Scale Efficiency

Following the scale properties of the above two models, (Cooper et al. 2000) the scale efficiency is defined as follows. For a particular DMU, the scale efficiency is defined as a ratio of its overall technical efficiency score (measured by the CCR model) and pure technical efficiency score (measured by the BCC model).

Cost Efficiency

The standard measure of cost efficiency is obtained via a two stage process: i) Estimate the minimum price-adjusted resource usage given technological constraints, and (ii) compare this minimum to actual, observed costs. Cost efficiency can be measured if input prices are available in addition to output and input data. Let $x = (x_1, \dots, x_k) \in R_+^k$ denote a vector of inputs and $y = (y_1, \dots, y_m) \in R_+^m$ denote vector of outputs. Formally, the cost efficiency model can be specified as:

$$\begin{aligned} & \text{Min}_{z,x} \sum w_j x_j && \dots (20) \\ \text{Subject to} & z.Y \geq y_0 \\ & z.X \leq x_0 \\ & z_i \geq 0 \\ & \sum z_i = 1 \end{aligned}$$

where Y is an $n \times m$ matrix of observed outputs for n industries and x is an $n \times k$ matrix of inputs for each industry. z is a $1 \times n$ vector of intensity variables and $w = (w_1, \dots, w_k) \in R_+^k$ denoted input prices. The constraints of the model (20) define the input requirement set given by:

$$\begin{aligned} L(y) = \{x, z, y \geq y_0, z x \leq x, z_i \geq 0, \\ \sum z_i = 1 \} && \dots (21) \end{aligned}$$

The input requirement set specifies a convex technology with variable returns to scale (VRS), which is imposed by the constraint $\sum z_i = 1$. Leaving the constraint out of the model changes the technology to constant returns to scale (CRS).

Allocative Efficiency

Allocative efficiency is defined as a ratio of cost efficiency score to technical efficiency score. Both under CRS production technology and VRS production technology, this efficiency score was estimated for the present study. Majumdar (1996), one of the earlier exponents of DEA in the Indian context, took different years as the Decision

Allocative efficiency is defined as a ratio of cost efficiency score to technical efficiency score.

Making Units (DMUs) and analysed the technical efficiency using DEA approach in Indian manufacturing from 1950 to 1993. Prasad (2005) estimated technical efficiency using the same approach for Metal Product industry of India from 1980-81 to 1997-98. Saon Ray (2004) applied input based measure of technical efficiency with variable returns to scale (BCC model) for tracing trends in the efficiency of firms in the Indian manufacturing sector for years 1991-2001. DEA has become increasingly popular in measuring efficiency in different National Banking Industries, as evident in the studies of Ferrier and Lovell (1990). Aly et al. (1990) measured allocative and cost efficiency using this method. Berg et al. (1993) and Brockett et al. (1997) also had applied this method for monitoring banking industry performances and have also applied this approach to insurance companies. All these efficiency measures were estimated by applying computer software DEAP version 2.1.

Results

Technical efficiency refers to the ability of the firm to maximise output from a given set of inputs (Farrell 1957). Scale efficiency is the ability of the firm to equate its output obtained at the minimum point of long run average cost curve. In other words, the quantum of input used exactly equals the required input associated with constant returns to scale. Allocative efficiency refers to the response to the economic signals and choice of optimum input combination, given the relative input prices. The cost inefficiency of a firm arises when actual

cost of production exceeds the minimum cost - the amount by which a firm lies below the production frontier and above its cost frontier, referred to as measure of cost inefficiency. These efficiency measures were derived by using DEA model. An important point to be remembered here regarding returns to scale of the industries is that, while production function estimates the same over 24 years, DEA estimates scale score each year. Technical and scale efficiencies were investigated taking into account gross value added (output) as dependent variable and labour input (number of employees) and capital input (fixed capital) as independent variables. Cost and allocative efficiencies were measured taking into account input prices (wage rate and rate of return on capital) in addition to output and input data (labour input and capital input). These efficiencies were measured under the assumption of constant returns to scale and variable returns to scale options. A value of unity indicates the industry is on the frontier, while a value of less than unity indicates the presence of inefficiency. Before investigating the efficiency measure of the selected industries, the variables were tested for the presence of stationarity by applying Augmented Dickey Fuller (ADF) test and the results are shown in table 2. From the analysis, it was found that all the variables involved in the efficiency analysis of the industries under study were stationary.

