ENSEMBLE
A bi-lingual peer reviewed academic journal
ISSN: 2582 - 0427 (Online)
Vol. 2, No. 2
September, 2020
http://www.ensembledrms.in

Article Type: Research Article
Article Ref. No.: 200510153N2AASR
https://doi.org/10.37948/ensemble-2021-0202-a020

A PERFORMANCE ANALYSIS OF HIGH-GROWTH INDUSTRIES IN THE POST-REFORM INDIA

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Abstract:

This paper[a] attempts to analyze the Technical and Economic Efficiency of four high performing manufacturing industries of India, viz., (i) Paper and paper products, (ii) Publishing, printing and reproduction of recorded media, (iii) Other non-metallic mineral products & (iv) Basic metals, in the post reform period. These four industries have been selected after comparing their growth rates among seventeen major industries with respect to the average industrial performance, which are calculated from ASI two digit level data for over two separate fifteen years span (1981-1995) & (1996-2010) representing the pre and post globalization states. After selecting the industries focus has been placed on their state of technical efficiency at the firm level. Here the analysis is carried out in terms of unit level ASI data and the method applied is the Stochastic Frontier Analysis. The years selected are 2003-04 and 2008-09. At the next step only the technically efficient firms have been culled out and an industry-wise analysis of their relative economic efficiency has been presented by considering the Generalized Leontief Production Function and applying Full Information Maximum Likelihood technique.

Article History: Submitted on 10 May 2020 | Accepted on 13 Feb 2021 | Published online on 01 Jul 2021

Keywords: Technical Efficiency, Stochastic Frontier Analysis (SFA), Allocative Efficiency, Generalized Leontief Production Function, Full-information-maximum-likelihood technique, Shadow Prices

1.0 Motivation:

After overcoming the initial phase of inertia, India has gained a worldwide recognition as one of the emerging economies and, the global presence of India in the commodity market has gone up substantially over years. Whether the benefit of this growth has been evenly shared by all industries or remaining concentrated to only a few, whether proceed of this growth has been equally enjoyed by all factors of production, whether irrespective of the industry-type the engine of growth is vested in the hand of bigger firms and whether the excellence attained by a section in production and allocation is giving any spill over benefit to the rest are some of the pertinent issues to be addressed. Given the time and space constraints, in this paper we have kept our focus limited to the questions like (i) which are the major industries that picked up very well in the post-reform period? (ii) What is the status of technical efficiency of these industries? Are they operating

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without slacks? (iii) Even when they are technically efficient are they efficient in economic sense? A systematic exploration of these questions is expected to shed light on the designing of more targeted industrial policies and will make the growth-path sustainable over time.

In this backdrop the rest of the paper is organized as follows: Section 2.0 presents an exploratory analysis carried over a 30 year period of industrial performance in India divided into two phases, 1981-82 to 1995-96: the pre-reform period and 1996-97 to 2010-11: the post-reform period. The major purpose of this analysis is to identify the sectors where new growth potential has been observed. Various policy reforms had been taken since 1980 but India had experienced major economic reform during 1991-93 when the government of India officially declared Economics Reform Policy in 1991. The major focus was to integrate India with the world economy. Globalization, privatization and liberalization jointly represent to this reform process. In literature like Ahluwalia (2002), Goldar (2004) and Sharma (2014) has defined the period before 1991 as pre reform period and the later period has been defined as the post reform period. Sarkar & Mehta (2010) and Veermani (2007) has defined period from 1993-94 onwards as post reform period. Siggel & Agarwal (2009) carried a small sample survey of manufacturing enterprises in the Delhi Region and found that maximum firms from the sample experienced increase competitive pressure in the late 1990s and after 2000s. This shows that import restrictions removed gradually after the reform in 1991 and a considerable time has taken to adjust with trade liberalization. Ahluwalia (2002) stated the Indian reform as gradualist and estimated that Indian economy had experienced 6.7% of growth during the first five years of Economic Reforms but for the next five years it slowed down to 5.4%. This reduction in growth rate was not due to the effect of reform but due to the failure to execute the reform successfully. From the early literature it can be state that the impact of reform has not seen from the immediate next years, rather it took time to adjust with reform properly and to experience the impact of reform. It may expect that to experience the impact of any policy change a minimum time period is required. In the current study the objective is to capture the impact of reform on Indian industry which only could be noticed after few years. So, in the current paper the period from 1996-97 to 2010-11 is being considered as the post reform period. Section 3.0, using unit-level ASI data will carry out an analysis to estimate the output-oriented efficiency score of individual factories belonging to these sectors by applying Stochastic Frontier Analysis (SFA) on TRANSLOG production function for two specific years: 2003-04 and 2008-09. Main objective is to find out technical efficiency and then to find out whether these technically efficient firms are also achieving allocative efficiency or not. The industries for which Section 3.0 and 4.0 would be calculated are new emerging industries and during the pre reform period performance of these industries were below the average. Therefore, it is unnecessary to calculate technical efficiency for pre reform period as during that period; lower performance indicates that they were inefficient. The year 2003-04 is selected as it is the starting point when India gained recognition as a BRIC member and the latter year is the year of global financial crisis that destabilized most of the major economies of the world. Section 4.0 will cull out the efficient units from these selected industries and will verify for their economic efficiency in terms of correspondence between observed and ideal input-price ration at the point of actual input use. Here a generalized Leontief type cost function will help us to carry out the input-oriented allocative efficiency scores. Finally, the paper will conclude by presenting an overall assessment of the scenario to indicate the specific gaps in the existing policy formulation which could be plugged better in terms of more specifically targeted interventions.

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[a] Authors wish to acknowledge the intellectual support and encouragement obtained from Professor Sarmila Banerjee, Department of Economics, University of Calcutta.

2.0 Selection of High Growth Industry in Post Reform Era: an Exploratory Analysis:

2.1. Selection of Periods and Database:

Here the data on manufacturing sectors have been collected over the two separate fifteen year span 1981-1995 & 1996-2010 for comparing pre & post globalization periods. Further decomposition has been taken by considering the sector specific contributions in Gross Value Added (GVA) and Employment generation. Finally, the sectors have been classified into four subsectors depending on their production performance over two decades which are performing above average in "Pre" and below average in "Post" globalization periods. Data are basically taken from Annual Survey of Industry (ASI) and Index of Industrial Production (IIP) for this part of the analysis *(see Table 1)*.

Table 1: Data Sources

Annual Survey of Industries (ASI)	Up to 1997-98 From EPW Research Foundation's Book
Annual Survey of Industries (ASI)	From the website of Ministry of Statistics and Program Implementation (www.mospi.nic.in) for 1998-99 To 2007-08;
Index of Industrial Production (IIP)	Up To 1981-1997 from Chandog Group Publication on the Indian Economy
Index of Industrial Production (IIP)	Up To 1993-94 To 2010-11 from www.rbi.org (Database of Indian Economy)

Source: Authors' compilation

The four variables have been collected for 17 major industries which are Gross Value Added (GVA), Fixed Capital (FC), Depreciation (D) and Total Emoluments (EM) from ASI, according to NIC classification at 2 digit levels with considering time based concordance tables, provided by the Central Statistical Organization (CSO). Finally, using IIP as a deflator, all the nominal variables have been converted to constant price at the base year 1993-14.

2.2. Selection of High Growth Industries:

The industries are matched over time in terms of NIC codes and in this process 17 industries could be identified. These 17 major industries is capturing at least 75% and at most 97% of total industrial production over the selected reference period (1981-82 to 2010-11 ; *see Table 2)*.

