DETERMINANTS OF COST EFFICIENCY OF FIRMS: A STUDY OF SELECTED CONSUMER GOODS FIRMS IN INDIA

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Abstract: This study deals with the determination of cost efficiency of selected firms of consumer goods-based industries in India during 2006-17 using data envelopment analysis taking labor and capital as input variables and volume of sale as output variable. After which, the cost efficiency score is regressed on parameters like size of the firm, return on assets, return on equity and return on sales. The study concluded that apart from return on assets, all the parameters are statistically significant. Size of the firm and return on sales are contributing positively for determination of efficiency of the selected firms whereas return on equity is negatively related to the cost efficiency of the firms.

Keywords: Consumer Goods; Data Envelopment Analysis; Cost efficiency, Panel data, Regression

Introduction

Consumer goods industry in India plays an important role in economic development of the country which motivates us to assess the performance of these firms. The most accepted performance measure is to assess the firms in terms of its efficiency. In the existing literature of performance measurement, Farrell (1957) [1] introduced the concept of efficiency in two different terms: technical efficiency and allocate efficiency. Technical efficiency implies the capability of a firm to reach at the maximal possible output for a given set of inputs whereas allocative efficiency measures the optimal input combination which can produce a given level of output. Hence, the overall economic efficiency can be examined using either input (cost efficiency) or output (overall revenue efficiency) based models. Accordingly, Stochastic Frontier Approach (SFA), formulated by Aigner, Lovell and Schmidt (1977) [2]; and Data

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Envelopment Analysis (DEA) developed by Charnes, Cooper and Rhodes (1978) [3] gained the greatest importance in the literature of performance measurement.

Cost efficiency is defined as the ratio of cost incurred by any firm in comparison to cost incurred by the best-practice firm's cost for producing the same level of output under the same conditions. Most studies have focused on the input side, estimating cost efficiency ([4], [5]). Accordingly, this study deals with DEA method and describes its application in measuring cost efficiency of selected firms under consumer goods industry first, and then attempted to determine its possible determinants.

Apart from this introductory part, the remaining paper is organized as: Section 2 summarizes the related literature and gap in the existing literature is identified. Section 3 presents the Data and Methods used in the study; and based on which results are presented and discussed in Section 4. Finally, the paper is concluded in Section 5.

Related Literature

Berger and Humphrey (1997) [6] systematically collate the information from 130 studies that apply frontier techniques to the analysis of the efficiency of financial institutions in 21 countries; and the majority of studies have centered on the analysis of cost efficiency. Vu (2016) [7] examined the technical efficiency of FDI firms in the manufacturing sector of Vietnam with the help of stochastic frontier Model (SFM). They used cross sectional data comprising the period between 2009 and 2013. The result inferred that the studied firms have about 60% efficiency. They also found positive correlations between technical efficiency of FDI and other factors like revenue per labor, farms 'age, expert activates. Fahmy (2018) [8] examined the technical efficiency of the Malaysian Textile manufacturing industry for the period of 2015. They have considered capital-labor ratio, educational level ratio, wage rates and information and communication technology expenses, size of the firm and R&D expenditure as determinants of efficiency. The capital labor ratio, the level of secondary and higher education, wage and communication cost and IT are found to be the determinates of inefficacies. Anh and Gan (2019) [9] investigated the profitability and marketability efficiencies of 102 listed manufacturing firms on Vietnam stock Exchange over the period from 2007 to 2018 by applying DEA approach and fractional Regression Model (FRN). The findings of the study revealed that the profitability efficiency of the studied firms is higher than their marketability efficiency. Additionally, it was also found that, the technology-intensive firms obtained higher efficiency as compared to the resource intensive or labor –intensive firms. They have also found some heterogeneous factors that attach the profit efficiencies of the firms. Diaz et.al (2021) [10] analyzed empirically the efficiency of European pharmaceutical industry over the period of 2010-2018 using DEA. The finding suggested moderate level of efficiency of

the selected firms. It was also found that the firms engaged in manufacturing and distribution putting emphasis on R& D is more efficient. Efficiency is higher for larger firms as compared to medium and small size firms. They also stated that efficiency is positively correlated with profit margins and financial solvency.