Technical Efficiency

The technical efficiency scores both under constant returns to scale (CCR model) and variable returns to scale

(BCC model) options based on the DEA model are presented in table 3. Under Constant Returns to Scale (CRS) production technology, the average efficiency during 1979-80 to 2002-03 were 0.801, 0.757, 0.596, 0.690 and 0.704 respectively for manufacture of Food Products, Beverages and Tobacco, Textiles, Leather and Leather Products, Wood and Wood Products and Paper and Paper Products. This implied that the industries would have needed only 80.1 per cent, 75.7 per cent, 59.6 per cent, 69.0 per cent and 70.4 per cent of the inputs currently being used. In terms of average inefficiency, it would have needed 24.8 per cent, 32.1 per cent, 67.8 per cent, 44.9 per cent and 42.0 per cent more inputs to produce the same output, which meant waste of resources to the extent mentioned above.

Under VRS production technology, the number of efficient DMUs exceeded the number of efficient DMUs under CRS production technology. Always under VRS production technology, higher average efficiency was recorded. It may be due to the reason that DMUs that were efficient under constant returns to scale (CRS) were accompanied by new efficient DMUs that might operate under increasing or decreasing returns to scale. High degree of average technical inefficiency particularly under constant returns to scale production technology can be attributable to the fact that the industries may not be using the most efficient technology available to transform the inputs into outputs; due to differences in products produced, the industries were likely to have different

best practice frontiers; relatively small regional spheres of operation of the industries may have resulted in inefficiencies; and structural problems regarding staff efficiency and operating efficiency may have prevented the firm from improving its efficiency level.

Disaggregation of figures on technical efficiency estimates for the period from 1979-80 to 1989-90 showed that efficiency score was more under variable returns to scale (VRS) production technology compared to constant returns to scale (CRS) production technology for all the industries. The average inefficiency showed that during this period a maximum of 72.7 per cent was observed under CRS production technology for Leather and Leather Products and minimum of 3.7 per cent in Food Products, Beverages and Tobacco under the same technology. During the second sub-period between 1990-91 and 2002-03, the same trend of greater efficiency under VRS production technology was observed for all the industries. Inefficiency estimates under CRS production technology was maximum (85.9 per cent) for Wood and Wood Products and minimum (24.7 per cent) for Food Products, Beverages and Tobacco. In the case of VRS production technology, the technical inefficiency recorded more (45.6 per cent) for Leather and Leather Products and minimum (20.2 per cent) in Food Products, Beverages and Tobacco. It can be concluded that though the efficiency of the firms varied considerably on account of the various reasons mentioned, all the firms were estimated

to be on the frontier at least once. In other words, both under CRS and VRS technology, the number of inefficiency scores exceeded the number of efficiency scores or levels during the entire period, which was indicative of the fact that the efficiency of firms was not strongly influenced by the size of production.

The efficiency of firms was not strongly influenced by the size of production.

Scale Efficiency

Table 4 presents details regarding the scale efficiency scores of industries along with average efficiency score, average inefficiency score and returns to scale which forms the basis to understand scale efficiency of the firms. DEA results applied to know the scale efficiency of industries for the entire period revealed that the industries were not operating at an optimum scale. The average scale efficiency of manufacture of Food Products, Beverages and Tobacco was maximum (89.8 per cent) followed by Textiles (88.4 per cent), Paper and Paper Products (82.6 per cent), Wood and Wood Products (79.0 per cent) and Leather and Leather Products (77.5 per cent). In terms of average inefficiency, it could increase additional production to the extent of 11.4 per cent, 13.1 per cent, 21.1 per cent, 26.6 per cent, and 29 per cent respectively in the above industries, by taking advantage of their scale characteristics.

DEA results applied to know the scale efficiency of industries for the entire period revealed that the industries were not operating at an optimum scale.

During the first sub-period (1979-80 to 1989-90) manufacture of Wood and Wood products took the maximum scale efficiency score (0.948) followed by Food Products, Beverages and Tobacco (0.826), Textiles (0.773), Paper and Paper Products (0.745) and Leather and Leather Products (0.651). The scale inefficiency score was more for Leather and Leather Products (53.6 per cent) and minimum for Wood and Wood Products (5.5 per cent). During the second sub-period (1990-91 to 2002-03), efficiency of more than 95 per cent was observed in Food Products, Beverages and Tobacco (95.9 per cent) and Textiles (97.9 per cent). The average inefficiency was maximum for Wood and Wood Products (51.5 per cent) and minimum for Textiles (2.1 per cent).

DEA allows to assess whether a firm lies in the range of increasing, constant and decreasing returns to scale. In other words, it revealed the scale characteristics of DMUs. If market contains firms operating with increasing and decreasing returns to scale, market efficiency can be increased if more DMUs attain constant returns to scale, because fewer resources are wasted. The measurement of economies of scale, therefore, helps assess at the same time whether higher market concentration should be encouraged to improve efficiency. A DMU may be

scale inefficient, if it experiences decreasing returns to scale or if it has not taken full advantage of increasing returns to scale. Indeed most of the inefficient DMUs presented increasing returns to scale characteristic which indicated that industries can increase the scales to effectively improve their efficiency. Scale inefficiency was observed in a few cases under decreasing returns to scale, particularly in Food Products, Beverages and Tobacco from 1996-97 to 2002-03. This phenomenon might be partially due to the fact that the markets of these might not have taken advantage of the available cost savings due to the absence of price transparency which in turn allowed the scale inefficient firms to survive at the end of periods. In general, it is very clear that inefficiency can be due to the existence of either increasing or decreasing returns to scale.

