Technical Efficiency in Indian Manufacturing Industry, 1981-2001: An Explorative Analysis

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Abstract

This paper has explored the technical efficiency levels in five selected manufacturing industries in India utilizing a stochastic frontier approach. In this analysis we have used a panel of 15 Indian States over the 21 years period (1980 -01). Our analysis showed that technical efficiency levels have decreased in four manufacturing sectors in the post reform period and increased only in one. Among the factors that influenced efficiency, man days lost due to industrial dispute has a negative effect while trade openness seems to boost efficiency. The infrastructural parameter such as bank per population has also a favorable effect. On the whole though reforms seemed to have a negative effect on efficiency, it is mostly cluster of other factors that are responsible for this seemingly perverse result.

Key words: *Industry studies, Manufacturing industries, Technical efficiency, Stochastic frontier analysis*

JEL classification: L60, O14, O47

1. Introduction

Developing countries have progressively adopted market friendly reforms during the 1980's and 1990's. One of the most important objectives of some of these reforms was to make the economies more resilient and less vulnerable to external shocks. In the sphere of industrial sector reforms, this amounts to increasing the competitiveness of the domestic firms so that they can withstand the pressure of global competition. The Indian economy has also undergone similar reforms since the mid eighties and especially during the nineties.

Before 1980, the key strategy for the development was to focus on large and heavy Industries under State Control and Central Planning. The strategy also involved impost substitution, rigid price controls, and severe restriction on private initiatives.

This strategy is now widely acknowledged to have been unsuccessful. The disappointing performance of the industrial sectors, therefore, forced policy-makers to revise their policy tools. In 1980's they started to implement some reforms, but most radical reforms occurred since 1990, after the severe economic crisis in 1990-91. A series of reforms were adopted at that time and all

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these effects are thought to be beneficial for the Industrial Sector and should lead to enhance performance of the Sector. These policy changes are expected to have significant effect on the structure and performance of Indian Industries. In this study, against the background of these policy reforms, we analyze the performance of some selected Industries in terms of technical efficiency. We also analyze few factors which may affect the efficiency level. This paper makes an attempt to analyze the performance of five manufacturing Industries (Food Industries; basic chemical Industries; Basic Metal Industries; Rubber, Plastic and petroleum and Machinery and equipments Industries) in 15 major Indian States in terms of technical efficiency from 1981-82 to 2001-02. For this we use panel data for 20 years from pre and post reforms period.

In Indian Context Several Studies have attempted to study the productivity of the Indian Industrial Sector (Brahmananda, 1982; Ahluwalia, 1991; Balakrishnan & Pushpangadhan, 1994; Dholokla & Dholokia, 1994; Srivastava, 1996; Goldar, 2002, 2004) Majority of these studies have focused on the measurement of productivity or the methodological aspects associated with it. Some of these studies have also examined the relationship between policy changes and movement of Industrial Productivity. The literature on productivity in India has also made an attempt to examine the relationship between economic reforms and manufacturing productivity. Some studies have showed that the total factor productivity growth has improved in the reforms period (Krishna & Mitra, 1998; Unel, 2003) whereas studies by Goldar and Kumari (2003) and Balakrishnan, Pushpangadan & Suresh Babu (2000) have found that the economic reforms have adversely affected Industrial Productivity. There are also studies that examined technical efficiency of manufacturing industry in 1990's. Agarwal (2001) analyses the performance of some selected public sector firms in terms of their technical efficiency. Mitra (1999) focuses on the State wise analyses of technical efficiency of the manufacturing Industry for the period 1976-77 to 1992 -93. Agarwal & Goldar (1999) examined the determinants of the technical efficiency of firms. Goldar, Renganathan and Banga (2003) have examined the effect of ownership of Industrial enterprises on their efficiency during the period from 1990-91 to 1999-2000. They clearly indicate that foreign firms on Indian engineering Industry have higher technical efficiency than domestically owned firms. Subash Roy (2002) has studied the levels of technical efficiency for manufacturing sector for each state in the pre and post reforms period. He examined whether the post reform years show any improvement in efficiency and which of the States have shown the most gain in efficiency.