Table 2: Share of Selected Industries in Total Industrial Production

Year	% of Total Industrial Output	Year	% of Total Industrial Output
1981-82	88.3	1996-97	95.2
1982-83	92.6	1997-98	87.8
1983-84	86.2	1998-99	90.0
1984-85	94.4	1999-00	91.2
1985-86	96.1	2000-01	90.2
1986-87	93.2	2001-02	89.6
1987-88	95.8	2002-03	89.9
1988-89	97.3	2003-04	90.0
1989-90	94.0	2004-05	90.9
1990-91	95.4	2005-06	90.0
1991-92	96.0	2006-07	89.8
1992-93	93.4	2007-08	89.1
1993-94	88.8	2008-09	81.0
1994-95	92.9	2009-10	75.7
1995-96	95.0	2010-11	79.0

Source: EPWRF, 2002; MOSPI-2016

So, the analysis carried out in terms of these industries can be taken as fairly representative in nature.

It has been found that the Textile Industry has performed at highest level in terms of Annual Average Growth Rate (AAGR) of GVA, Fixed Capital & Employment, over the three conductive periods, 1981-90; 1991-00 and 2001-10 among those 17 industries *(see, Table 3)*. In terms of GVA growth, further it can be said that manufacturing industry of Electrical Machinery and Apparatus N.E.C have shown negative growth rate over the three decades and it had the lowest growth rate during the first decade. In the first and second decades, textile industry had the highest growth rate of 44.75% and 89.2% respectively and then again it had dropped down to 14.3% during the last decade. On the other hand, in the second decade six manufacturing industries had experienced negative growth rates namely, Electrical Machinery and Apparatus N.E.C; Motor Vehicles, Trailers and Semi-Trailers; Other Transport Equipment; Wood And Wood Products; Machinery And Equipment N.E.C and Rubber And Plastic Product Industry.

Table 3: Rate of Growth of GVA, EMP and FC of Two-Digit Level of Industries (1981-90; 1991-00 and 2001-10)

Industry	Code	1981-90			1991-00			2001-10		
		GVA	EMP	FC	GVA	EMP	FC	GVA	EMP	FC
Electrical Machinery And Apparatus N.E.C	31	-2.2	3.4	-0.7	-3.7	-4.9	-4.1	-2.0	14.0	-4.1
Motor Vehicles, Trailers And Semi-Trailers	34	9.0	-0.5	5.9	-1.5	-5.3	4.1	8.5	20.6	4.1
Other Transport Equipment	35	9.0	-0.5	5.9	-6.3	-7.0	2.5	4.3	6.2	2.5
Paper And Paper Products	21	9.3	-0.2	7.7	8.3	-4.3	1.0	21.2	-0.6	1.0
Publishing, Printing And Reproduction Of Recorded Media	22	9.3	-0.2	7.7	0.6	-6.7	37.8	32.7	4.6	37.8
Wood And Wood Products	20	12.5	-1.8	23.4	0.1	-2.9	9.8	7.1	5.9	9.8
Furniture, Manufacturing N.E.C.	36	12.5	-1.8	16.4	54.1	7.8	2.3	-6.6	13.9	2.3
Basic Metals	27	13.3	0.6	18.1	0.9	-0.7	17.1	22.3	9.6	17.1
Machinery And Equipment N.E.C	29	13.4	1.8	21.4	-3.1	-5.6	0.5	1.3	7.3	0.5
Coke, Refined Petroleum Products And Nuclear Fuel	23	16.5	1.3	19.2	-4.1	-9.8	8.6	36.1	7.4	8.6
Rubber And Plastic Product	25	16.5	1.3	19.2	-6.4	-6.3	8.0	17.8	10.0	8.0
Chemical And Chemical Products	24	20.5	4.5	17.8	41.7	23.2	3.3	2.7	4.9	3.3
Other Non-Metallic Mineral Products	26	20.7	2.0	26.6	5.6	-0.5	9.2	15.7	10.9	9.2
Food Products And Breverages	15-16	24.4	-1.0	23.7	12.1	1.2	12.1	9.7	1.7	12.1
Leather And Related Product	19	33.1	7.7	26.3	2.4	2.7	10.9	12.8	11.1	10.9
Textiles	17	44.8	8.1	44.3	89.2	67.1	33.7	14.3	2.5	33.7

Source: EPWRF, 2002; MOSPI, 2016; DBIE-RBI, 2016

Out of these six industries all the industries except Electrical Machinery and Apparatus N.E.C had experienced positive growth rate during the last decade. Again last decade, Furniture & Manufacturing N.E.C. also experienced negative growth rate while this industry had positive growth rate for the previous two decades. Last but not the least at last decade Coke, Refined Petroleum Products and Nuclear Fuel industry had the highest growth rate of 36.1% while it had negative growth rate during the second decade. In terms of Employment Growth, the rate declined in seven industries out of total seventeen industries and the decline was the highest in Wood & Wood Products and Furniture, Manufacturing N.E.C. industries in first decades. For the next decade, again textile industry had experienced maximum growth rate in all the three aspects. In this decade employment growth rate had declined in ten industries. Declined in employment was the highest in Coke, Refined Petroleum Products and Nuclear Fuel Industry. Two industries (Furniture, Manufacturing N.E.C. and Food Products and Breverages) had experienced negative growth rate in employment during the first decade but then during the next decade these two industries had improvement in employment growth rate. During the last decade (2001-10) of our analysis only one industry, Paper and Paper Products had declined in employment growth rate while all other industries had positive growth rate. Finally in three decades only Electrical Machinery and Apparatus N.E.C. industry had declined in growth rate in Fixed Capital. Interestingly in first decade growth rate in fixed capital was the highest in Textile Industry (44.3%) while for the next two decade it was the highest for Publishing, Printing and Reproduction of Recorded Media industry, 37.8% *(see, Table 3)*.

Interestingly, the greater correlation coefficient between GVA and Fixed Capital than GVA and Employment, has explored the inclination for the implementation of capital intensive technique in Indian manufacturing sector *(see, Table 4)*.

Table 4: Correlation Coefficient between GVA, Employment & Fixed Capital

	GVA	EMP	FC
GVA	1.0		
EMP	0.5	1.0	
FC	0.8	0.4	1.0

Source: Authors' estimations

Considering the industry specific share of GVA and share of Employment over the period 1981 to 2010, it has been found that Coke, Refined Petroleum Products and Nuclear Fuel industry (15.39%) followed by Basic Metals (11.42%) and Chemical and Chemical products (11.36%) performed well. Share in employment was the highest in Food Products and Beverages industry (22.5%). Wood and Wood Products industry was lowest in terms of GVA and employment shares, 0.27% & 0.9% *(see, Table 5)* respectively.

Table 5: Share in GVA and employment in two digit industries, 1981-2010

Industries	Industries (NIC-98)	Share in GVA (%)	Share in EMP (%)
Wood And Wood Products	20	0.27	0.9
Leather And Related Product	19	0.71	1.7
Furniture, Manufacturing N.E.C.	36	0.75	1.6
Publishing, Printing And Reproduction Of Recorded Media	22	3.19	3.0
Paper And Paper Products	21	3.52	3.3
Other Transport Equipment	35	3.59	5.0
Electrical Machinery And Apparatus N.E.C	31	4.48	4.6
Motor Vehicles, Trailers And Semi-Trailers	34	4.66	6.0
Other Non-Metallic Mineral Products	26	5.49	6.6
Textiles	17	6.77	9.1
Rubber And Plastic Product	25	8.66	6.3
Machinery And Equipment N.E.C	29	9.68	9.2
Food Products And Beverages	15-16	10.07	22.5
Chemical And Chemical Products	24	11.36	6.7
Basic Metals	27	11.42	8.6
Coke, Refined Petroleum Products And Nuclear Fuel	23	15.39	4.9

Source: EPWRF, 2002; MOSPI-2016

Industries like, Food Products and Beverages, Textiles and Other Non-Metallic Mineral Products etc. industries exhibit their higher share in value added than in employment by lying below the 45^o diagonal line of Share of GVA & Employment reference frame *(see Fig. 1)*.