It is very clear that inefficiency can be due to the existence of either increasing or decreasing returns to scale.

Cost Efficiency

Cost efficiency estimates taking into account input prices (wage rate and rate of return on capital) in addition to output and input data (labour and capital) for various industries are presented in Table 5. Under constant returns to scale (CRS) technology, industries such as Food Products, Beverages and Tobacco, Textiles, Leather and Leather Products, Wood and Wood Products and Paper and Paper Products were efficient to the

extent of 64.8 per cent, 58.5 per cent, 54.6 per cent, 59.8 per cent and 61.2 per cent respectively. Under variable returns to scale (VRS) production technology the same industries were more efficient to the extent of 81.8 per cent, 69.7 per cent, 72.8 per cent, 66.7 per cent and 69.5 per cent respectively. Considering the cost efficient DMUs, it was found to be more under VRS production technology. The average cost inefficiency was more under CRS production technology than under VRS production technology.

Cost efficiency estimates during the first half period (1979-80 to 1989-90) revealed that 80 per cent efficiency was found in Wood and Wood Products and minimum (54.4 per cent) in Leather and Leather Products under CRS production technology. Inefficiency was more (83.8 per cent) for Leather and Leather Products and minimum (28.4 per cent) for Wood and Wood Products. With regard to the efficiency estimates under VRS production technology, maximum (93.4 per cent) was observed in Food Products, Beverages and Tobacco followed by Wood and Wood Products (86.6 per cent), Leather and Leather Products (84.8 per cent), Paper and Paper Products (75.4 per cent) and Textiles (75.3 per cent). During the second sub-period (from 1990-91 to 2002-03) cost efficiency varied between 54.8 per cent (Leather and Leather Products) and 61.7 per cent (Paper and Paper Products) under CRS production technology. Under VRS production technology option, cost efficiency varied between 49.9 per cent (Wood and Wood Products) and 71.9 per cent (Food Products, Beverages and Tobacco).

Inefficiency score under CRS production technology ranged between 62 per cent (Paper and Paper Products) and 82.5 per cent (Leather and Leather products). Under VRS production technology minimum of 39.1 per cent (Food Products, Beverages and Tobacco) and maximum of 100 per cent (Wood and Wood Products) inefficiency was observed. This may be due to the inefficiency of the firms in the selection of cost minimising input quantities.

Allocative Efficiency

Allocative efficiency estimates taking into account input prices (wage rate and rate of return on capital) in addition to output (GVA) and input data (labour and capital) for various industries under constant returns to scale (CRS) production technology and variable returns scale (VRS) production technology is presented in table 6. Estimates revealed that over the study period, the industries under CRS production technology had on an average allocative efficiency level of 80.5 per cent, 78.3 per cent, 91.8 per cent, 86.6 per cent and 86.9 per cent in Food Products, Beverages and Tobacco, Textiles, Leather and Leather Products, Wood and Wood Products and Paper and Paper Products respectively implying that the industries were 19.5 per cent, 21.7 per cent, 8.2 per cent, 13.4 per cent and 13.1 per cent inefficient respectively. In the case of VRS production technology, an average allocative efficiency of 91.3 per cent, 79.6 per cent, 93 per cent, 76.7 per cent and 81.2 per cent could be observed in Food Products,

Beverages and Tobacco, Textiles, Leather and Leather Products, Wood and Wood Products and Paper and Paper Products respectively implying that the industries were on an average 8.7 per cent, 23.4 per cent, 7 per cent, 23.3 per cent and 18.8 per cent inefficient respectively in these industries. More efficient DMUs were observed in VRS production technology compared to CRS production technology. Average inefficiency was maximum under CRS production technology for Textiles (27.7 per cent). Under VRS production technology, it was more for Wood and Wood Products (30.4 per cent).