Rajesh et.al (2007) [11] studied the technical efficiency level of the manufacturing sector of India taking firm's level evidence from the Indian manufacturing sector using translog stochastic frontier production function. According to the finding of the study, technical inefficiency is high in the informed manufacturing sector in Kerala. It was additionally found that, firm Size, ownership, region and seasonality of operation have significant influence on the technical efficiency of firms in most industry groups. Debnath et.al (2014) [12] investigated the efficiency of the Iron and steel industry of India DEA. They have studied the constant returns to scale (CRS) and the variable returns to scale (VRS) in the DEA framework. The input variables which they have incorporated are gross fixed assets, total energy cost, total number of employees and current asset. On the other hand, they have taken into consideration income, sales, PBIT and PAT as the output variables. The finding suggested that the PSUs are working under inconvenient operating environment as compared to their private sector Counterparts. It has also been found that 45 percent of the private sector Units are both technically and scale in efficient. Das and Patel (2014) [13] studied the cost efficiency of 24 pharmaceutical firms who are specified in manufacturing drugs for specific diseases prevalent in India. They have made a comparative assessment of the different drug manufacturing firms including the multinational cooperation. They used Delphi technique for calculating specific prevalent diseases in India. Finally, they used DEA in order to find the cost efficiency of the selected drug manufacturing firms.

To the best of our knowledge, no study is available till date, at least in India, investigating the determinants of firm's cost efficiency from a special industry point of view. Therefore, this study shall take into account the cost efficiency of firms under Consumer Goods based industry in India and examine its possible determinants.

Data and Methods

The study focused on comparing performance of firms under Consumer Goods based industry in India. The Reference study period was twelve years FY 2006 to FY 2017 i.e., 2006-2017. The firms are selected from the ProwessIQ database (https://prowessiq.cmie.com). After collecting information on all the firms under Consumer Goods in the industry, the data has been processed to prepare a balanced panel. Finally, the complete data was available for 199 firms. Then, this study applied the DEA to determine the Cost Efficiency of selected firms. After which, this study selected the firms for further analysis which showed the cost efficiency level at least 0.25. In

this way, a total of fifteen numbers of firms are selected. These are: Ajanta Raj Proteins Ltd, Allana Investments & Trdg. Co. Pvt. Ltd, Cottanad Plantations Ltd, Gillapukri Tea Co. Ltd, Govind Nagar Sugar Ltd, Jai Beverages Pvt. Ltd, Kubisi Green Earth Ltd, Kumaon Seeds Ltd, Kwality Feeds Ltd, N K G India Coffee Pvt. Ltd, National Protein & Solvent Ltd, Poona Bottling Co. Pvt. Ltd, Rajasthan Vanaspati Products Ltd, Vijay Agro Products Pvt. Ltd, Vimal Dairy Ltd. All the financial data has been collected and/ or converted in terms of Indian currencies (in Crore INR). To enhance the accuracy of the data; no approximation or rounding off exercise has been carried out. However, before using panel data analysis the assumptions of normality, multicollinearity, heteroskedasticity and outliers' detection has been conducted to make the data compatible for statistical analysis and different specification tests are also carried out to make the model fit the data.

Cost Efficiency DEA Model

Suppose that

i=1, 2, ….., n, be the number of firms;

$y_i = (y_{i1},\ldots,y_{iq})$ be the output vector;

$r_i=(r_{i1},\ldots,r_{iq})$ be the output price vector;

$x_i=(x_{i1},\ldots,x_{ip})$ be the input vector;

$w_i=(w_{i1},\ldots,w_{ip})$ be the input price vector

The cost efficiency for the case of firm j can be represented as an LPP:

$$Min\sum_{p} w_{jp}x_{jp}$$

$$\text{s.t.} \sum_{i} a_i y_{iq} \geq y_{jq}$$

$$\sum_{i} a_i x_{ip} \leq x_{jp}$$

$$\sum_{i} a_i = 1; \text{ for all } i = 1, 2, \ldots.. N$$

After solving the LPP, we can get $x^*_j = (x^*_{j1},\ldots, x^*_{jp})$ as the optimal input demand vector which minimizes the costs If this hypothetical firm had the same input price vector as firm j would have a cost

$$C_j^* = \sum w_{pj}.x_{pj}^*$$

Hence, the cost efficiency for firm j (CE_j) can be expressed as

$$CE_j = \frac{\Sigma_p w_{jp}x_{jp}^*}{\Sigma_p w_{jp}x_{jp}}$$

Where$CE_j \leq 1$ represents the ratio between the minimum costs (C^*_j and the observed costs (C_j) for firm j.