Other three industries are also lying below the diagonal line such as Publishing, Printing and Reproduction of Recorded Media, Paper & Paper Products and Rubber and Plastic Product etc. The calculated average growth rate for all the industries for the period 1981-1995 was 10.16% while it has surprisingly declined to only 5.22% for the next period 1996-2010. Growth of all the industries varied widely across the industries and it also varied within the same industry across the periods.

Average growth rate of gross value added for the period 1981-1995 has drawn in the X-axis and average growth rate of gross value added for the next fifteen years, 1996-2010, has been shown in the Y-axis in *Fig. 2*.

The growth rate of the two fifteen year periods coincide with each other at the point (10.16, 5.22) and divide the diagram into four subsectors. The industries which are placed in the *first quadrant* exhibit above average growth in GVA for both periods. The industries placed in the *second quadrant* actually performed better in the second period than first period. *Third quadrant* exhibits those industries which did not perform well in both periods. The industries placed in *fourth quadrant* performed above average in first periods but drop down below in second period. Four industries namely, *Manufacture of Paper and Paper Products (NIC98-21), Manufacture of Publishing, Printing and Reproduction of Recorded Media (NIC98-22), Manufacture of other Non-Metallic Mineral Products (NIC98-26)* and *Manufacture of Basic metals (NIC98-27)* are emerging industries which are performing well in post globalization period rather than pre.

Now the first question is, are they performing well in terms of GVA by adopting more efficient technique in post reform period? If yes, then the next question is, are they allocate there resources efficiently after achieving the technical efficiency? In the next section Firm Level Technical Efficiency Analysis of these four industries will be carried out at the two time points in post reform era for assessing their improvement in terms of technical efficiency.

3.0 Firm Level Technical Efficiency Analysis for Selected Industries: A Stochastic Frontier (SFA) Approach:

3.1. Two Selected Time Points in Post Reform Era for SFA Analysis:

In this section Stochastic Frontier Production Function (SFPF) technique has been adopted for estimating the technical efficiency by using disaggregated unit level ASI data for the year 2003-04 and 2008-09 of four selected industries.

3.2. Methodology of Technical Efficiency Estimation Using Stochastic Frontier Production Function (SFPF):

In general, SFPF considers the following specification of the production function: suppose there are k inputs (X_1, X_2, …., X_k), indexed by j, needed to produce a single output Y and there are N producing units indexed by i. The production frontier model may be written as:

$$\hat{Y}_i = f(X_i; \beta)$$

Equation (1)

Here $\hat{Y}_i$ is the maximum output of producer i, $f(X_i; \beta)$ is the production frontier, X_i is the vector of k inputs and β is the corresponding technology parameters. The actual production level will be represented as:

$Y_i = f(X_i; \beta)\mu$ …………. Equation (2), with μ representing TE.

By presuming a TRANSLOG functional form equation (1) can be written as a log-linear form

$$\ln f(X_i;\beta) = \beta_0 + \sum_{j=1}^{k}\beta_j \ln X_{ji} + \sum_{j=1}^{k}\frac{\beta_{jj}}{2}[\ln X_{ji}]^2 + \sum_{j,l=1}^{k}\beta_{jl}[\ln X_{ji}][\ln X_{li}]$$

Equation (3)

Denoting ($\ln X_{ji}$) as x_{ji} and ($\ln Y_i$) as y_i, the logarithm of observed output can be written as

$$y_i = \beta_0 + \sum_{j=1}^{k}\beta_j x_{ji} + \sum_{j=1}^{k}\frac{\beta_{jj}}{2}x_{ji}^2 + \sum_{j,l=1}^{k}\beta_{jl}x_{ji}x_{li} - u_i$$

Equation (3/)

Here u_i is the index of technical inefficiency of the i^{th} producing unit distributed independently and normally with mean 0 and variance σ_u^2 . Thus it should be assumed that $u_i \geq 0$for each i to ensure$Y_i \leq f(X_i;\beta)$ as for a particular vector of inputs the observed level of corresponding output for any firm cannot exceed the frontier. Therefore the distance CC/ (Fig. 3) would imply the TE and u_i is the technical inefficiency that yields an estimate of TE for each producer i.

Thus the specification of distribution is needed for this one sided inefficiency error component [in view of the fact that $TE_i = exp(-u_i)$]. This can follow different alternative specifications like exponential distribution, truncated normal distribution, gamma distribution or half-normal distribution. Here, u_i is distributed independently and normally with mean 0 and variance σ_u^2 , truncated at zero i.e. $u_i \sim$ iid $N^+(0, \sigma_u^2)$. Though u_i is capturing the extent of technical inefficiency, in this deterministic frame there is no scope to accommodate the possibility of random fluctuations in production those are beyond the control of any individual producer. As proposed by Aigner et. al. (1977) and Meeusen and Van Den Broeck (1977), the SFPF is able to capture these unobserved random factors provided an independent random term v is incorporated in the production frontier itself. This v would be independently and identically normally distributed with, 0 mean and constant variance σ_v^2 . By adding this random error term v to the non-negative variable u and assuming them to be uncorrelated equation (3) can be written as,

$$y_i = \beta_0 + \sum_{j=1}^{k}\beta_j x_{ji} + \sum_{j=1}^{k}\frac{\beta_{jj}}{2}x_{ji}^2 + \sum_{j,l=1}^{k}\beta_{jl}x_{ji}x_{li} + (v_i - u_i)$$

Equation (4)

$$y_i = \beta_0 + \sum_{j=1}^{k}\beta_j x_{ji} + \sum_{j=1}^{k}\frac{\beta_{jj}}{2}x_{ji}^2 + \sum_{j,l=1}^{k}\beta_{jl}x_{ji}x_{li} + \varepsilon_i$$

Equation (4/)

Thus,

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

Equation (5)

The joint density of u & v is:

$$f(u,v) = \frac{2}{2\pi\sigma_u\sigma_v}\exp\left\{-\frac{u^2}{2\sigma_u^2} - \frac{v^2}{2\sigma_v^2}\right\}$$

Equation (6)

Since $v = (\varepsilon + u)$, the joint density for u and ε is:

$$f(u,\varepsilon) = \frac{2}{2\pi\sigma_u\sigma_v}\exp\left\{-\frac{u^2}{2\sigma_u^2} - \frac{(\varepsilon+u)^2}{2\sigma_v^2}\right\}$$

Equation (6/)

The marginal density of ε is:

$$f(\varepsilon) = \int_0^\infty f(u, \varepsilon) du$$

$$= \frac{2}{\sqrt{2\pi}\sigma}\left[1 - \Phi\left(\frac{\varepsilon\lambda}{\sigma}\right)\right] \exp\left\{-\frac{\varepsilon^2}{2\sigma^2}\right\} = \frac{2}{\sigma}\varphi\left(\frac{\varepsilon}{\sigma}\right)\Phi\left(-\frac{\varepsilon\lambda}{\sigma}\right)$$