During the first sub-period up to 1990, the maximum allocative efficiency of 94.4 per cent was recorded by Leather and Leather Products and minimum of 86.5 per cent by Paper and Paper Products under CRS production technology. Also the maximum inefficiency score (0.094) was observed in Food Products, Beverages and Tobacco and minimum (0.059) in Leather and Leather Products. Under VRS production technology, Food Products, Beverages and Tobacco, Leather and Leather Products and Wood and Wood Products had allocative efficiency of more than 90 per cent. With regard to inefficiency estimates, the maximum was recorded by Textiles (28.2 per cent) and minimum by Food Products, Beverages and Tobacco (3.2 per cent). During the second sub-period (1990-91 to 2002-03) only under VRS production technology more than 90 per cent of efficiency score was observed in Leather and Leather Products (0.914) and the

minimum of 0.668 (66.8 per cent) in Textiles under CRS production technology. Inefficiency estimates recorded more (40.4 per cent) for Food Products, Beverages and Tobacco and a minimum of 9.4 per cent was found in Leather and Leather Products under VRS production technology. The low allocative efficiency scores in certain cases might be due to the inability of industries to adjust to new environment or high non-recurring costs.

The low allocative efficiency scores in certain cases might be due to the inability of industries to adjust to new environment or high non-recurring costs.

Conclusion

It could be concluded that for the entire period, technical, scale, cost and allocative efficient DMUs were more under variable returns to scale (VRS) production technology than under constant returns to scale (CRS) production technology. Also it is very clear that inefficiency could be due to the existence of either increasing or decreasing returns to scale. Technical efficiency was more for Food Products, Beverages and Tobacco both under CRS and VRS production technology. Technical inefficiency was more for Leather and Leather Products under CRS and VRS production technology. Cost efficiency both under CRS and VRS production technology was more in Food Products, Beverages and Tobacco, while cost inefficiency was more in Leather and

Leather Products under CRS production technology. Wood and Wood Products was found to be cost inefficient, when compared to other industries under VRS production technology. Allocative efficiency under CRS and VRS technology was observed more in Leather and Leather Products. On the contrary, high allocative inefficiency was observed in Textiles under CRS production technology, while Wood and Wood Products proved as an allocatively inefficient industry under VRS production technology when compared with others.

References

- Ahluwalia, I.J. (1991), Productivity and Growth in Indian Manufacturing, Oxford University Press, New Delhi.
- Banker, R.D. Charnes, A. & Cooper, W.W. (1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis", *Management Science*, 30 :1078-2092.
- Charnes A. Cooper, W.W. & Rhodes, E. (1978), "Measuring the Efficiency of Decision Making Units", *European Journal of Operation Research*, 2:429-44.
- Farrell, M.J. (1957), "The Measurement of Productive Efficiency", *Journal of the Royal Statistical Society, Series A*, 120:253-81.
- Goldar, B.N. (1986), Productivity Growth in Indian Industry, Allied Publishers Pvt. Ltd., New Delhi.
- Kendrick, J.W. (1973), Post War Productivity Trends in U.S. 1948-69, Princeton University Press, National Bureau of Economic Research, New York .
- Lakhwinder Singh & Sigal, K.C. (1985), "Capital-Labour Substitution in Punjab Industry", *Indian Journal of Industrial Relations*, 21, October.
- Rashmi Banga (2004), "Impact of Japanese and US FDI on Productivity Growth", *Economic & Political Weekly*, XXXIX (5): 453-60.
- Srivastava, V. (2001), The Impact of India's Economic Reforms on Industrial Productivity, Efficiency and Competitiveness. A Panel Study of Indian Companies, 1980-97, NCAER, New Delhi.
- Saon Ray (2004), "MNEs, Strategic Alliances and Efficiency of Firms", *Economic and Political Weekly*, XXXIX (5): 434-40.
- Tybout, J. (2000), "Manufacturing Firms in Developing Countries, How Well Do They Do and Why?", *Journal of Economic Literature*, March, :11-44.

Government Publications / Reports

- Annual Survey of Industries (ASI), Various Issues, Central Statistical Organisation (CSO), Government of India, New Delhi.
- Economic Survey, Various Issues, Government of India, New Delhi.
- Tamil Nadu - An Economic Appraisal, Evaluation and Applied Research Department, Government of Tamil Nadu. Website w.w.tn.gov.in.2008.

Table 1: Two Digit NIC of Manufacturing Industries

S. No.	NIC Code	Name of the Product Group
1	15	Manufacture of Food Products and Beverages.
2.	16	Manufacture of Tobacc
3.	17	Manufacture of Textile
4.	18	Manufacture of Wearing apparel ; Dressing and Dyeing of F
5.	19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlers, Harness and Foot Wear
6.	20	Manufacture of Wood and of Products of Wood and cork, except Furniture
7.	21	Manufacture of Articles of Straw and Plaiting Materials
8.	22	Manufacture of Paper and Paper Products
9.	23	Publishing, Printing and Re-production of Recorded Med
10.	24	Manufacture Coal, Refined Petroleum Products and Nuclear Fuel
11.	25	Manufacture of Rubber and Plastic Products
12.	26	Manufacture of Other Non-metallic Mineral Products
13.	27	Manufacture of Basic Metals
14.	28	Manufacture of Fabricated Metal Products, except Machinery and Equipme
15.	29	Manufacture of Machinery and Equipment n.e.c
16.	30	Manufacture of Office, Accoutning and Computing Machinery
17.	31	Manufacture of Electrical Machinery and Apparatus, n.e.c
18.	32	Manufacture of Radio, Television and Communication Equipment and Appara
19.	33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clock
20.	34	Manufacture of Motor Vehicles, Trailers and Semi Trailer
21.	35	Manufacture of Other Transport Equipment
22.	36	Manufacture of Furniture Manufacturing n.e.c
23.	37	Recycling