The purpose of our present study is to make an objective assessment of the impact of series of reforms taken in 1991 on technical efficiency in selected Indian manufacturing. By making Indian manufacturing more competitive these reforms should lead to more efficient utilization of resources. As a result technical efficiency would improve. in this paper, state-level input & output data constructed from the annual survey of industries (ASI) for the period 1981-82 through 2001-02 are analyzed to measure levels of technical efficiency in each state for each of the sample years using the stochastic frontier approach (SFA).The resulting information is used to examine whether the post–reforms years show an improvement in efficiency compared to the years prior to the reforms.

The paper is organized as follows. In section 2 we discuss alternative approaches for measuring efficiency. We outline here the existing theory of the stochastic frontier model- a model that has been used extensively in the literature to estimate technical efficiency. Section 3 presents a description of our dataset, definitions of the variables considered for our analysis and the model. Section 4 presents the empirical results, and section 5 concludes.

2. Model for Measuring Efficiency:

Measurement of efficiency of a producing unit effectively started with the analysis of Farrell (1957). A distinction is made between TE and allocative efficiency (AE). In the case of TE, a comparison is made between observed output and the maximum potential output obtainable from the given inputs (an output-oriented efficiency) or between the observed inputs and the minimum possible inputs required to produce a given level of outputs (an input-oriented efficiency). The AE, in contrast, refers to the ability of a firm to combine inputs and outputs in optimal proportions, given their respective prices and production technology (see Coelli et al., 1998, pp. 134-140, and Lovell, 1993, p. 40, for detailed discussions).

A substantial literature, both theoretical and empirical, exists using Farrell's (1957) classic definition of TE. Basically there are two alternative methods to measure the TE scores of firms: data envelopment analysis, which involves mathematical programming methods, and the stochastic frontier approach, which involves econometric methods. In this study, we only consider estimation using the stochastic frontier models, which were developed independently by Aigner et al. (1977) and Meeusen and van den Broeck (1977).

To briefly describe this method,consider a stochastic production frontier, $f\left(X_i;\beta\right)\exp\left(v_i\right)$, which
represents the maximum possible output producible with the input vector used by the *i*th firm, X_i, given the corresponding vector of technology parameters, β, and a random variable seeking to capture all random factors outside the control of this firm e.g., weather, natural disaster, and strikes) that are likely to affect its maximum possible output, v_i. However, the *i*th firm's observed output, Y_i, may lie below the frontier output for a variety of reasons, e.g., workers shirking or having lower ability, poor management decisions, or inadequate monitoring efforts (Ray, 2004, pp. 13-14). Such shortfalls are then attributed to the presence of technical inefficiency in the firm. Since the actual output can be no more than the frontier output, we may write:

$$Y_i = f\left(X_i;\beta\right)\exp\left(v_i\right)\exp\left(-u_i\right), \quad (1)$$

With $u_i \geq 0$ implying that $\exp\left(-u_i\right) \leq 1$. A measure – or, as it is called in the literature, an output-oriented Farrell measure – of the TE of the *i*th firm. TE_i, is then given by the ratio of the actual output to the frontier output:

$$TE_i = \frac{Y_i}{f\left(X_i;\beta\right)\exp\left(v_i\right)} = \exp\left(-u_i\right), \quad (2)$$

for $u_i \geq 0$. Since $\exp\left(-u_i\right) \cong 1-u_i$, the TE_i varies inversely with u_i and lies between 0 and 1. The maximum value 1 is attained when $u_i = 0$, i.e., there is no inefficiency. Alternatively, u_i may be taken as an index of inefficiency.