Equation (7)

where: $\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$ and $\lambda = \frac{\sigma_u}{\sigma_v}$

The log-likelihood function of the sample of N firms is:

$$\ln L = CONS - N\ln\sigma + \sum_{i=1}^{N} \ln\Phi\left(-\frac{\varepsilon_i\lambda}{\sigma}\right) - \frac{1}{2\sigma^2}\sum_{i=1}^{N} \varepsilon_i$$

Equation (8)

The conditional distribution of $u \mid \varepsilon$ is:

$$f(u|\varepsilon) = \frac{f(u, \varepsilon)}{f(\varepsilon)}$$

$$= \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(u-\mu)^2}{2\sigma^2}\right\}\left[1 - \Phi\left(-\frac{\mu}{\sigma}\right)\right]$$

Equation (9)

where: $\mu = -\frac{\varepsilon\sigma_u^2}{\sigma^2} \wedge \sigma^2 = \frac{\sigma_u^2\sigma_v^2}{\sigma^2}$

Estimated technical efficiency of the i[th] production unit:

$$TE_i = E(\exp\{-u_i\}|\varepsilon_i)$$

$$= \left[\frac{1-\Phi(\sigma-\mu_i\sigma)}{1-\Phi(-\mu_i\sigma)}\right] \exp\left\{-\mu_i + \frac{1}{2}\sigma^2\right\}$$

Equation (10)

3.3. Inputs & Output Variable Selection and Explicit Form of Estimated Production Function:

The input-output variables have been constructed according to Bhandari and Maiti (2007) from 5 digit level disaggregated unit level data of ASI. The variable structure is given below:

- **Output**: The total ex-factory value of products and by-products produced by the firm during the year in question (to be denoted by OUT).
- **Intermediate Inputs:** The nominal value of inputs (addition of indigenous and imported ones, including power, fuels etc.) used by the firm during the year (to be denoted by INTRINP).
- **Capital:** The net value of fixed assets of the firm at the beginning of a year (to be denoted by FA).
- **Labour**: The total number of man-days worked during the year (to be denoted by MDW).

This paper first estimates the TRANSLOG production function and firm level technical efficiency for 2003-04 and 2008-09 assuming that the inefficiency term follows the one-sided half normal distribution [Bandyopadhyay and Majumder (2013)]. In this exercise only those firms are considered which have positive value in every inputs and output. The estimated TRANSLOG production function is expressed in Equation-11

$$\ln(OUT) = \beta_0 + \beta_1 \ln(INTRINP) + \beta_2 \ln(FA) + \beta_3 \ln(MDW) + \frac{1}{2}\beta_{11}[\ln(INTRINP)]^2 + \beta_{12}[\ln(INTRINP) \times \ln(FA)] + \beta_{13}[\ln(INTRINP) \times \ln(MDW)] + \frac{1}{2}\beta_{22}[\ln(FA)]^2 + \beta_{23}[\ln(FA) \times \ln(MDW)] + \frac{1}{2}\beta_{33}[\ln(MDW)]^2 + (v_i - u_i)$$

Equation (11)

Where: $v_i \sim IN(0,\sigma_v^2)\forall i \& u_i \sim IID \sim N^+(0,\sigma_u^2)\forall i$;

In this paper the package ***"frontier"*** and ***"micEcon"*** have been used to estimate the translog production frontier and technical efficiency. These two packages have been operated in ***R-2.15.1*** statistical package. All the statistical estimations and tests have also been performed by syntax of R-***2.15.1*** used in Majumder, 2016. The estimated coefficients of the production function have been reported *Table 6 & 7* for the year 2003-04 & 2008-09.

Table 6: Estimated Coefficient of Frontier Model for 2003-04

Coefficient	Paper And Paper Products		Publishing, Printing And Reproduction of Recorded Media		Other Non-Metallic Mineral Products		Basic Metals	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
β_0	3.62809561	< 2.2e-16 ***	0.71037425	0.55012	2.9946955	< 2.2e-16 ***	1.88845	3.765e-08 ***
β_1	0.64025244	2.585e-16 ***	1.02997407	1.913e-06 ***	0.2126764	8.098e-06 ***	0.7242	< 2.2e-16 ***
β_2	-0.10214113	0.073903	-0.27230793	0.06051	-0.0388745	0.170545	0.03891	0.271
β_3	0.18682489	0.021903 *	0.54182086	0.07192	0.9635187	< 2.2e-16 ***	0.17224	0.008668 **
β_{11}	0.00012196	0.991654	-0.00560535	0.86268	0.0990532	< 2.2e-16 ***	0.03073	2.520e-05 ***
β_{12}	0.02289382	0.003821 **	0.00059953	0.97197	-0.0051712	0.147808	-0.0096	0.011836 *
β_{13}	-0.00830606	0.492984	-0.01047775	0.79208	-0.095279	< 2.2e-16 ***	-0.0223	0.005157 **
β_{22}	-0.01110753	0.103209	0.00329153	0.69836	0.0058789	0.007773 **	0.00273	0.5194
β_{23}	-0.01023793	0.223386	0.02809615	0.20911	0.0081429	0.065356	0.01226	0.06503
β_{33}	0.01896222	0.292422	-0.07937145	0.25052	0.0649114	2.598e-09 ***	0.01292	0.31478
Sigma Sq (σ^2)	0.117023	< 2.2e-16 ***	0.99326971	< 2.2e-16 ***	0.2226291	< 2.2e-16 ***	0.1831	< 2.2e-16 ***
Gamma (γ)	0.80296105	< 2.2e-16 ***	0.81581426	< 2.2e-16 ***	0.7981306	< 2.2e-16 ***	0.8314	< 2.2e-16 ***
log likelihood	52.01243		-756.9576		-1024.731		-331.1358	

Source: Authors' estimation

Table 7: Estimated Coefficient of Frontier Model for 2008-09

Coefficient	Paper And Paper Products		Publishing, Printing And Reproduction of Recorded Media		Other Non-Metallic Mineral Products		Basic Metals	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
β_0	1.9835276	0.0006868 ***	0.20150575	0.883164	4.6705678	< 2.2e-16 ***	1.32977	0.0002969 ***
β_1	0.8641771	4.336e-16 ***	0.94678163	0.000193 ***	-0.0369135	0.49123	0.94385	< 2.2e-16 ***
β_2	-0.2028832	0.0023659 **	0.08555066	0.427997	0.0415306	0.24387	-0.0232	0.55237
β_3	0.3163761	0.0040784 **	0.25620605	0.424399	0.9548297	< 2.2e-16 ***	0.00367	0.9602
β_{11}	0.0040722	0.7728856	-0.02620809	0.53197	0.1289226	< 2.2e-16 ***	0.00481	0.53864
β_{12}	0.0089464	0.2866504	-0.00087021	0.964651	-0.0230264	1.106e-06 ***	0.00155	0.71751
β_{13}	-0.0184334	0.1981653	0.04003857	0.365233	-0.0986286	< 2.2e-16 ***	-0.015	0.06046

β_{22}	0.0036028	0.3301281	-0.00125032	0.833106	0.0178903	7.321e-10 ***	-0.0089	0.0304159 *
β_{23}	0.0025201	0.7797504	-0.00412385	0.892998	0.012697	0.01935 *	0.01741	0.0081441 **
β_{33}	0.0036898	0.8796194	-0.08335049	0.292338	0.0690547	4.130e-07 ***	0.00597	0.62723
Sigma Sq (σ^2)	0.1449174	< 2.2e-16 ***	1.4165643	< 2.2e-16 ***	0.2003211	< 2.2e-16 ***	0.19095	< 2.2e-16 ***
Gamma (γ)	0.7035132	< 2.2e-16 ***	0.91601614	< 2.2e-16 ***	0.5273902	< 2.2e-16 ***	0.77808	< 2.2e-16 ***
log likelihood	-144.1212		-575.1086		-1164.086		-511.5114	

Source: Authors' estimation

In the following tables β coefficients represent the impact of each independent variable on the dependent variable. It could be seen that other than Publishing, Printing and Reproduction of Recorded Media for all other three industries almost all variables are statistically significant for both the time period. Parameter σ^2 is ($\sigma_u^2 + \sigma_v^2$) and it represents total variability of output. The parameter γ, i.e., $\sigma_u^2/(\sigma_u^2 + \sigma_v^2)$, measured the proportion of the total variability in output (across firms with the same input quantities) due to variation in TE alone and the estimated value of γ clearly indicates that for both these two years the entire part of such variability is due to variation in TE.