Source : Annual Survey of Industries - NIC 98'

Table 2: Augmented Dickey Fuller (ADF) Test for First Difference

Industry / Variable	ADF value
Food Products, Beverages and Tobacco	
Gross Value Added (GVA)	- 4.6906*
Labour input (L)	- 4.6161*
Wage rate (W)	- 3.7599*
Capital input (FC)	- 5.6909*
Rate of return on capital (RFC)	- 4.2880*
Textiles	
Gross Value Added (GVA)	- 6.1117*
Labour input (L)	- 3.9909*
Wage rate (W)	- 7.9675*
Capital input (FC)	- 4.5874*
Rate of return on capital (RFC)	- 3.8459*
Leather and Leather Products	
Gross Value Added (GVA)	- 4.5721*
Labour input (L)	- 4.2871*
Wage rate (W)	- 3.7985*
Capital input (FC)	- 6.0391*
Rate of return on capital (RFC)	- 6.0391*
Wood and Wood Products	
Gross Value Added (GVA)	- 5.6908*
Labour input (L)	- 4.5721*
Wage rate (W)	- 5.5987*
Capital input (FC)	- 4.6908*
Rate of return on capital (RFC)	- 5.9562*
Paper and Paper Products	
Gross Value Added (GVA)	- 7.6908*
Labour input (L)	- 7.5720*
Wage rate (W)	- 4.8722*
Capital input (FC)	- 6.8287*
Rate of return on capital (RFC)	- 7.6206*

Source : Estimation based on ASI data.

Note : * Significant at 5% level.

Table 3: Technical Efficiency (TE) Estimates

Industry DMU	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1979-80	0.539	1.000	1.000	1.000	0.493	1.000	0.877	1.000	0.807	1.000
1980-81	0.572	0.842	0.922	1.000	0.550	1.000	0.930	0.985	0.838	1.000
1981-82	0.643	0.888	0.620	0.980	0.469	0.925	0.877	0.913	0.861	0.965
1982-83	0.754	0.890	0.560	0.971	0.526	0.940	0.655	0.750	0.709	0.955
1983-84	0.895	0.995	0.615	0.980	0.726	1.000	0.754	0.799	0.706	0.938
1984-85	0.923	0.997	0.597	0.917	0.604	0.900	1.000	1.000	0.732	1.000
1985-86	0.799	1.000	0.621	0.943	0.528	0.834	0.754	0.799	0.641	0.846
1986-87	0.917	1.000	0.575	0.962	0.506	0.811	1.000	1.000	0.584	0.879
1987-88	0.823	0.988	0.698	0.921	0.605	0.844	0.736	0.819	0.483	0.879
1988-89	0.927	1.000	0.707	0.912	0.676	0.829	0.999	1.000	0.559	0.977
1989-90	1.000	1.000	1.000	1.000	0.662	0.762	0.983	1.000	0.823	0.923
1990-91	0.844	0.892	0.988	1.000	0.748	0.820	0.783	0.991	0.939	0.999
1991-92	0.879	0.898	0.826	0.918	0.789	0.835	0.558	0.763	1.000	1.000
1992-93	0.700	0.808	0.896	0.913	0.750	0.798	0.382	0.711	1.000	1.000
1993-94	0.764	0.799	0.939	0.943	1.000	1.000	0.703	0.846	1.000	1.000
1994-95	0.896	0.898	1.000	1.000	0.576	0.628	0.515	0.865	0.507	0.785
1995-96	0.721	0.721	0.725	0.785	0.629	0.677	0.387	0.715	0.776	0.837
1996-97	0.994	1.000	0.873	0.878	0.605	0.660	0.471	0.877	0.728	0.894
1997-98	0.972	1.000	0.704	0.727	0.645	0.720	0.596	1.000	0.591	0.738
1998-99	0.665	0.698	0.728	0.734	0.382	0.469	0.641	0.828	0.307	0.512
1999-00	0.746	0.751	0.655	0.660	0.499	0.626	0.494	0.738	0.587	0.610
2000-01	0.740	0.750	0.642	0.646	0.468	0.591	0.494	0.738	0.585	0.600
2001-02	0.744	0.758	0.636	0.638	0.414	0.543	0.496	0.746	0.557	0.574
2002-03	0.765	0.840	0.631	0.634	0.452	0.559	0.474	0.728	0.575	0.575

(Contd.)