To estimate the magnitude of technical inefficiency prevailing across firms in the particular industry in question, we follow the procedure of Battese and Coelli (1993) and Lundvall and Battese (2000). It may be noted that in (1) there are two error terms. One is u_i, a non-negative random variable introduced so as to measure the magnitude of technical inefficiency in production prevailing in the *i*th firm. The other is the usual error term, v_i. It is assumed that the v_i are independently, identically normally distributed with mean zero and variance σ_v^2 , and the u_i are independently distributed from a normal distribution with mean μ_i and variance σ_u^2 truncated at zero. Further, the v_i and u_i are assumed to be independent of each other.

Several empirical studies have investigated the determinants of TEs at the firm level through a two-stage procedure. In the first stage, efficiency indices for individual firms are estimated by fitting a stochastic frontier, and in the second stage, the estimated efficiency levels are regressed on firm-specific factors (see, for an example in the Indian context, Goldar et al., 2004, and Nikaido, 2004). Such an approach has, however, been argued to suffer from an inconsistency of assumptions (see Coelli et al., 1998, pp. 207-209, and Kumbhakar and Lovell, 2000, pp. 262-264, for discussion of this point and for references to other relevant studies).

An alternative approach, developed by Battese and Coelli (1993), seeks to estimate and explain firms' efficiency at the same time. We follow this approach here. This approach consists of adding to (1) the following relation explaining the inefficiency of the *i*th firm in terms of a vector of firm-specific variables, z_i, and then estimating the vector of associated parameters, δ, along with the parameters of frontier production function through a single-stage maximum likelihood method. The mean technical inefficiency is thus written:

$$\mu_i = \delta' z_i , \quad (3)$$

where δ' is the transpose of δ. This assumption is consistent with the assumption that u_i comes from a truncation of $N\left(\delta' z_i , \sigma_u^2\right)$. Further, for this type of specification, we can easily obtain the density function of u_i conditional on $\varepsilon_i = v_i - u_i$ as well as the expected value of TE_i given ε_i, i.e., $E\left[\exp\left(-u_i\right)\middle|\varepsilon_i\right]$ (for details, see Battese and Coelli, 1988, 1993).

3. Sources of data and model:

We measure the technical efficiency of manufacturing Industries for 15 major States over the period from 1981-82 to 2001-02. The data used in this study for different manufacturing Industry are collected by the Central Statistical Organization (CSO) of the Government of India through its ASI. We use five variables in our empirical analyses. For output we use date on gross value added. The gross measure of value added is obtained by adding depreciation to net value added. The date on gross value added is deflated using industry specific wholesale prices (at 1993-94 prices). For labor input, the total number of persons employed is used. Net fixed capital stock is taken as the measure of capital input. The construction of net fixed capital series has been done by perpetual inventory Accumulation Method. Other inputs used are Material and Fuel. Data of material & fuel are collected from the reported series of material and fuel (ASI). Material and Fuel inputs are deflated by appropriate price indices of each industry.

To measure the technical efficiency of States overtime and to explain some factors of technical inefficiencies, we are using a stochastic frontier production function, along with an inefficiency model as proposed by Battese and Coelli (1995). We employ the model developed by Battese and Coelli, as the stochastic frontier production and the technical inefficiency functions can be estimated simultaneously.

We assume that the frontier production function is of Cobb-Douglas Form as given in equation (1)

$$In Y_{it} = \beta_0 + \sum_{j=1}^{4} \beta \, In X_{jit} + \beta_t T + \sum_{j=1}^{4} \beta_{tj} t_x In X_{jit} + V_{it} - U_{it} \quad \text{..........} (1)$$

The subscripts *i* and *t* indicate the ith state and the t^{th} year of observation respectively where Ln Y represents output (gross value added), X_1 represents capital stock, X_2 represents labour employed, X_3 represents Fuel and X_4 represents Material. T is the time trend included in the equation to allow frontier to shift over time.

