Assessing the Financial Efficiency in Indian Pharmaceutical Industry: An Application of Data Envelopment Analysis

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Abstract

Indian pharmaceutical industry, which accounts for approximately 2.4 percent of the global pharmaceutical industry in value terms and 10 percent in volume terms, is now in the bust phase due to high competition and challenging price environment. Most of the investors experienced to taste bitterness in earnings of the industry in the recent past which is now impacting the sentiments of the sector for the long-term. In the wake of above issues, it is an imperative task to figure out the financial efficiency levels in the Indian pharmaceutical industry. The present study attempts to carry out an in depth analysis into the financial efficiency levels of 91 companies based on cross-sectional data of 2015-16 using DEA approach. The DEA results highlight that the level of financial inefficiency in Indian pharmaceutical industry is a whopping 30.54 percent. Out of this scale size and managerial incapacity are almost equal contributors of inefficiency. Therefore, there is a huge scope for improvement in financial efficiency in the industry. The findings hold an important place in the wake of the overwhelming contribution of Indian pharmaceutical industry to India's economyand the need for maximizing the shareholder's value so as to make it attractive for the investors globally.

Keywords: *India, Pharmaceutical Industry, DEA, Financial Efficiency.*

1. Introduction

The pharmaceutical industry in India has developed rapidly after the economic liberalization. Firms in the industry have undergone series of changes right from licensing, regulation and process patent to delicensing, deregulation and product patent. The players in pharmaceutical industry of India are facing severe competition both on domestic as well as global front. However, despite of huge competition, the Indian pharmaceutical industry is one of the most dynamic and growth oriented industries of India. Wheremostofthe developing counties still rely heavily on imports of pharmaceutical products, India is one amongst the few exporting countries which is capable of producing a wide range of Active Pharmaceutical Ingredients (APIs). The underlying strength of Indian pharmaceutical industry is its generic drugs segment which contributes to 70 percent of total market share in terms of revenue and is armed with domestic production processes that has made the country a leading producer of low-cost medicines in the world. Further, various international companies associated with this sector have also stimulated, assisted and spearheaded its dynamic development and helped to put India on the pharmaceutical map of the world. In spite of the long development and high cost of drug research, pharma companies are undeniably more profitable than companies of any other industry. However, things have changed in recent years. The so-called defensive pharmaceutical sector is on the way to the ventilator. The financial performance of Indian pharmaceutical industry is getting degraded day by day. Indian pharmaceutical companies used to be the main players to get approvals from United States Food and Drug Administration (USFDA). But the market is now getting crowded. Nearly, a third of approvals have been given to players from outside traditional markets. Companies from Turkey, New Zealand, Taiwan and even Bangladesh have now got clearance to sell products in Unites States. Further, lower number of buyers and increasing number of new entrant tilt the balance of negotiations in the hands of the buyers, hitting profit margins badly.

Market often makes it a boom or bust play. In pharma's case, the valuation multiple i.e., the price earning (P/E) ratio, which measures how expensive the field is, shows that prices have outstripped earnings far too much. So far in the calendar year 2017, the Nifty Pharma index has underperformed with a fall of nearly 6%, as compared to a rally of around 15% in the Nifty 50 and the S&P BSE Sensex. Where the overall market is in boom phase, the pharma sector is in the bust phase. Most of the investors continued to taste bitterness in earnings due to high competition and challenging price environment, which is impacting the sentiments of the sector for the long-term. For export oriented Indian pharmaceutical companies, there are certain speed breakers on the road due to the stringent quality and compliance issues of United States Food and Drug

Administration (USFDA). Further, due to massive loss of income and sales as a result of patent expirations of blockbuster drugs, even the big pharma companies are becoming dinosaurs for investors. Despite scientific advances and favorable demographics, the industry suffers from long lead times to get its products through the R&D, regulatory maze and on sale. Usage of more generic medicines and price regulations of National Pharmaceutical Pricing Authority (NPPA) are amongst the few other reasons due to which pharma stocks are declining and also approaching to its 52 week low. All these turbulences contend that pharma stock prices aren't going to head up in any meaningful way, any time soon. This made the pharma sector investors little scared and unhappy.