Table 3 Contd.

Industry	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
Average Technical Efficiency (1979-80 to 2002-03)	0.801	0.892	0.757	0.878	0.596	0.782	0.690	0.859	0.704	0.854
Average Technical inefficiency (1979-80 to 2002-03)	0.248	0.121	0.321	0.138	0.678	0.289	0.449	0.164	0.420	0.171
No. of Technically efficient DMUs (1979-80 to 2002-03)	1	7	3	5	1	4	2	6	3	6
Average Technical efficiency (1979-80 to 1989-90)	0.799	0.964	0.720	0.962	0.579	0.895	0.870	0.915	0.704	0.942
Average Technical inefficiency (1979-80 to 1989-90)	0.252	0.037	0.389	0.040	0.727	0.117	0.149	0.093	0.420	0.062
Average Technical efficiency (1990-91 to 2002-03)	0.802	0.832	0.788	0.806	0.612	0.687	0.538	0.811	0.704	0.779
Average Technical inefficiency (1990-91 to 2002-03)	0.247	0.202	0.269	0.241	0.634	0.456	0.859	0.233	0.420	0.277

Source : Estimation based on ASI data.

Note : Average technical inefficiency score = $1 - \bar{x}$ (\bar{x} = Average technical efficiency)

Table 4: Scale Efficiency (SE) Estimates

Industry DMU	Food Products, Beverages and Tobacco	RTS	Textiles	RTS	Leather and Leather Products	RTS	Wood and Wood Products	RTS	Paper and Paper Products	RTS
1979-80	0.539	IRS	1.000	CRS	0.493	IRS	0.877	CRS	0.807	IRS
1980-81	0.679	IRS	0.922	IRS	0.550	IRS	0.944	IRS	0.838	IRS
1981-82	0.724	IRS	0.633	IRS	0.507	IRS	0.961	IRS	0.892	IRS
1982-83	0.847	IRS	0.577	IRS	0.560	IRS	0.873	IRS	0.742	IRS
1983-84	0.899	IRS	0.928	IRS	0.726	IRS	0.944	IRS	0.753	IRS
1984-85	0.926	IRS	0.651	IRS	0.671	IRS	1.000	CRS	0.732	IRS
1985-86	0.799	IRS	0.659	IRS	0.633	IRS	0.944	IRS	0.758	IRS
1986-87	0.917	IRS	0.598	IRS	0.624	IRS	1.000	CRS	0.664	IRS
1987-88	0.833	IRS	0.758	IRS	0.717	IRS	0.899	IRS	0.549	IRS
1988-89	0.927	IRS	0.775	IRS	0.815	IRS	0.999	IRS	0.572	IRS
1989-90	1.000	CRS	1.000	CRS	0.869	IRS	0.983	IRS	0.892	IRS
1990-91	0.946	IRS	0.988	IRS	0.912	IRS	0.787	IRS	0.940	IRS
1991-92	0.979	IRS	0.900	IRS	0.945	IRS	0.731	IRS	1.000	CRS
1992-93	0.867	IRS	0.981	IRS	0.940	IRS	0.537	IRS	1.000	CRS
1993-94	0.956	IRS	0.996	IRS	1.000	CRS	0.831	IRS	1.000	CRS
1994-95	0.998	IRS	1.000	CRS	0.917	IRS	0.595	IRS	0.646	IRS
1995-96	1.000	CRS	0.924	IRS	0.929	IRS	0.541	IRS	0.927	IRS
1996-97	0.994	DRS	0.994	IRS	0.917	IRS	0.537	IRS	0.814	IRS
1997-98	0.972	DRS	0.968	IRS	0.896	IRS	0.596	IRS	0.801	IRS
1998-99	0.953	DRS	0.992	IRS	0.814	IRS	0.774	IRS	0.600	IRS
1999-00	0.993	DRS	0.992	IRS	0.797	IRS	0.670	IRS	0.962	IRS
2000-01	0.987	DRS	0.994	IRS	0.792	IRS	0.670	IRS	0.975	IRS
2001-02	0.911	DRS	0.997	IRS	0.762	IRS	0.665	IRS	0.970	IRS
2002-03	0.911	DRS	0.995	IRS	0.809	IRS	0.651	IRS	1.000	CRS

(Contd.)

Table 4 Contd.