The V_{its} are assumed to be independently and identically distributed normal random variables with mean zero and variance, σ_v^2 ; and

the U_{it} s are non-negative random variables, associated with technical inefficiency, which are assumed to be independently distributed, such that U_{it} is the truncation (at zero) of the normal distribution with mean, μ_{it}, and variance σ^2.

where μ_{it} is defined as follows:

$\mu_{it} = \delta_0 + \delta_1$ (Industrial disputes) + δ_2 (Trade openness index) + δ_3 (Bank / Population) + δ_4 Reforms Dummy + δ_5 (Time)................ (2)

We have considered certain factors that have very important influence on the industrial efficiency. These factors may be economic or non economic in character. One of the most important factors is the man days lost due to industrial disputes resulting strikes and lockouts in different states over the year of our study.

Industrial disputes affect efficiency in at least two ways –direct and indirect effect. Consider two production units A and B both using the same amount of labor now suppose there is a loss of man days due to industrial disputes in A. Consequently A will be able to produce less output than B with the same labour.This is a direct loss of efficiency. On the other hand, industrial dispute lowers the morale of both the worker & employees .This loss in cohesion again crop up in reduced efficiency. This is the indirect effect on efficiency. In short the atmosphere in industrial disputes is not very conducive in a healthy work environment that is so necessary in efficient production.

Many trade economists think that there is a relationship between trade & manufacturing efficiency. There are many mechanisms by which a liberal trade regime should affect efficiency in manufacturing. The first mechanism arises from the fact that in order to compete against international producers, domestic firms must adopt newer & more efficient technology. The second reason arises from the difficulty of replacing imports of intermediate & capital goods by domestically produced goods. Increased availability of better as well as differentiated imported intermediates & capital goods should lead to higher output & improved efficiency for industries in developing countries. The third explanation for efficiency improvement is that higher volumes of exports & imports increase international technical knowledge spillovers. Increased access to knowledge in turn leads to better improvements to the manufacturing process. In this way efficiency may increase. To explore the relationship between trade & efficiency we have used the trade openness index as constructed by Margit, Kar & Maity,(2007). The purpose of construction of this index is to study how Indian States are “Open” with respect to international trade. This methodology can be applied to the Indian case where state level trade data is not available. This trade openness may have positive impact on productivity and growth. Openness exposes countries to the most advanced new ideas and methods of production dictated by international behavior and thus it enhances efficiency. Here we will see whether there is any impact of trade openness on efficiency. If a state has a high production share of the item which is chief export items of the country, then it can be inferred that this state is contributing more to exports than others. And the state is more “open”. Correspondingly if a state has high production value of import substitutes

then it must be relying less on imports and hence is not so “open”. Thus, in their study, a state to be open requires consistency of its production structure with the trade pattern of the country.
Infrastructural development is very crucial for the development of industrial sector in a state. Banking facilities in a state is an important component of infrastructure. Banks usually cater the financial needs for the promotion, expansion and upgradation of industrial sectors of a state. Depending upon the bank per population ratio we can classify different states as highly developed states, moderately developed states and low developed states. Developed states may have some positive impact on productivity and efficiency. So in our study we can have a proportional relation between bank per population ratio and efficiency.

The time trend is included in the model to allow the inefficiency effects to change over time. A dummy variable is included to capture the effect of the changed economic environment on technical inefficiency. The dummy takes value zero till 1990-91 and there after one.

4. Empirical Results

The frontier production function defined by (4) and the inefficiency model defined by (5) are estimated simultaneously by using maximum likelihood method for five industries separately (Manufacture of food products, Manufacture of Basic Metals, Manufacture of Chemicals and Chemical Products, Manufacture of Rubber, Plastic products, coke & petroleum products and Manufacture of Machinery & equipments). For estimating the model (4) and (5) we have used Frontier Computer programme (Version 4.1) described in Coelli (1994).