3.4. Results & Analysis:

In this subsection an analysis has been done based on estimated technical efficiency of selected four industries for two selected years (2003-04 & 2008-09). But before going to final analysis through technical efficiency score, one has to primarily asses the customary behavior of the considering function by some standard production function related test.

It is quite possible that some of the inputs are unimportant. The importance of each input in producing the output can be judged by checking the statistical significance of the parameters associated with the input variables in terms of likelihood ratio test. If the null hypothesis of insignificant input is rejected at a higher level of confidence, then the importance of the input gets statistically established. The likelihood ratio test is also used to determine the exact functional form of production frontier. The results of our study are summarized in *Table 8 & 9*.

Table 8: Generalized Likelihood Ratio Test on Frontier Model for 2003-04

Null Hypothesis	Estimated Value of Generalized Log Likelihood Ratio Statistics							
	Paper and Paper Products		Publishing, Printing And Reproduction of Recorded Media		Other Non-Metallic Mineral Products		Basic Metals	
	Chi Square	P-Val	Chi Square	P- Val	Chi Square	P-Val	Chi Square	P-Val
No Intermediate Input (H_0: $\beta_1 = \beta_{11} = \beta_{12} = \beta_{13} = 0$)	2866.8	< 2.2e-16 ***	736.23	< 2.2e-16 ***	6814.1	< 2.2e-16 ***	5383.7	< 2.2e-16 ***
No Fixed Assets (H_0: $\beta_2 = \beta_{12} = \beta_{22} = \beta_{23} = 0$)	11.271	0.02368 *	9.2018	0.05625	79.059	2.756e-16 ***	38.063	1.087e-07 ***
No Mandays (H_0: $\beta_3 = \beta_{13} = \beta_{23} = \beta_{33} = 0$)	40.962	2.737e-08 ***	6.2975	0.178	1553.3	< 2.2e-16 ***	144.82	< 2.2e-16 ***
Cobb-Douglas Function	48.151	1.102e-08 ***	8.3628	0.2127	523.61	< 2.2e-16 ***	30.124	3.723e-05 ***

(H_0: β_{11}= β_{12}= β_{13}= β_{21}= β_{22}= β_{23}= β_{33}= 0)								

Source: Authors' estimation

Table 9: Generalized Likelihood Ratio Test on Frontier Model for 2008-09

Null Hypothesis	Estimated Value of Generalized Log Likelihood Ratio Statistics							
	Paper and Paper Products		Publishing, Printing And Reproduction of Recorded Media		Other Non-Metallic Mineral Products		Basic Metals	
	Chi Square	P-Val	Chi Square	P- Val	Chi Square	P-Val	Chi Square	P-Val
No Intermediate Input (H_0: β_1= β_{11}= β_{12}= β_{13}= 0)	2084.3	< 2.2e-16 ***	499.28	< 2.2e-16 ***	4804.3	< 2.2e-16 ***	5598.4	< 2.2e-16 ***
No Fixed Assets (H_0: β_2= β_{12}= β_{22}= β_{23}= 0)	20.809	0.0003455 ***	1.4512	0.8353	120.99	< 2.2e-16 ***	34.943	772e-07 ***
No Mandays (H_0: β_3= β_{13}= β_{23}= β_{33}= 0)	35.488	3.688e-07 ***	4.7609	0.3127	872.54	< 2.2e-16 ***	107.32	< 2.2e-16 ***
Cobb-Douglas Function (H_0: β_{11}= β_{12}= β_{13}= β_{21}= β_{22}= β_{23}= β_{33}= 0)	27.292	0.0001276 ***	4.0329	0.6722	436.31	< 2.2e-16 ***	25.948	0.0002276 ***

Source: Authors Estimation

It has been found that all the inputs are statistically important to construct the production frontier for all two years except Publishing, Printing and Reproduction of Recorded Media where only intermediate inputs shown its significance. The TRANSLOG form which has been considered here is the ideal one because the Cobb-Douglas form was rejected in terms of the likelihood ratio test. However, again Publishing, Printing and Reproduction of Recorded Media is behaving differently by accepting Cobb Douglas form for both the year. To check the regularity of the production function, i.e., the properties of weak monotonicity and quasi concavity needs to be checked i.e., the output should not reduce after applying greater amount of any relevant input, or in other words, the output elasticity of input should be non-negative for all relevant inputs. Again for the quasi concavity of the production function to hold one needs to verify the second order conditions of efficient production. That would be ensured by the semi definiteness of the bordered Hessian matrix with respect to inputs for each observation. The year wise percentages of firm satisfying these two conditions are given in *Table 10*.

Table 10: Percentage of Firms Satisfying Various Regularity Conditions

Industries	Firms	2003-04		2008-09	
		Weak Monotonicity	Quasi Concavity	Weak Monotonicity	Quasi Concavity
Paper and Paper Products	Total	1183	1183	1036	1036
	Satisfying	907	1020	925	886
	Percentage (%)	76.67	86.22	89.29	85.52
Publishing, Printing and Reproduction of Recorded Media	Total	737	737	524	524
	Satisfying	479	570	440	476
	Percentage (%)	64.99	77.74	83.97	90.84
Other Non-Metallic Mineral Products	Total	3599	3599	2876	2876
	Satisfying	3413	3060	2634	2159
	Percentage (%)	94.83	85.02	91.87	75.31
Basic Metals	Total	2089	2089	2322	2322

	Satisfying	2075	2009	2207	2223
	Percentage (%)	99.33	96.17	95.05	85.11

Source: Authors' estimation

It has been found that more than 75% observation satisfying the weak monotonicity and 85% observation satisfying quasi concavity condition for two years. Interestingly, the function behaved more formally in 2008-09 rather than 2003-04.

Finally, in terms of technical efficiency it has been found that, except Publishing, Printing and Reproduction of Recordable Media, other three industries continuously perform well in both the time periods. The average technical efficiency scores was more than 70% for all three industries in two selected periods *(see Table 11)*.

Table 11: Summery Statistics of Estimated Technical Efficiency

Statistics	Year	Paper and Paper Products	Publishing, Printing and Reproduction of Recorded Media	Other Non-Metallic Mineral Products	Basic Metals
Mean	2003-04	0.813	0.569	0.753	0.773
	2008-09	0.804	0.526	0.792	0.776
Median	2003-04	0.825	0.614	0.766	0.794
	2008-09	0.813	0.568	0.798	0.786
SD	2003-04	0.09	0.168	0.11	0.113
	2008-09	0.08	0.192	0.069	0.093
Skewness	2003-04	-3.474	-0.989	-2.275	-2.732
	2008-09	-4.313	-0.775	-3.926	-3.49
Kurtosis	2003-04	23.172	3.763	12.274	13.651
	2008-09	32.084	3.18	30.755	23.157

Source: Authors' estimation

The median was continuously higher than mean indicating negatively skewed distribution of efficiency scores. It is actually exhibiting the concentration of the efficient firms at the higher end *(see Fig. 4)*.