Industry DMU	Food Products, Beverages and Tobacco	RTS	Textiles RTS	Leather and Leather Products	RTS	Wood and Wood Products	RTS	Paper and Paper Products	RTS	
Average Scale Efficiency (1979-80 to 2002-03)	0.898	-	0.884	-	0.775	-	0.790	-	0.826	-
Average Scale inefficiency (1979-80 to 2002-03)	0.114	-	0.131	-	0.290	-	0.266	-	0.211	-
No. of Scale efficient DMUs (1979-80 to 2002-03)	2	-	3	-	1	-	2	-	4	-
Average Scale efficiency (1979-80 to 1989-90)	0.826	-	0.773	-	0.651	-	0.948	-	0.745	-
Average Scale inefficiency (1979-80 to 1989-90)	0.211	-	0.294	-	0.536	-	0.055	-	0.342	-
Average Scale efficiency (1990-91 to 2002-03)	0.959	-	0.979	-	0.879	-	0.660	-	0.895	-
Average Scale inefficiency (1990-91 to 2002-03)	0.043	-	0.021	-	0.138	-	0.515	-	0.117	-

Source : Estimation based on ASI data.

Notes : RTS - Returns to Scale;
 IRS - Increasing Returns to Scale;
 DRS - Decreasing Returns to Scale;
 CRS - Constant Returns to Scale.

Average scale inefficiency score = $1 - \bar{x} / \bar{x}$ (\bar{x} Average scale efficiency).

Table 5: Cost Efficiency (CE) Estimates

Industry DMU	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1979-80	0.344	1.000	0.691	1.000	0.391	1.000	0.705	1.000	0.555	1.000
1980-81	0.490	0.778	0.868	0.950	0.508	0.893	0.927	0.982	0.750	0.988
1981-82	0.571	0.828	0.586	0.739	0.468	0.883	0.852	0.901	0.787	0.956
1982-83	0.671	0.888	0.549	0.680	0.498	0.862	0.565	0.592	0.666	0.870
1983-84	0.857	0.990	0.608	0.703	0.628	0.883	0.667	0.685	0.692	0.830
1984-85	0.863	0.971	0.590	0.659	0.602	0.855	0.689	1.000	0.469	0.487
1985-86	0.775	0.914	0.596	0.660	0.523	0.800	0.667	0.685	0.584	0.797
1986-87	0.883	1.000	0.410	0.463	0.502	0.783	1.000	1.000	0.471	0.505
1987-88	0.791	0.936	0.688	0.747	0.590	0.818	0.722	0.813	0.442	0.518
1988-89	0.919	0.973	0.649	0.679	0.659	0.791	0.883	0.943	0.505	0.577
1989-90	1.000	1.000	1.000	1.000	0.616	0.759	0.887	0.929	0.758	0.768
1990-91	0.469	0.476	0.736	0.783	0.582	0.641	0.612	0.636	0.904	0.917
1991-92	0.698	0.702	0.643	0.649	0.761	0.807	0.482	0.482	0.995	0.999
1992-93	0.504	0.524	0.636	0.680	0.679	0.725	0.378	0.471	1.000	1.000
1993-94	0.605	0.612	0.680	0.881	1.000	1.000	0.587	0.606	0.855	1.000
1994-95	0.674	0.811	0.620	1.000	0.537	0.595	0.374	0.419	0.421	0.460
1995-96	0.551	0.560	0.373	0.375	0.469	0.510	0.373	0.592	0.491	0.534
1996-97	0.600	0.917	0.379	0.581	0.533	0.588	0.328	0.399	0.471	0.575
1997-98	0.621	1.000	0.389	0.452	0.507	0.572	0.466	0.516	0.415	0.420
1998-99	0.451	0.697	0.430	0.633	0.333	0.429	0.456	0.518	0.287	0.332
1999-00	0.553	0.721	0.484	0.571	0.456	0.602	0.440	0.466	0.551	0.564
2000-01	0.551	0.737	0.482	0.587	0.438	0.580	0.440	0.466	0.552	0.568
2001-02	0.549	0.757	0.482	0.613	0.409	0.541	0.441	0.467	0.529	0.540
2002-03	0.565	0.837	0.482	0.634	0.422	0.552	0.420	0.446	0.549	0.572

(Contd.)

Table 5 Contd.

Industry DMU	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
Average cost Efficiency (1979-80 to 2002-03)	0.648	0.818	0.585	0.697	0.546	0.728	0.598	0.667	0.612	0.695
Average cost inefficiency (1979-80 to 2002-03)	0.543	0.222	0.706	0.435	0.832	0.374	0.669	0.499	0.634	0.439
No. of cost efficient DMUs (1979-80 to 2002-03)	1	4	1	3	1	2	1	3	1	3
Average cost efficiency (1979-80) to 1989-90)	0.742	0.934	0.658	0.753	0.544	0.848	0.779	0.866	0.607	0.754
Average cost inefficiency (1979-80) to 1989-90)	0.348	0.071	0.520	0.328	0.838	0.179	0.284	0.155	0.647	0.326
Average cost efficiency (1990-91) to 2002-03)	0.569	0.719	0.585	0.649	0.548	0.626	0.598	0.499	0.617	0.645
Average cost inefficiency (1990-91) to 2002-03)	0.757	0.391	0.709	0.541	0.825	0.597	0.672	1.000	0.620	0.540

Source : Estimation based on ASI data.