First we test for some restrictions on the production Frontier and inefficiency model. For this we use the generalized likelihood-ratio (LR) statistic. This test statistic has a chi-square (or a mixed chi-square distribution) with degrees of freedom equal to the difference between the parameters in the null and alternative hypothesis. Table-1 presents the results of these tests.

Table 1 : Generalised Likelihood-Ratio tests of hypothesis for parameters of the Stochastic Production functions

Null Hypothesis	Machinery & equipments	Basic Metal	Chemical & chemical products	Rubber, Plastic coke & petroleum products	Food	Critical value
1. No Technical change $H_0=\beta_5=\beta_6=\beta_7=\beta_8=\beta_9=0$	29.24	–12.18	9.40	7.7	25.04	11.07* 9.24#
2. No Technical inefficiency $\gamma==\delta_1=\delta_2=\delta_3=\delta_4=\delta_5=0$	13.34	227.44	155.91	21.59	73.64	11.91**

*All critical values are at 5 percent level of significance.
#All critical values are at 10 percent level of significance.
**The critical value for the test involving =0 are obtained from Table 1 of Kodde & Palm (1986).

The null hypothesis which includes the restriction that γ is zero does not have a chi square distribution. In this case the LR statistic follows a mixed chi-square distribution with the degress of freedom are q+1 and q is the number of parameters which are specified to be zero.

The first null hypothesis of no technological progress at the frontier is rejected for Machinery & equipments industry, chemical & chemical product industry and food industry, implying shift of the production frontier over time. The second null hypothesis of no technical inefficiency effects is rejected in all industries. Thus, given that the technology can be described by the stochastic frontier, industries can not be supposed to be technically efficient. The parameter γ measures the proportion of the total variability in output due to variation in technical efficiencies. We can see from the results of table 3 that there is evidence that Stochastic frontier model is an appropriate specification, since γ is statistically significant in all the industries. Hence the inefficiency effects are important, as indicated in Table 3 also, with the rejection of null hypothesis that $\gamma = \delta = 0$.

Technical efficiency score for each state in the five industries are predicted for each year. The TE scores are further classified into pre-reforms period (1980-81 to 1990-91) and post-reforms period (1991-92 to 2001-02). The average level of technical efficiency scores are calculated for each state in the five industries in two sub period and for the entire period of study. From Table-2 we can see that majority of the States have shown a decline in the level of technical efficiency scores in the post reforms period expect in the Rubber, Plastic, Petroleum & coal product industry. In that industry we have seen a substantial increase in level technical efficiency in all the 15 States of our study. Graphically we have also plotted the efficiency scores of best performing state, medium performing state, &worst performing state in Rubber, Plastic and petroleum sector. Among the five manufacturing sectors only in this sector we have seen a increasing trend in the efficiency score.

We also estimated the technical inefficiency levels in the 5 manufacturing industries and the results are presented in Table 3. The estimates of the inefficiency model (given in table 3) give how the technical inefficiency is related to variables of our interest.

The coefficients of industrial dispute have significant positive sign in Machinery & equipments and chemical & chemical product industries. In these two industries industrial disputes has an unfavorable effect on technical efficiency over different States of our study. Industrial disputes are the result of clash of interest between the employee and employer. Absence of suitable environment to work leads to fall in the level of efficiencies in two industries of our study. In the rest of three industries the industrial disputes have insignificant unfavorable impact on efficiencies

Trade openness index has significant positive effect on technical efficiency in Basic metal & Rubber, Plastic & Petroleum industries. In chemical & chemical products industry the trade openness index has significant positive sign, i.e, trade openness increases the level of inefficiency. The counter intuitive result in the case of chemical & chemical product industries may be explained due to persistence of structural constraints, an obsolescence of the applied technology. It may be that existing chemical industries in India were using some obsolete technology that did not permit further fall in cost as the market is opened up. This may have raised the inefficiency.