Panel Regression

As mentioned above the present study examined the determinants of the cost efficiency of different firms under Consumer Goods based industry of India during 2006-2017 using a panel data analysis which contains both a cross-sectional and a time series dimension. General panel regression based on the above mention explanatory variables may be represented as

$$Y_{it} = \beta_0 + \beta_1 . x_{1it} + \beta_2 . x_{2it} + \beta_3 . x_{3it} + \beta_4 . x_{4it} + \beta_5 . x_{5it} + \alpha_i + U_{it}$$

Following (Baltagi, et al, 2005) [14] the present study consider the following panel regression model.

$Y_{it} = \alpha + \beta X_{it} + u_{it}$ ... (1)

Where Y_{it} is 'efficiency parameter 'i' of selected companies in year *t*; X_{it} denotes the determinents of parameter *i* in the year *t*, α is a constant, u_{it} in the error term, and β the firm parameters related to determinants of efficiency of firms. Frther a one-way error component model for the distrubances is considered.

$u_{it} = \mu_{it} + v_{it}$ ... (2)

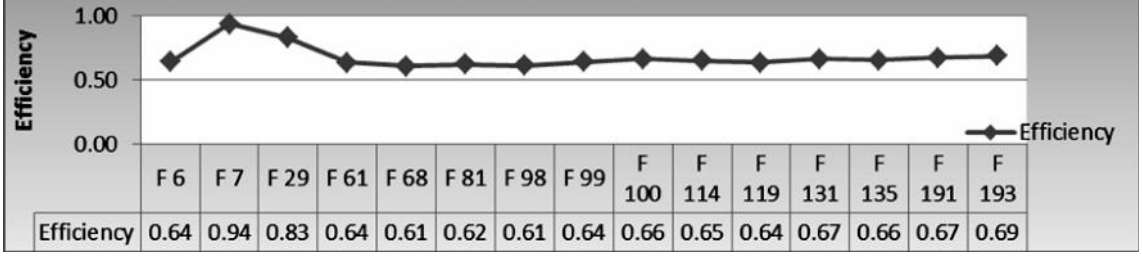
Where μ_i denotes the unobservable individual-specific effect and v_{it} denotes the remainder disturbance. The panel data model is then estimated using a fixed effiect and random effect model. In fixed effect model they are assumed to be fixed parameters to be estimated and the remainder disturbances stochastic v_{it} ~ IID (0, σ_v^2). The X_{it} are assumed independent of the v_{it} for all *i* and *t*. FE estimator cannot estimate the effect of any time invariant variable as these variables are wiped out by the within transformation. FE has less degree of freedom and takes into calculation only thevariation 'within' units, not between units. An advantage of random effects is that we can estimate individual and time invariant variables. RE model is suitable as differences across economic groups (entities) have some influence on our dependent Variable. The random effect model is obtained by assuming that μ_i are random. And $_i$, v_{it} ~ IID (0, σ^2) and the μ_i are independent of the v_{it}. In addition, X_{it} the are independent of the μ_i and v_{it}, for ... *i* and *t*. The use of panel data allows us not only to investigate dynamic relations but also to control for unobserved cross-section heterogeneity.