Note : Average cost inefficiency score = $1 - X/\bar{X}$ (\bar{X} = Average cost efficiency).

Table 6: Allocative Efficiency (AE) Estimates

Industry DMU	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1979-80	0.638	1.000	0.691	1.000	0.794	1.000	0.803	1.000	0.688	1.000
1980-81	0.856	0.923	0.941	0.950	0.923	0.893	0.997	0.997	0.895	0.988
1981-82	0.888	0.932	0.945	0.754	0.998	0.955	0.972	0.987	0.914	0.991
1982-83	0.889	0.997	0.980	0.700	0.945	0.918	0.863	0.789	0.939	0.911
1983-84	0.958	0.994	0.989	0.717	0.865	0.883	0.884	0.857	0.981	0.885
1984-85	0.936	0.974	0.987	0.719	0.998	0.950	0.689	1.000	0.641	0.487
1985-86	0.970	0.914	0.960	0.699	0.991	0.960	0.884	0.857	0.912	0.942
1986-87	0.963	1.000	0.713	0.481	0.992	0.966	1.000	1.000	0.807	0.574
1987-88	0.961	0.947	0.986	0.812	0.975	0.970	0.981	0.993	0.916	0.590
1988-89	0.992	0.973	0.918	0.744	0.975	0.954	0.884	0.943	0.903	0.590
1989-90	1.000	1.000	1.000	1.000	0.930	0.996	0.902	0.929	0.921	0.832
1990-91	0.556	0.534	0.745	0.783	0.778	0.782	0.785	0.642	0.962	0.918
1991-92	0.793	0.781	0.779	0.708	0.964	0.966	0.864	0.632	0.995	0.999
1992-93	0.719	0.649	0.710	0.745	0.905	0.908	0.990	0.663	1.000	1.000
1993-94	0.792	0.766	0.724	0.935	1.000	1.000	0.836	0.716	0.855	1.000
1994-95	0.752	0.904	0.620	1.000	0.933	0.946	0.727	0.485	0.831	0.585
1995-96	0.764	0.778	0.515	0.477	0.746	0.753	0.965	0.828	0.633	0.638
1996-97	0.604	0.917	0.433	0.662	0.880	0.891	0.697	0.455	0.647	0.532
1997-98	0.639	1.000	0.552	0.621	0.786	0.795	0.783	0.516	0.701	0.569
1998-99	0.677	0.999	0.591	0.863	0.871	0.915	0.711	0.626	0.934	0.649
1999-00	0.741	0.959	0.740	0.866	0.914	0.961	0.890	0.632	0.939	0.924
2000-01	0.744	0.982	0.751	0.909	0.936	0.981	0.890	0.632	0.944	0.948
2001-02	0.738	1.000	0.758	0.962	0.988	0.996	0.889	0.626	0.949	0.941
2002-03	0.738	0.997	0.763	0.999	0.933	0.988	0.887	0.612	0.954	0.994

(Contd.)

Table 6 Contd.

Industry DMU	Food Products, Beverages and Tobacco		Textiles		Leather and Leather Products		Wood and Wood Products		Paper and Paper Products	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
Average Allocative Efficiency (1979-80 to 2002-03)	0.805	0.913	0.783	0.796	0.918	0.930	0.866	0.767	0.869	0.812
Average Allocative inefficiency (1979-80 to 2002-03)	0.242	0.095	0.277	0.256	0.089	0.075	0.155	0.304	0.151	0.232
No. of Allocative efficient DMUs (1979-80 to 2002-03)	1	5	1	3	1	2	1	3	1	3
Average Allocative efficiency (1979-80) to 1989-90)	0.914	0.969	0.919	0.780	0.944	0.950	0.896	0.941	0.865	0.799
Average Allocative inefficiency (1979-80) to 1989-90)	0.094	0.032	0.088	0.282	0.059	0.053	0.116	0.063	0.156	0.252
Average Allocative efficiency (1990-91) to 2002-03)	0.712	0.867	0.668	0.733	0.895	0.914	0.840	0.630	0.873	0.823
Average Allocative inefficiency (1990-91) to 2002-03)	0.404	0.153	0.497	0.364	0.117	0.094	0.190	0.613	0.145	0.215

Source : Estimation based on ASI data.

Note : Average allocative inefficiency score = $1 - x / \bar{x}$ (\bar{x} = Average allocative efficiency).