Expansion of bank branches, i.e. bank per population has a significant negative effect on technical inefficiency in three industries, i.e. Machinery & equipments, Basic Metal and chemical & chemical product. As bank per population increases in different states, it increases the level of technical efficiency in these three industries. The bank per population ratio can be used to classify states into highly developed, moderately developed & low developed. With the increase in this ratio the level of efficiencies have increased in three industries of our study.

The dummy variable representing the change in economic policy environment since 1991 has a significant positive sign in Machinery & equipments and basic metal industries. This indicates that the change in the policy has an unfavorable effect on its efficiency. In chemical & chemical product industry the reform dummy has a significant negative sign, indicating that post 1991 period has a favorable effect on its efficiency.

The estimated value of δ_5 (Time) is positive and statistically significant in machinery & equipments, Basic metal and chemical & chemical product industries. This indicates that inefficiency has increased over time in these three industries of our study. In Rubber Plastic petroleum industries the coefficient has significant negative sign. It indicates that out of the 5 industries of our study, this is the only industry where efficiency has increased over time.

5. Conclusions

In this paper we use state level data on manufacturing inputs & outputs from Annual Survey of Industries for the years 1981-82 through 2000-01 to measure the technical efficiency in five selected manufacturing industries in India utilizing a stochastic frontier approach. In this analysis we have used a panel of 15 Indian States over the 21 years period (1980-81 to 2000-01). Our analysis showed that technical efficiency levels have decreased in four manufacturing sectors in the post reform period and increased only in one. Among the factors that influenced efficiency, man days lost due to industrial dispute has a negative effect while trade openness seems to boost efficiency. The infrastructural parameter such as bank per population has also a favorable effect. To analyze the effect of liberalization on efficiency ,we also include a trend term that will capture the change in efficiency over time(trend).It shows a declining trend in efficiency levels in all the manufacturing sectors expect one(Rubber,plastic,petroleum & coal products).

In this paper, we began with the expectation that liberalisation in India is likely to increase the level of efficiency on manufacturing sector. But here we found that the level of efficiency has fallen. The factors like trade openness, bank branches per population have favorable impact on efficiency. These result seemed to contradict our general findings regarding the increasing inefficiency in the post liberalization period. However liberalization is a very broad process involving many types of structural reforms. Increase in trade openness, bank branches is only a part of it. Thus this is a partial effect while the former (the effect of liberalization) is a general effect. It is not necessary that they should converge. Industries have various structural constraint, technological obsolescence, inflexibilities etc. Liberalization is bound to affect these in a negative way, though trade openness is by itself may be beneficial, by creating larger markets for the outputs. On the whole though reforms seemed to have a negative effect on efficiency, it is mostly cluster of other factors that are responsible for this seemingly perverse result.