In this scenario, the moot questions in every investor's mind are such that - are there any chances of recovery? If the fundamentals of the individual businesses are still strong? Despite being suffering from market-driven conditions, can companies sustain or create more shareholder value with the existing resources? If the answer to all these questions is yes, how much chances of improvement are there?

Keeping all these questions in mind, this paper attempts to measure the financial efficiency of the Indian pharmaceutical industry considering the shareholder value maximization as one of the important parameters. The study will offer the direction for improvement of financial efficiency of Indian pharmaceutical companies along with some important policy implications. In order to achieve the above mentioned objective, a non-parametric linear programming based frontier technique named data envelopment analysis (DEA) has been utilized due to its capability of taking multiple inputs and outputs simultaneously for calculating the relative efficiency and come up with a scalar measure of overall performance for easier decision making. DEA has been widely used and accepted as methodology for performance evaluation and benchmarking. The basic concept of directing methodology at frontiers rather than central tendencies such as statistical regression, gives DEA an advantage over traditional methods. DEA is capable of identifying relationships among entities that traditional methods are not able to identify. It quantifies relations of entities in a direct manner without requiring several assumptions or variations on data sets.

The rest of paper is organized as follows. In Section 2, we provide a brief review of the related studies on the subject matter. In Section 3, the methodological framework, data sources, sample selection and details of variables taken in this study are outlined. Section 4 presents the empirical findings of the DEA models employed in this study. The final section concludes the paper by providing some useful policy implications.

2. Review of Literature

In this section, we discuss some reviews of the related literature concerning this study given as follows:

González & Gascón (2004) analyzed the efficiency and productivity growth of 80 pharmaceutical companies of Spain between 1994 to 2000. The results of the study suggested that the contribution of technical change to productivity growth was negligible. The poor result of R&D activities hindered the efficiency and growth of Spanish pharmaceutical industry. The study concluded that there is a need to intensify the R&D efforts and expansion of production possibilities to develop high margin and patented products.

Saranga & Phani (2004) applied DEA on a sample of 44 Indian pharmaceutical companies for the period of 1992-2002 to look at the internal efficiencies of pharmaceutical companies. Technical and scale efficiencies were computed using the CCR and BCC models. The results of DEA were analyzed along with their Compounded Annual Growth Rate (CAGR) to check whether internal efficiencies, size and growth rate are related or not. Findings showed that the size of a company has no influence on the internal efficiencies scores. However, efficiency scores and growth rates were found to be positively related except for a few companies.

Hashimoto & Haneda (2008) measured the R&D efficiency of 10 Japanese firms for the period of 1982-2001 using DEA based Malmquist productivity index. The results showed that innovation of R&D technology had not taken place so much for decade 1983–1992 and Japanese pharmaceutical industry experienced a great R&D efficiency loss in year 1992 to 50 percent. Although, the firms had continued to increase R&D expenditure every year, yet the R&D efficiency showed no significant improvement over time.

Tripathy et al. (2009) examined the levels and determinants of firm's efficiency using firm-level data of 90 Indian pharmaceutical firms for the years 2001-02 to 2007-08. A two stage DEA model, considering one output variable and three input variables was applied to compute the technical efficiency scores. The results showed that the performance of a large number of sample firms was sub-optimal and with the introduction of product patents, the pharmaceutical industry has become more competitive. To become efficient, the firms need to reduce their inputs to attain a given level of output.

Wang et al. (2011) gauged the efficiency of 12 Taiwanese

pharmaceutical companies using grey relational analysis coupled with DEA based Malmquist analysis. The study primarily focused on how to utilize intellectual capital more efficiently in order to strengthen the competitiveness of enterprises. The results indicated that the companies in the intellectual capital management, still have great room for improvement and need to reduce waste of input resources, to enhance the intellectual capital management performance.