Results and Discussions

DEA Results

This study first considers the available firms of Consumer Goods based Industry in India during 2006-17. After that using Data Envelopment analysis (DEA), cost efficiency scores are calculated and on the basis of performance of the firms, fifteen firms are chosen which exhibits mean cost efficiency of at least 0.25. The trend of cost efficiency scores of the selected firms are presented below:

Fig 1: Mean Cost Efficiency of the selected firms during 2006-17



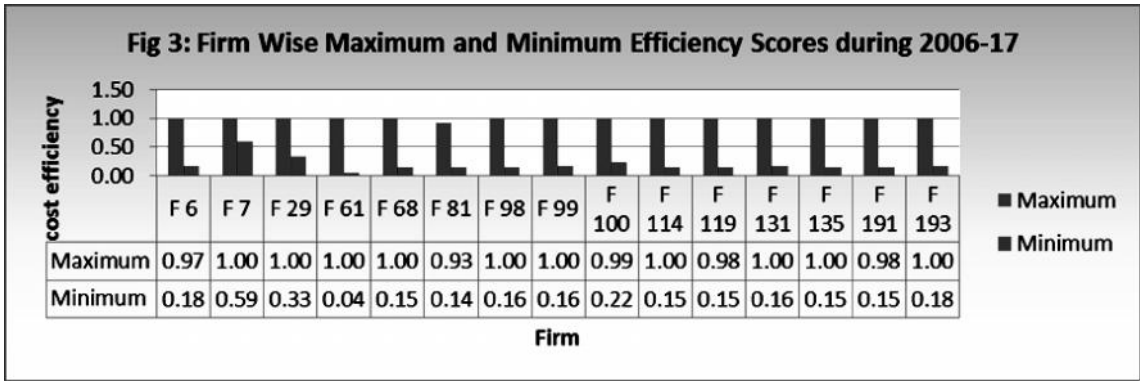
	F 6	F 7	F 29	F 61	F 68	F 81	F 98	F 99	F 100	F 114	F 119	F 131	F 135	F 191	F 193
Efficiency	0.64	0.94	0.83	0.64	0.61	0.62	0.61	0.64	0.66	0.65	0.64	0.67	0.66	0.67	0.69

Source: Authors' calculation

The second firm exhibited maximum mean cost efficiency followed by third and fifteen firms. On the other hand, fifth firm shows the least mean cost efficiency followed by the seventh firm. The year wise mean efficiency of selected firms is presented below:

Source: Authors' calculation

During the study period, the mean cost efficiency lies between 1 and 0.2. The maximum cost efficiency occurred during 2010 whereas it reached its minimum during 2015. During the study period, mean cost efficiency was not uniform at all rather fluctuates occasionally. From 2008 to 2009& from 2014 to 2015 the mean cost efficiency of the selected firms decreased continuously till it reaches its minimum level in 2015. And it reached its maximum level in 2010. Again, the trend shows a declining tendency till 2015 where it reached nearby minimum level. Then it again showed a rising tendency. Hence to explore the trend of mean cost efficiency, a high-low chart of cost efficiency score of the selected firms during the study period is essential. Based on Table 1, the High-Low chart of the cost efficiency scores of selected firms are presented below:



	F 6	F 7	F 29	F 61	F 68	F 81	F 98	F 99	F 100	F 114	F 119	F 131	F 135	F 191	F 193
Maximum	0.97	1.00	1.00	1.00	1.00	0.93	1.00	1.00	0.99	1.00	0.98	1.00	1.00	0.98	1.00
Minimum	0.18	0.59	0.33	0.04	0.15	0.14	0.16	0.16	0.22	0.15	0.15	0.16	0.15	0.15	0.18

Source: Authors' calculation

From the above figure, it is evident that out of fifteen firms, eleven firms' exhibits efficient one with the maximum score of 1.00 and six is the least efficient one. Further, the second, third and ninth firms seem to be most consistent. The fourth firm exhibits the maximum range of cost efficiency followed by the seventh, eighth, tenth, twelfth, thirteenth and fifteenth firms among the high scored firms.

Table 1: Descriptive Statistics of Cost Efficiency Scores of Selected Firms during 2006-2017