Table-2 Technical efficiency scores in five industries

Food industries				Machinery & equipments			
	Pre.GM MEAN	Post.GM Mean	overall mean.(GM)		Pre.GM MEAN	Post.GM Mean	overall mean.(GM)
AP	0.774	0.719	0.744	AP	0.926	0.926	0.926
ASSAM	0.815	0.827	0.821	ASSAM	0.948	0.922	0.934
BIHAR	0.759	0.783	0.772	BIHAR	0.953	0.928	0.94
GUJRAT	0.792	0.729	0.758	GUJRAT	0.92	0.935	0.928
HARAYANA	0.906	0.825	0.863	HARAYANA	0.932	0.907	0.919
KARNAT	0.877	0.883	0.88	KARNAT	0.949	0.931	0.94
KERALA	0.912	0.898	0.905	KERALA	0.909	0.878	0.893
MP	0.792	0.715	0.751	MP	0.939	0.919	0.928
MAH	0.901	0.881	0.89	MAH	0.954	0.957	0.956
ORRI	0.786	0.56	0.658	ORRI	0.904	0.931	0.918
PUNJ	0.911	0.915	0.913	PUNJ	0.899	0.892	0.895
RAJ	0.566	0.678	0.623	RAJ	0.907	0.913	0.91
T.NADU	0.881	0.836	0.857	T.NADU	0.917	0.898	0.907
UP	0.749	0.748	0.748	UP	0.931	0.941	0.936
WB	0.679	0.603	0.638	WB	0.934	0.935	0.935
Basic metal				Chemical & chemical products			
AP	0.74	0.511	0.609	AP	0.672	0.805	0.738
ASSAM	0.817	0.687	0.746	ASSAM	0.505	0.354	0.419
BIHAR	0.866	0.253	0.468	BIHAR	0.484	0.179	0.302
GUJRAT	0.825	0.668	0.738	GUJRAT	0.816	0.681	0.743
HARAYANA	0.838	0.762	0.797	HARAYANA	0.722	0.668	0.693
KARNAT	0.585	0.674	0.63	KARNAT	0.861	0.861	0.861
KERALA	0.834	0.793	0.812	KERALA	0.901	0.821	0.858
MP	0.819	0.631	0.715	MP	0.77	0.777	0.774
MAH	0.89	0.562	0.7	MAH	0.875	0.791	0.83
ORRI	0.732	0.739	0.736	ORRI	0.542	0.255	0.348
PUNJ	0.819	0.62	0.708	PUNJ	0.829	0.802	0.815
RAJ	0.701	0.328	0.471	RAJ	0.726	0.812	0.77
T.NADU	0.767	0.58	0.663	T.NADU	0.785	0.717	0.749
UP	0.847	0.786	0.814	UP	0.724	0.741	0.733
WB	0.689	0.649	0.668	WB	0.572	0.732	0.651

Rubber,plastic ,petroleum							
	Pre.GM	Post.GM	overall		Pre.GM	Post.GM	overall
	MEAN	Mean	mean.(GM)		MEAN	Mean	mean.(GM)
AP	0.438	0.88	0.632	MAH	0.491	0.9	0.674
ASSAM	0.464	0.955	0.677	ORRI	0.454	0.89	0.646
BIHAR	0.537	0.955	0.726	PUNJ	0.414	0.784	0.579
GUJRAT	0.46	0.89	0.64	RAJ	0.374	0.759	0.542
HARAYANA	0.5	0.873	0.669	T.NADU	0.44	0.839	0.617
KARNAT	0.483	0.884	0.663	UP	0.441	0.893	0.651
KERALA	0.488	0.938	0.687	WB	0.435	0.837	0.613
MP	0.473	0.856	0.637				