In sum, a careful screening of the available literature reveals that most of the studies have been conducted outside India. Few studies that have been conducted for Indian pharmaceutical industry are prior to the global recession of 2008 and focused only on operational parameters. After 2008, major structural changes have taken place at national and global level. The environment in which companies are operating now is not same as before. Therefore, keeping this in mind, the present study seeks to fill such gaps and intends to enrich the available literature concerning with the measurement of financial efficiency of Indian pharmaceutical industry using DEA methodology.

3. Methodological Framework

3.1 Concept and Measurementof Technical Efficiency

The literature on the measurement of efficiency begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to consider the technical efficiency measure in a single-output and single-input situation. Farrell proposed that the efficiency of a firm consists of two components viz. technicalefficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and allocativeefficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measurements are then combined to provide a measure of total economic efficiency. The measure of the allocative efficiency requires the information on both output and input prices data. Because India's economy is still under the process of transformation to a planned economy, the complete and authentic price data is not yet available for Indian pharmaceutical industry. For this reason the analysis in this paper will concentrate on the parameters of technical efficiency alone. Since the technical efficiency essentially measures the gap between the possible outputs, or the best practice and actual outputs of a firm, it demonstrates the extent to which the observed firms' performance approaches its potential or the so-called 'best practice' standard.

3.2 The DEA Approach – CCR and BCC Models

DEA was originally developed in the late 70's to provide a linear programming based mathematical technique for measuring the efficiency of a set of decision-making units (DMUs). Since the inception of DEA methodology, numerous mathematical programming models have been proposed in DEA literature (See Charnes et al., 2013; Zhu, 2014). The first seminal paper introducing DEA was given by Charnes et al. (1978), which got recognized after their names as CCR (Charnes, Cooper and Rhodes) model. CCR model uses the optimization method of mathematical programming to generalize the Farrell's (1957) single-output and single-input technical efficiency measure to the multiple-output and multiple-input situation by constructing a single 'virtual' output to a single 'virtual' input relative efficiency measure. The DEA technique is non-parametric in the sense that it is entirely based on the observed input-output data to estimate the efficient production frontier in a piecewise linear fashion. The purpose of DEA is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier and then to determine if the DMU under consideration is technically efficient or not. Because DEA calculations are generated from actual observed data for each DMU, they produce only relative efficiency measures. The relative efficiency of each DMU is calculated in relation to all the other DMUs, using the actual observed values for the outputs and inputs of each DMU.

CCR model was further expanded by Banker, Charnes and Cooper (1984) which later on got recognition as BCC model. The basic difference between CCR and BCC model is that the former has an assumption that all firms operate at constant returns to scale, while the latter accounts for variable returns to scale. Both these models are further divided into two orientations namely input and output orientation. The input orientated model is the method that seeks to measure technical efficiency as a proportional reduction in input usage, with output levels held constant. On the contrary the output orientation model seeks to measure technical efficiency as a proportional increase in output production, with input levels held fixed (Coelli et al., 2005). Since in Indian pharmaceutical industry, the major concern is shareholder value maximization. So in this case, an output orientation is more appropriate.

An intuitive way to comprehend DEA is via the ratio form. For each DMU, we would like to obtain a measure of the ratio of all outputs over all inputs. To illustrate the CCR model, consider n DMUs, $j=1,2,.....,n$. The units are homogeneous with the same types of inputs and outputs. Assume there are m inputs,