	Year wise Cost Efficiencies of Selected Firms during 2006-17												Firm wise Efficiency			
Firm	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Maximum**	**Minimum**	**Mean**	**sd**
F 6	0.821	0.704	0.841	0.175	0.973	0.629	0.629	0.352	0.952	0.180	0.623	0.828	0.973	0.175	0.642	0.275
F 7	1.000	1.000	0.796	1.000	1.000	1.000	1.000	1.000	1.000	0.593	1.000	0.918	1.000	0.593	0.942	0.126
F 29	0.988	1.000	0.383	1.000	0.837	1.000	1.000	1.000	0.326	1.000	1.000	0.433	1.000	0.326	0.831	0.276
F 61	0.804	0.861	1.000	0.042	1.000	1.000	1.000	0.272	0.765	0.149	0.221	0.526	1.000	0.042	0.637	0.373
F 68	0.986	0.920	0.857	0.215	1.000	0.373	0.373	0.391	0.913	0.152	0.317	0.825	1.000	0.152	0.610	0.330
F 81	0.912	0.736	0.766	0.185	0.927	0.839	0.839	0.287	0.864	0.142	0.241	0.740	0.927	0.142	0.623	0.310
F 98	1.000	0.825	0.797	0.179	0.977	0.495	0.495	0.292	0.892	0.155	0.385	0.862	1.000	0.155	0.613	0.314
F 99	0.991	0.964	0.844	0.182	1.000	0.590	0.590	0.425	0.875	0.162	0.262	0.827	1.000	0.162	0.643	0.319
F 100	0.919	0.877	0.846	0.318	0.990	0.628	0.628	0.432	0.979	0.250	0.222	0.880	0.990	0.222	0.664	0.292
F 114	0.954	0.947	0.821	0.360	1.000	0.625	0.625	0.291	0.876	0.155	0.304	0.871	1.000	0.155	0.652	0.303
F 119	0.920	0.763	0.814	0.169	0.982	0.512	0.512	0.419	0.941	0.153	0.558	0.886	0.982	0.153	0.636	0.292
F 131	0.992	0.926	0.851	0.190	0.999	0.549	0.549	0.381	0.888	0.162	0.526	1.000	1.000	0.162	0.668	0.315
F 135	1.000	1.000	0.854	0.180	0.973	0.657	0.657	0.482	0.810	0.151	0.271	0.847	1.000	0.151	0.657	0.316
F 191	0.969	0.807	0.852	0.178	0.982	0.653	0.653	0.551	0.959	0.155	0.429	0.885	0.982	0.155	0.673	0.294
F 193	0.968	0.882	0.846	0.179	0.978	0.625	0.625	0.514	0.957	0.208	0.509	1.000	1.000	0.179	0.691	0.294
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Minimum	0.804	0.704	0.383	0.042	0.837	0.373	0.373	0.272	0.326	0.142	0.221	0.433				
Mean	0.948	0.881	0.811	0.304	0.975	0.678	0.678	0.473	0.867	0.251	0.458	0.822				
sd	0.063	0.097	0.129	0.291	0.043	0.194	0.194	0.230	0.163	0.236	0.255	0.154				

Note:

F6: Ajanta Raj Proteins Ltd. **F7:**Allana Investments &Trdg. Co. Pvt. Ltd **F29:** Cottanad Plantations Ltd.

F61: Gillapukri Tea Co. Ltd. **F68:** Govind Nagar Sugar Ltd. [Merged] **F81:** Jai Beverages Pvt. Ltd.

F98: Kubisi Green Earth Ltd. **F99:** Kumaon Seeds Ltd. **F100:** Kwality Feeds Ltd.

F114: N K G India Coffee Pvt. Ltd. **F119:** National Protein & Solvent Ltd. **F131:**Poona Bottling Co. Pvt. Ltd.

F135: Rajasthan Vanaspati Products Ltd. **F191:** Vijay Agro Products Pvt. Ltd. **F193:** Vimal Dairy Ltd.

Panel Regression Analysis

This study has employed the 5-point summary measures to describe the sample data. Then, Correlation analysis is carried out to identify the linear relationship between two variables. Finally, the results of the panel regression are presented and discussed accordingly in the subsequent sections.

Table 2: Descriptive Statistics of Determinants of Cost Efficiency

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
EFF	180	.6787211	.3005178	0.422905	1
SIZE	180	8.365927	1.904123	.3364722	11.85254
ROA	180	.2093971	.8455924	-.9115903	8.404912
ROE	180	.138154	6.119119	-54.62101	41.87601
ROS	180	-.006179	.4503247	-3.785714	.9990407

Source: Authors' calculation

Table 3 shows the correlation matrix and their significant level for dependent and independent variables. There is a positive correlation with that of two variables viz. SIZE and ROA where as there is negative correlation with that of two variables viz. ROE and ROS. Further, there are statistically significant correlation ROA, ROE and ROS. From the above analysis, it is clear that the selected independent variables have a strong and significant relationship with the dependent variable.