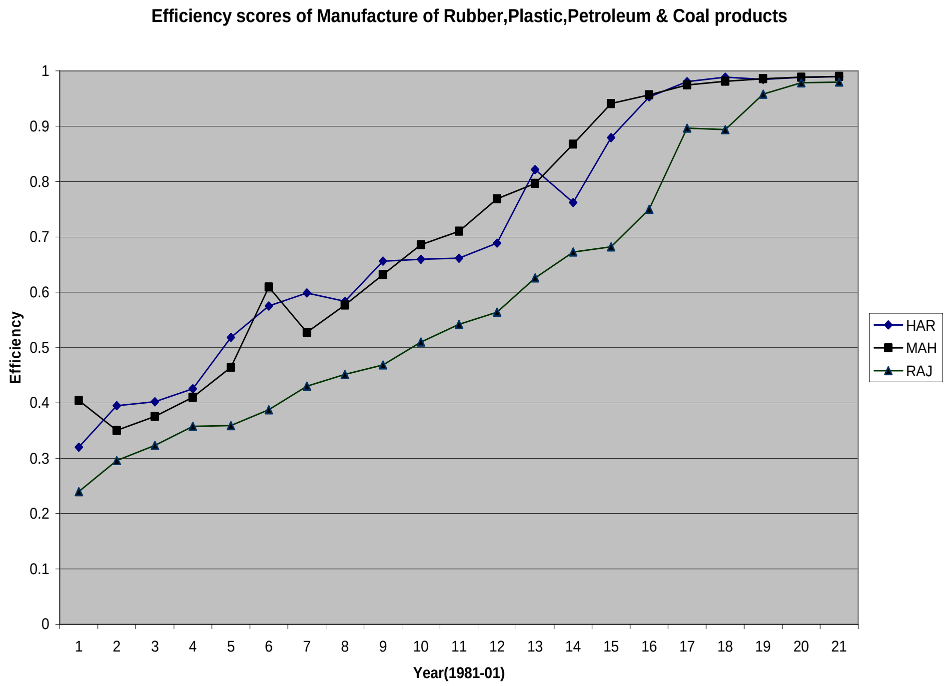

Table – 3

		Machinery & equipments	Basic Metal & alloys	Chemical & Chemical Products	Rubber, Plastic Petroleum & coal Products	Food
Intercept	β_0	–.345(–.385)	–2.87(–3.14)	–1.98 (1.88)	.681(.586)	1.79(1.74)
ln (K) (Capital)	β_1	.520(5.80)	.590(8.15)	.331(4.09)	.228(2.24)	.221(2.17)
ln Lab (L)	β_2	.544(5.55)	–.0063(.070)	.303(3.17)	.0002(–.004)	.484(6.97)
Ln Fuel (F)	β_3	.061(–.797)	.100(.924)	.113(1.26)	.240(2.45)	.629(5.57)
Ln Materials	β_4	.044(.405)	.254(2.79)	.361(4.16)	.441(4.73)	–.257(–1.97)
Time (t)	β_5	.148(2.41)	.119(1.70)	–.167(1.78)	–.059(–.610)	–.140(–1.65)
t* Ln(k)	β_6	–.030(–4.79)	–.010(–1.51)	.014(2.00)	.0009(.114)	.0097(1.12)
t * Ln (L)	β_7	–.001(–.1.63)	.0062(.838)	–.013(–1.67)	–.0007(–1.28)	–.010(–1.99)
t * Ln(F)	β_8	.006(.969)	–.0165(1.81)	–.006(–.937)	.0020(.270)	–.033(–3.75)
t* Ln (M)	β_9	.033(3.90)	–.011(–1.49)	.005(.751)	–.0017(–.249)	.030(2.92)
In efficiency model :						
Constant	δ_0	–.991(–3.80)	–7.53(–6.25)	–7.51(–9.19)	1.63(5.21)	3.01(1.75)
Industrial disputes	δ_1	.481(3.50)	.017(.023)	2.47(5.42)	.0281(.413)	.577(1.17)
Trade Openness Index	δ_2	.0155(.903)	–.442(–7.83)	.484(7.80)	–.047(–3.67)	–.186(–1.25)
Bank/ Population	δ_3	–19.91(–2.66)	–15.20(–3.99)	–75.9(–4.46)	–.916(–1.00)	–52.53(–1.34)
Pre/Post Reforms Dummy	δ_4	.755(2.03)	1.57(1.61)	–2.53(–4.93)	.040(.226)	.277(.488)
Time	δ_5	.564(3.80)	.380(6.30)	.438(7.06)	–.076(–3.92)	.324(.667)
Variance parameters :						
σ^2		.155(7.06)	2.80(7.11)	1.96(6.74)	.211(19.03)	.445(1.41)
γ		.734(12.24)	.983(247.17)	.982(205.70)	.020(1.90)	.910(15.70)
LLF		17.807	–153.61	–121.54	–204.93	–53.54
LR of one sided error		13.34	227.44	155.91	21.59	73.64

Figures in the bracket represent *t* value.
The coefficients (δ_0 -δ_5) are determinants of inefficiency: a positive coefficient implies that the variable increases inefficiencies or decreases efficiency

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