i=1,2,.....,m and s outputs, *r=1,2,.....,s*. Let x_{ij} and y_{rj} denote, respectively, the input and output vectors for the j^{th} DMU. Thus, x_{ij} is a *(m×1)* column vector and y_{rj} is a *(s×1)* column vector. Moreover, *X=(x_1,x_2,.....,x_n)* is the *(m×n)* input matrix and *Y=(y_1,y_2,.....,y_n)* is the *(s×n)* output matrix. The CCR model assigns weights to each input and output, and then assesses the efficiency of a given DMU by the ratio of the aggregate weighted output to the aggregate weighted input. The weights assigned must be non-negative. Also, they must restrict each DMU from receiving a ratio (of the weighted output to the weighted input) that is greater than 1. Mathematically, when evaluating the efficiency of the DMU *k*, we solve for the following linear programming problem (LPP):

$$\underset{\{u,v\}}{Maximize}\ \frac{u^T y_k}{v^T x_k} \qquad [1]$$

$$Subject\ to: \frac{u^T y_j}{v^T x_j} \le 1$$

$$j = 1,2,.....,n$$

$$u, v \ge 0$$

Where u is the *(s×1)* vector of output weights and v is the *(m×1)* vector of input weights. T denotes the matrix transpose operator. Thus, u and v are chosen to maximize the efficiency measure of the DMU k subject to the constraints that the efficiency levels of all units must be less than or equal to 1.

One problem with this particular ratio formulation is that it has an infinite number of solutions. To generate a unique solution, an additional constraint $v^T x_k = 1$ is imposed. The maximization problem then becomes:

$$\underset{\{u,v\}}{Maximize}\ u^T y_k \qquad [2]$$

$$Subject\ to: v^T x_k = 1$$

$$u^T y_j - v^T x_j \le 0$$

$$j = 1,2,.....,n$$

$$u, v \ge 0$$

The duality problem to output-oriented CCR model can be written as follows:

$$Maximize\ \psi_k \qquad [3]$$

$$Subject\ to: \sum_{j=1}^{N} \lambda_j x_{ij} \le x_{ik}$$

$$\sum_{j=1}^{N} \lambda_j y_{rj} \ge \psi_k y_{rk}$$

Where, λ is a (n×1) column vector; ψ is a scalar; *i=1,2,.....,m* (Counter for inputs); *r=1,2,.....,s* (Counter for outputs); *j=1,2,.....,n* (Counter for companies); *x_ij* = amount of input *i* used by DMU *j*; y_{rj} = amount of output *r* produced by DMU *j*; and *k* represents the DMU whose efficiency is to be evaluated.

Let *q* and is the solution to (3) then obviously $\psi_k^* \ge 1$. According to the Farrell's definition (1957), if $\psi_{k*}^* = 1$, it indicates a CCR technically efficient DMU, if $\psi_k > 1$ indicates CCR technically inefficient. Here it is worthwhile to note that the above linear programming problem must be solved *n* times, once for each DMU in the sample. A value of 1≤ is then obtained for each DMU. We denote $TE_{CRS} = 1/\psi_k = \theta$, the overall technical efficiency (OTE) score measured by the output oriented CCR method.

The CCR model is based on the assumption of constant returns to scale. Given this assumption, the size of the DMU is not considered to be relevant in assessing the relative efficiency. This means that even small DMUs can produce at the same level parallel to large DMUs. However, this assumption is not appropriate in developing economies where economies/dis-economies of scale could set in. In fact, not all DMUs always operate at an optimal scale. Imperfect competition, constraints on finance, etc. may cause a DMU to be not operating at optimal scale (Coelli et al., 2005). Therefore, a less restrictive VRS frontier can be constructed where Overall Technical Efficiency (OTE) can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE). The VRS model incorporates the dual of CRS model, with an extra convexity constraint $\sum_{j=1}^{N} \lambda_j = 1$ into problem, which essentially ensures that an inefficient DMU is only benchmarked against DMUo of similar size.