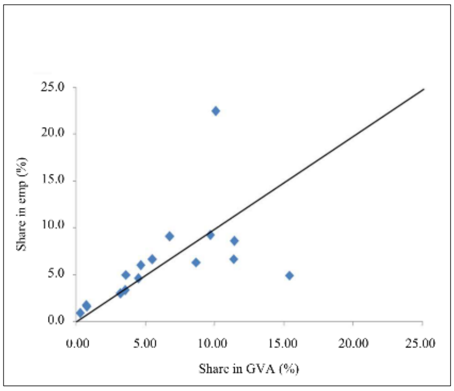
Therefore, it has been explored that the three selected industries among four, those are statistically performing well in post reform era, achieved technical efficiency. Since there is not much variation in the behaviour of the selected high-growth industries over the two selected time points, in the next section an attempt would be made to find out the status of economic efficiency of three out of four selected industries by concentrating on the most efficient firms for the year 2008-09 only.

4.0 Industry Wise Analysis of Economic Efficiency:

4.1. Selection of Firm for Allocative Efficiency:

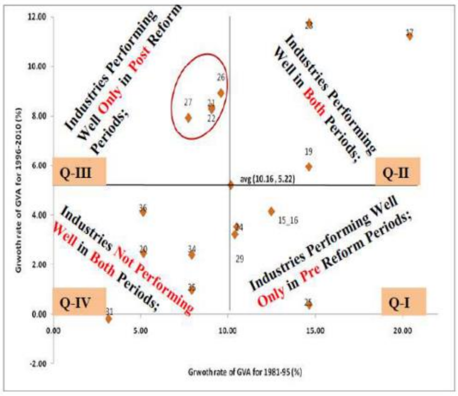
The firms, which have achieved at least 90% technical efficiency in the year 2008-09, are considered as the efficient firms. For the assessment of industry wise allocative efficiency, those firms have only been considered in this exercise. For Paper and Paper Products (NIC98-21; NIC08-17) total 33 firms has been considered as technical efficienct on the basis of only efficiency score but, finally 19 firms have been taken for this industry due to the unavailability of data. Unfortunately Printing and Reproduction of Recorded Media (NIC98-22; NIC08-18) has been dropped for this analysis because of insufficient number of efficient firms. In case of Other Non-Metallic Products (NIC98-26; NIC08-23) and Other Basic Metals (NIC98-27; NIC24) numbers of technically efficient firms were 42 and 82 respectively. However, considering all required information, representative numbers are finally coming down to 15 for Other Non-Metallic Products and 42 for Other Basic Metal.

Fig. 1: Scatter between Share of GVA & Share of Employment



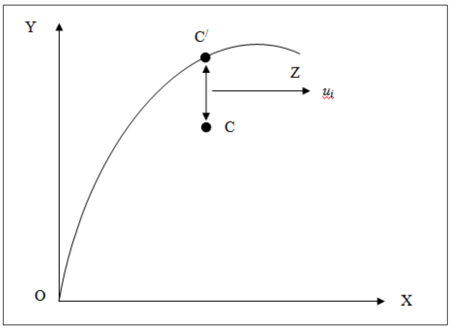
Source: Authors' calculation

Fig. 2: Growth Rate of GVA for (1981-1995) & (1996-2010)



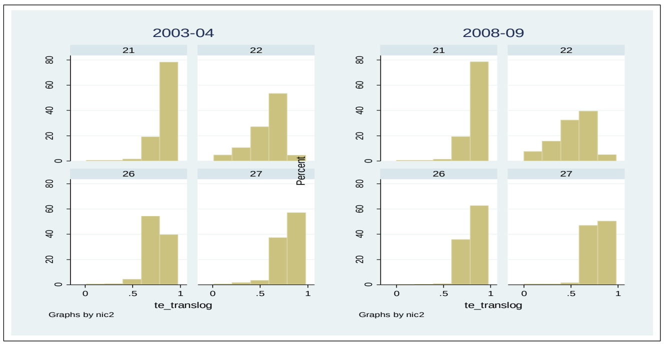
Source: Authors' calculation

Fig. 3: Technical Efficiency



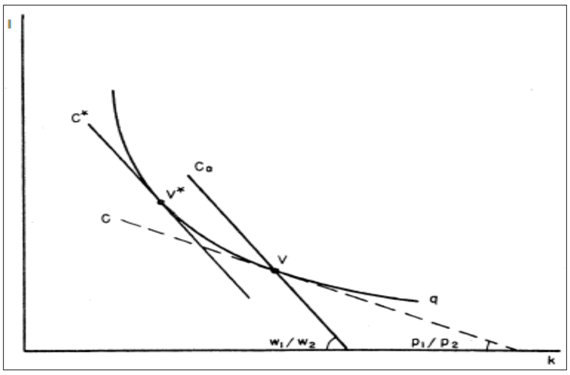
Source: Authors' drawing

Fig. 4: Histogram of Technical Efficiency



Source: Authors' calculation

Fig. 5: Iso-quant and Iso-cost in the Presence of Factor Price Disparity



Source: Toda (1976)

4.2. Methodology of Allocative Efficiency Calculation:

The analysis carried out in the preceding section will equip us to explore the cost-structure of Indian high-growth industries in terms of allocative and therefore economic efficiency in the post reform period. Since the analysis is carried out in the margin only here one needs to estimate the average fixed and average variable costs of production. Here the analysis will mostly follow the methodology developed in Diewert (1971), Toda (1976) and Jha, Murty, Paul & Sahni (1991). In the production process if the production unit is technically efficient then allocative efficiency is achieved by equating the relative marginal factor productivities with the relative factor prices. This equality also guarantees the correspondence between the market price and the shadow price (socially optimal price) of the factors of production. If the actual price relatives are different from this shadow prices, then the disparity indicates the presence of allocative inefficiency. Fig. 5 illustrates the relation of the observed cost to the minimum cost.

The two axes of the figure measure the factor-product ratios. We draw an iso-quant that corresponds with the observed output q. From the point of view of technical efficiency, the observed factor mix V is on this iso-quant. The observed cost is depicted by the iso-cost line C_a passing V with the slope w_1/w_2. The minimum cost at V is shown by the broken line C whose slope is equal to p_1/p_2, the shadow price ratio. At the price ratio w_1/w_2, cost minimizing production was possible at V*. So, operating at V instead of V* shows the extent of allocative inefficiency.