Table 3: Correlation Matrix of Selected Variables

	EFF	SIZE	ROA	ROE	ROS
EFF	1.0000				
SIZE	0.0608	1.0000			
ROA	0.0726	0.0417	1.0000		
ROE	0.1402	0.0237	0.3964	1.0000	
ROS	0.0340	0.1432	0.4380	0.6702	1.0000

Source: Authors' calculation

However, significant correlation among some of the independent variables may lead to the problem of multicollinearity which may cause the estimated regression equation to be biased. To avoid such biased regression results the Variance Inflation Factor (VIF) technique has been applied to identify the presence of possible multicollinearity problem and the estimated results are presented.

Table 4: Test of Multicollinearity

Variable	VIF	1/VIF
ROS	2.00	0.501005
ROE	1.88	0.532812
ROA	1.27	0.788916
SIZE	1.03	0.969951
Mean VIF	1.54	

Source: Author's calculation

Theoretically, a VIF more than 10 implies the possibility of multicollinearity due to the respective variable. But from the above table it is evident that none of the VIFs are excessively high which automatically implies that the problem of multicollinearity of explanatory variables in not a major problem in this study.

This study first applies a Generalized Least Square (GLS) random Effects model; and model fit as probability > chi2 = 0.1997> 0.05, hence GLS regression model cannot be rejected. However, in order to compare between random-effect and pooled regression, this study further applied the Breusch and Pagan Lagrangian multiplier test. The result shows that the random-effect GLS regression cannot be rejected. Hence, the data set contains the panel structure. Hence, this study applied the fixed effect regression model and compared it with random-effect GLS regression using the Hausman test. Since, the Prob>Chi2 =0.0003<0.05, the model is consistent with fixed effect regression model. Further, this study applied some regression diagnostic test. Moreover, for unbiased results the study further attempts to detect the presence of heteroskedasticity and serial autocorrelation, before presenting the result of fixed-effect (within) regression model. The final estimated results are presented below:

Table 5: Fixed-effects (within) Regression vce (robust)

Fixed-effects (within) regression Group Variable : firm					Number of obs= 180 Number of groups=15 Obs per group: min=12 avg=12.0	
R-sq:	within=0.1089 between=0.4017 overall=0.0012				max=12 F(4,14) =40.84 prob>F =0.0000	
corr(u_i,xb)=-0.8793 (std. Err. Adjusted for 15 clusters in firm)						
			Robust			
EFF	Coef.	Std. Err.	T	p>|t|	[95% Conf.	Interval]
SIZE	-0.1174148	.0269402	-4.36	0.001	-.1751957	-.0596339
ROA	.0273266	.0037585	7.27	0.000	.0192654	.0353878
ROE	.0036447	.0020734	1.76	0.101	-.0008024	.0080918
ROS	.071269	.0327229	2.18	0.047	.0010854	.1414525
_cons	1.655219	.2260396	7.32	0.000	1.170413	2.140026
sigma_u	.27799144					
sigma_e	.28634666					
Rho	.48519789 (fraction of variable due to u_i)					

Source : Authors' calculation based on sample data

Hence, the estimated equation becomes

EFF_{ij}=1.655219-0.1174148($SIZE_{ij}$)*+ 0.0273266(ROA_{ij}) +0.0036447(ROE_{ij})*+ 0.071269(ROS_{ij})*

Conclusions

This study deals with the determination of cost efficiency of selected firms of consumer goods-based industries in India during 2006-17. After which, the cost efficiency score is regressed on parameters like size of the firm, return on assets, return on equity and return on sales. The study concluded that apart from return on assets, all the parameters are statistically significant. Size of the firm and return on sales are contributing positively for determination of efficiency of the selected firms whereas return on equity is negatively related to the cost efficiency of the firms.

Conflict of Interests

The authors declare that there are no conflict of interests that are directly or indirectly related to this research work.

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