The duality problem to output oriented BCC model can be written as follows:

$$Maximize = \mu_k \qquad [4]$$

$$Subject\ to: \sum_{j=1}^{N} \lambda_j x_{ij} \le x_{ik}$$

$$\sum_{j=1}^{N} \lambda_j y_{rj} \ge \mu_k y_{rk}$$

$$\sum_{j=1}^{N} \lambda_j = 1$$

$$\lambda_j \ge 0$$

We denote $TE_{VRS} = 1/\mu_k =$, the pure technical efficiency (PTE) score measured by the output oriented BCC method. It is worthwhile to mention that BCC model measures the PTE, whereas CCR model measures both PTE and SE. Clearly, $TE_{CRS} \leq TE_{VRS}$, hence by using TE^k_{CRS} and TE^k_{VRS} measures, we derive a measure of SE as a ratio of TE^k_{CRS} to TE^k_{VRS} given as:

$$SE^k = \delta_k \quad TE^k_{CRS} \Big/ TE^k_{VRS} \quad \psi_k \Big/ \varphi_k = OTE \Big/ PTE \qquad [5]$$

The idea of looking at scale efficiency is appealing because it provides a measure of what could be gained by adjusting the size of the firm (Bogetoft & Otto, 2010). Banker et al. (1984) introduced the concept of Most Productive Scale Size (MPSS) to define the level of operations that maximizes the efficiency of a DMU. In short run, a DMU may either operate at DRS or IRS, nevertheless in the long run, it will move to CRS by becoming larger or smaller as a result of changing its operating strategy in terms of scaling up or scaling down to survive in a competitive market.

Data and Sample

In this study, the analysis is based on cross-sectional data of 91 Indian pharmaceutical companies for the year 2015-16. All the data relating to selected input and output variables have been extracted from the Prowess database of Centre for Monitoring Indian Economy (CMIE). Initially, we got the data of 93 pharmaceutical companies. In order to detect the potential outliers from the sample we then applied the method suggested by Bogetoft & Otto (2015). In this process, 2 companies were turned out to be outlier. The removal of outliers provided us with a more representative frontier. We used software R to perform the empirical analysis.

Selection of Input and Output Variables

The selection of inputs and outputs is one the most crucial exercises of DEA analysis. However, there are no specific rules defined for the selection of input and output variables, generally the inputs are defined as resources utilized by the DMU and outputs as the benefits generated. Since an organization's performance is a complex phenomenon requiring more than a single criterion, recent studies have argued that a multi-factor performance measurement model may be used (Zhu, 2000). Indeed, an accurate selection of the indicators, which are best adapted to the objectives of the analysis, is critical to the relevance and usefulness of the results. The foremost task for the computation of technical efficiency using DEA is to specify a set of input & output variables. Since an organization's performance is a complex phenomenon requiring more than a single criterion, recent studies have argued that a multi-factor performance measurement model may be used (Zhu, 2000). So far our choice of input and output variables is concerned, we referred to various natural choices amongst various researchers (See Kakani et al., 2001; Tehrani et al., 2012; Dastgir et al., 2012)

In the present study, our choice of inputs is governed by the fact that three major elements of financial performance viz. Liquidity, Solvency and Profitability have been considered. Two key ratios for each Indicator have been taken. The final input variables which have been considered are (i) Current Ratio, (ii) Quick Ratio, (iii) Debt-equity Ratio, (iv) Interest Coverage Ratio, (v) Return-on-Assets and (vi) Return-on-Equity.

While making the choice of output variables, we found Tobin's Q ratio and market value to book value ratio as widely accepted proxies for measuring firm value amongst various researchers. (See Wernerfelt & Montgomery, 1988; Beaver & Ryan, 1993; Fama & French 1995; Kakani et al., 2001). Likewise, following the same pattern, we used (i) Tobin's Q Ratio and (ii) Market Value to Book Value Ratio as two outputs.

The size of the sample utilized in the present study is consistent with the various rules of thumb available in the DEA literature. Cooper, Seiford, and Tone (2007) provides two such rules that together can be expressed as: $n \geq \{m \times s\}$ or $n \geq \{3(m+s)\}$" n = number of DMUs, m = number of inputs, s = number of outputs. The first rule of thumb states that sample size should be greater than equal to product of inputs and outputs. While the second rule states that number of observation in the data set should be at least three times the sum of number of input and output variables. Given m=6 and s=2 in our study, the sample size n=91 used in the present study exceeds the desirable size as suggested by the above mentioned rules of thumb to obtain sufficient discriminatory power.