4.2.2. Formulation of a Cost Function:

We will take a generalized Leontief type cost function with an implicit assumption of constant returns to scale (CRS) to verify the presence of economic efficiency in our selected industries. Since the cost of production is a homogeneous function of input prices alone, this CRS assumption will not impose any additional binding constraint on the system. The method to be applied can be illustrated with a simple example of 3-factor Leontief-type cost function, without loss of generality (Toda 1976, Jha, Murty, Paul & Sahni 1991). Since the unit-level ASI data on the selected industries are available on GVA, total emoluments paid to the workers, depreciation, cost of inputs including materials and energy, etc. our model, which consists of one output and three inputs (called capital, labour and material plus energy) will have the following variables:

C = the unit cost which is minimum with the output level as given;
C_a = the unit cost as actually observed;
q = the level of output;
k = the capital-output ratio;
l = the labour-output ratio;
m = the material (including energy)-output ratio;
p_1 = the shadow price of capital, i.e., the socially optimal rental rate;

p_2 = the shadow price of labour, i.e., the socially optimal wage rate;
p_3 = the shadow price of material (+ energy);
w_1 = the market rental rate;
w_2 = the market wage rate;
w3 = the market price of material (+ energy);
We will take only those producing units that are *technologically efficient* when the factors actually in use are on the isoquant that corresponds to the observed output level. From this assumption it follows that the unit cost is minimum if the observed *k, l & m* are evaluated at shadow prices.

$$C = p_1 k + p_2 l + p_3 m;$$

Equation (12)

Since, given the technological requirement of inputs, the average cost is a function of input prices alone it has been implicitly assumed that we have constant returns to scale. We take a cost function of generalized Leontief type that states:

$$C = \sum_{i=1}^{3}\sum_{j=1}^{3} A_{ij} p_i^{1/2} p_j^{1/2}$$

Equation (13)

$$C = A_{11}p_1 + A_{22}p_2 + A_{33}p_3 + 2\mathrm{A}_{12}p_1^{1/2}p_2^{1/2} + 2\mathrm{A}_{13}p_1^{1/2}p_3^{1/2} + 2\mathrm{A}_{23}p_2^{1/2}p_3^{1/2}$$

Equation (13/)

The convexity condition of (13) is that the coefficient matrix A_{3x3} be symmetric and semi-positive definite, i.e.,

$$A_{ij} \geq 0 \forall i,j; A_{ij} = A_{ji} \forall i,j; |A| > 0;$$

Equation (14)

An important property of Cost function is stated by Shepherd's lemma that shows that the partial derivative of the cost function with respect to the shadow price of a factor is equal to the quantity of that factor (Diewert 1971). Taking partial derivatives of (13) we may express the capital-output ratio (k), the labor-output ratio (l) and the material-output ratio (m) as follows:

$$k = A_{11} + A_{12}(p_2 p_1)^{1/2} + A_{13}\left(\frac{p_3}{p_1}\right)^{1/2};$$

Equation (15)

$$l = A_{22} + A_{12}(p_1 p_2)^{1/2} + A_{23}(p_3 p_2)^{1/2};$$

Equation (16)

$$m = A_{33} + A_{13}\left(\frac{p_1}{p_3}\right)^{1/2} + A_{23}\left(\frac{p_2}{p_3}\right)^{1/2};$$

Equation (17)

The observed unit cost can be defined as:

$$C_a = w_1 k + w_2 l + w_3 m;$$

Equation (18)

This cost may be different from Cost Function (12), because the observed prices may be different from the shadow prices. Let us assume that the observed price ratio differs from the shadow price ratio of by a fixed proportional factor α. So,

$$\frac{p_j}{p_i} = \alpha_{ji}\frac{w_j}{w_i}; \text{ with } \alpha_{ji} > 0 \forall i,j;;$$

Equation (19)

Using (19) equations (15), (16) & (17) can be written as:

$$k = A_{11} + A_{12}\alpha_{21}^{1/2}(w_2 w_1)^{1/2} + A_{13}\alpha_{31}^{1/2}\left(\frac{w_3}{w_1}\right)^{1/2};$$

Equation (20)

$$l = A_{22} + A_{12}\alpha_{12}^{1/2}(w_1 w_2)^{1/2} + A_{23}\alpha_{32}^{1/2}(w_3 w_2)^{1/2};$$

Equation (21)

$$m = A_{33} + A_{13}\alpha_{13}^{1/2}\left(\frac{w_1}{w_3}\right)^{1/2} + A_{23}\alpha_{23}^{1/2}\left(\frac{w_2}{w_3}\right)^{1/2};$$

Equation (22)

Where

$$\alpha_{21} = (\alpha_{12})^{-1}, \alpha_{31} = (\alpha_{13})^{-1}, \alpha_{32} = (\alpha_{23})^{-1}$$

Equation (23)

Substitution of (20), (21) & (22) into (18) leads to the actual cost function whose variables are all observed ones.

$$C_a = \sum_i A_{ii} w_i + \sum_i \sum_j \left[\alpha_{ji} A_{ji} w_i^{1/2} w_j^{1/2};\right]_{i \neq j}$$

Equation (24)

If α_{ji} is equal to 1, for all (i,j), then there will be no deviation between the shadow price and the observed price and the efficient cost function (12) would become:

$$C* = \sum_{i=1}^{3} \sum_{j=1}^{3} A_{ji} w_i^{1/2} w_j^{1/2}$$

Equation (25)

Comparing C^a with C^* one may decide about the efficiency status of resource allocation; in fact, testing for efficiency (or the absence of price disparity) boils down to testing the hypothesis αji = 1.

4.2.3. Estimation of Cost Function:

The estimable system of equations will comprise equations (20), (21) & (22) with stochastic error terms added to each one.

$$k = A_{11} + A_{12}\alpha_{21}^{1/2}(w_2 w_1)^{1/2} + A_{13}\alpha_{31}^{1/2}\left(\frac{w_3}{w_1}\right)^{1/2} + u_1;$$

Equation (20/)

$$l = A_{22} + A_{12}\alpha_{12}^{1/2}(w_1 w_2)^{1/2} + A_{23}\alpha_{32}^{1/2}(w_3 w_2)^{1/2} + u_2;$$

Equation (21/)

$$m = A_{33} + A_{13}\alpha_{13}^{1/2}\left(\frac{w_1}{w_3}\right)^{1/2} + A_{23}\alpha_{23}^{1/2}\left(\frac{w_2}{w_3}\right)^{1/2} + u_3;$$

Equation (22/)

$$C_a = \sum_i A_{ii} w_i + \sum_i \sum_j \left[\alpha_{ji} A_{ji} w_i^{1/2} w_j^{1/2} + u_4;\right]$$

Equation (24/)

Since by equation (18) k, l, m and C_a are linearly connected, hence equations (20/) – (24/) are not linearly independent. To estimate the system one needs to drop one equation. The estimation result of the system should be robust with respect to this dropping decision. It has been discussed in the literature that the most robust estimation is possible by using Full Information Maximum Likelihood (FIML) technique where equation (24/)will be dropped.

Equation (20/) & (21/) can jointly be written as:

$$\begin{bmatrix} k \\ l \\ m \end{bmatrix} = A_{12}\left(\alpha_{12}^{1/2} - \alpha_{12}^{-1/2}\right)\begin{bmatrix} 0 \\ \left(\frac{w_1}{w_2}\right)^{1/2} \\ 0 \end{bmatrix} + A_{12}\alpha_{12}^{-1/2}\begin{bmatrix} \left(\frac{w_1}{w_2}\right)^{-1/2} \\ \left(\frac{w_1}{w_2}\right)^{1/2} \\ 0 \\ \end{bmatrix} +$$

$$A_{13}\left(\alpha_{13}^{1/2}-\alpha_{13}^{-1/2}\right)\begin{bmatrix}0\\0\\\left(\frac{w_1}{w_3}\right)^{1/2}\end{bmatrix}+A_{13}\alpha_{13}^{-1/2}\begin{bmatrix}\left(\frac{w_1}{w_3}\right)^{-1/2}\\0\\\left(\frac{w_1}{w_3}\right)^{1/2}\end{bmatrix}+A_{23}\left(\alpha_{23}^{1/2}-\alpha_{23}^{-1/2}\right)\begin{bmatrix}0\\0\\\left(\frac{w_2}{w_3}\right)^{1/2}\end{bmatrix}+$$

$$A_{23}\alpha_{23}^{-1/2}\begin{bmatrix}0\\\left(\frac{w_2}{w_3}\right)^{-1/2}\\\left(\frac{w_2}{w_3}\right)^{1/2}\end{bmatrix}+A_{11}\begin{bmatrix}1\\0\\0\end{bmatrix}+A_{22}\begin{bmatrix}0\\1\\0\end{bmatrix}+A_{33}\begin{bmatrix}0\\0\\1\end{bmatrix}+\begin{bmatrix}u_1\\u_2\\u_3\end{bmatrix}$$

Equation (26)

$$\text{Or, } y=A_{12}\left(\alpha_{12}^{1/2}-\alpha_{12}^{-1/2}\right)d_1+A_{12}\alpha_{12}^{-1/2}W_1+A_{23}\left(\alpha_{23}^{1/2}-\alpha_{23}^{-1/2}\right)d_2+A_{23}\alpha_{23}^{-1/2}W_2+ A_{13}\left(\alpha_{13}^{1/2}-\alpha_{13}^{-1/2}\right)d_3+A_{13}\alpha_{13}^{-1/2}W_3+A_{11}Z_1+A_{22}Z_2+A_{33}Z_3+u$$

Equation (27)

Here, $y=\begin{bmatrix}k\\l\\m\end{bmatrix};\ d_1=\begin{bmatrix}0\\\left(\frac{w_1}{w_2}\right)^{1/2}\\0\end{bmatrix};\ d_2=\begin{bmatrix}0\\0\\\left(\frac{w_2}{w_3}\right)^{1/2}\end{bmatrix};\ d_3=\begin{bmatrix}0\\0\\\left(\frac{w_1}{w_3}\right)^{1/2}\end{bmatrix};\ W_1=\begin{bmatrix}\left(\frac{w_1}{w_2}\right)^{-1/2}\\\left(\frac{w_1}{w_2}\right)^{1/2}\\0\end{bmatrix};$

$$W_2=\begin{bmatrix}0\\\left(\frac{w_2}{w_3}\right)^{-1/2}\\\left(\frac{w_2}{w_3}\right)^{1/2}\end{bmatrix};\ W_3=\begin{bmatrix}\left(\frac{w_1}{w_3}\right)^{-1/2}\\0\\\left(\frac{w_1}{w_3}\right)^{1/2}\end{bmatrix};\ Z_1=\begin{bmatrix}1\\0\\0\end{bmatrix};\ Z_2=\begin{bmatrix}0\\1\\0\end{bmatrix};\ Z_3=\begin{bmatrix}0\\0\\1\end{bmatrix};\ u=\begin{bmatrix}u_1\\u_2\\u_3\end{bmatrix};$$

Since Z_1, Z_2 & Z_3 cannot be taken as intercept variables simultaneously, to avoid the problem of singularity we will drop Z_3. This will give the final estimable equation as:

$$y=\theta_1 d_1+\theta_2 d_2+\theta_3 d_3+\beta_1 W_1+\beta_2 W_2+\beta_3 W_3+\gamma_1 Z_1+\gamma_2 Z_2+u;$$

Equation (28)

Our procedure would be to estimate equation (28) twice, once with different combinations of d^1, d^2 & d^3 included and once with d's excluded. The significance of the price disparity will be tested by the extent to which the RSS will reduce due to inclusion of d's. The values of the likelihood functions can be compared in an F test to ascertain the presence of economic (in) efficiency.

4.2.4. Empirical Estimation:

Data is Needed On:

- k: cost of capital by the value of output, where cost of capital in any particular year is given by [(a) depreciation + (b) interest on fixed asset evaluated in terms of rate of interest on 1-year term deposit announced by the RBI];
- l: Cost of labor (i.e., total emoluments) by the value of output,
- m: value of material & energy by the value of output;
- (w^1/w^2): [Cost of capital/ value of Fixed Asset]*[(Total emoluments/man-days-work)$^{-1}$];
- (w^2/w^3): [(Total emoluments/man-days-work)]*[(unit price of material & energy)$^{-1}$];
- (w^1/w^3): [Cost of capital/ value of Fixed Asset]*[(unit price of material & energy)$^{-1}$];

Method is FIML:

- Since in equation (13), u^1, u^2 & u^3 are all homoscadastic, serially uncorrelated and their contemporaneous covariance is assumed to be zero, hence, we can stack the variables in appropriate vector form and can apply Ordinary Leasts Squares (OLS) to estimate the unknown parameters.
- For each industry qualified for economic efficiency verification, we will estimate the equation once with the variable d^i and once by dropping the variable d^i. While the former equation will give the unrestricted residual sum of square (URSS) the latter one will give the restricted residual sum of squares (RRSS). Then by applying the following F test we may decide on the statistical influence of 'd^i', which, if significant would indicate the presence of allocative inefficiency.

$$F = \frac{(RRSS - URSS)/r}{URSS/df} \sim F_{r,df}$$

4.3. Result Analysis of Alocative Efficiency:

It is interesting to note that for all the industries the value of F statistics is lower than the critical value. So we will accept the null hypothesis that d1, d2 and d3 are jointly insignificant. If the coefficient of d1, d2 and d3 are zero then the value of α =1 and then $p^j/p^i=w^j/w^i$ that factors are enjoying their socially optimal (shadow) price *(see Table 12)*. This indicates that the sources are getting paid according to their marginal productivity. Therefore, for our three selected industries the firms which have achieved 90% technical efficiency are also achieved allocative efficiency. And for these three industries the technically efficient units are not exploiting their resources.

Table 12: Regression Result of Allocative Efficiency

Industry	p-value	Observation (3 × No. of Firms)	RRSS	URSS	F	df
Paper and Paper Products	0.000	57	0.247736	0.223617	1.61	(8,48)
Other Non-Metallic Products	0.000	45	0.508745	0.44264	1.64	(8,36)
Basic Metals	0.000	126	0.97752	0.967616	0.40	(8,117)

Source: Authors' estimation

So, being efficient is not a rule, rather an exception. So, a comparison of average size of the efficient firms with that of the sector as a whole has been calculated in terms of GVA and it has been found without any exception that all the efficient firms are the bigger ones. These observations are taking us to extend some comments on the prevailing policies.

5.0 Overall Assessment and Policy Implications

In this paper an attempt has been made to identify the industries showing high growth potential in the post reform India where, economic liberalization policy has been adopted to make the production structure more competitive, both locally as well as globally. In our analysis, four emerging industries *[(i) Paper and paper products, (ii) Publishing, printing and reproduction of recorded media, (iii) Other non-metallic mineral products & (iv) Basic metals]* has been selected and showed that a marginal section of the emerging industries is revealing all-round efficiency. Behaviour of Publishing, *printing and reproduction of recorded media* is quite different than the other three industries and, these three industries performed better for both the year 2004-05 and 2008-09. However, the efficient firms are mostly the bigger firms and a large number of small firms are failing to attain even technical efficiency. Technically efficient firms of each industry have been chosen to calculate their allocative efficiency. Due to the limitations of data, allocative efficiency has not been presented for publishing, printing and reproduction of recorded media. For other three industries firms with technical efficiency more than 90% also achieved allocative efficiency. So, it will be better to promote technical efficiency as a significant number of firms from all industries. Under current circumstances, the present state of high performance will turn out to be a transient euphoria and the economy will not be able to catch up with the path of sustainable future.

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