Empirical Findings

In this section, the efficiency results obtained through output-oriented CCR and BCC models have been presented and discussed. Table 1 presents the descriptive statistics and frequency distribution of overall technical efficiency (OTE) scores of all the 91 Indian pharmaceutical companies for the year 2015-16 obtained by running output oriented CCR model. We find that the mean of OTE scores has turned out to be 0.6946 indicating that on an average the companies in Indian pharmaceutical industry have overall technical inefficiency

(OTIE) of about 30.54 percent. The perusal of the Table 1 further tells that out of 91 pharmaceutical companies included in the sample, only 24 companies have been found to be relatively efficient with OTE score equal to one. It represents that 26.37 percent companies set an example of best-practice by defining the efficient frontier. The practices of these companies must be imitated by the inefficient companies to improve their score of OTE. It clearly dictates that there is a huge scope of more value creation for the investors of Indian pharmaceutical industry.

Table 1: Frequency Distribution and Descriptive Statistics of Overall Technical Efficiency (OTE) Scores of Indian Pharmaceutical Industry

Frequency Distribution		
OTE Scores Range	**No. of Companies**	**Percentage**
OTE < 0.4	15	16.48
0.4 ´´OTE <0.5	11	12.09
0.5 ´´OTE <0.6	14	15.38
0.6 ´´OTE <0.7	5	5.49
0.7 ´´OTE <0.8	5	5.49
0.8 ´´OTE <0.9	10	10.99
0.9 ´´OTE <1	7	7.69
OTE = 1	24	26.37
Total	**91**	**100.00**

Descriptive Statistics						
Minimum	**First Quartile**	**Mean**	**Median**	**Third Quartile**	**Maximum**	**Standard Deviation**
0.1789	0.4748	0.6946	0.7125	1.0000	1.0000	0.2645

Source: Authors' calculations.

Decompositionof Overall Technical Efficiency

As stated earlier, the OTE scores obtained through CCR model can be decomposed into two mutually exclusive non-additive components viz. pure technical efficiency (PTE) and scale efficiency (SE). Recall, *SE=OTE/PTE i.e. OTE=PTE×SE*. It can be done by using the BCC model upon the same data. If there is a difference in scores for a particular DMU, it indicates that there exists scale inefficiency (SIE). In DEA literature, the DMUs getting OTE scores equal to 1 are referred to as 'globally technical efficient' and DMUs getting PTE scores equal to 1 but OTE scores not equal to 1 are called 'locally technical efficient'. Table 2 provides the descriptive statistics and frequency distribution of PTE scores of Indian pharmaceutical companies. The mean value of PTE scores has turned out to be 0.8396 indicating that the extent of pure technical inefficiency (PTIE) in the Indian pharmaceutical industry is to the tune of about 16.04 percent. Only 50 pharmaceutical companies out of 91 (i.e. 54.95 percent) have acquired the status of locally technical efficient since they attained PTE score equal to 1. Out of these 50 pharmaceutical companies, 24 pharmaceutical companies are also relatively efficient under CRS with OTE score equal to 1 i.e. they are globally as well as locally technical efficient. Further, for remaining 26 pharmaceutical companies it may be stated that they are locally technical efficient but globally inefficient.

Table 2: Frequency Distribution and Descriptive Statistics of Pure Technical Efficiency (PTE) Scores of Indian Pharmaceutical Industry

Frequency Distribution						
PTE Scores Range			**No. of Companies**		**Percentage**	
PTE < 0.4			9		9.89	
0.4 ´´PTE <0.5			4		4.40	
0.5 ´´PTE <0.6			5		5.49	
0.6 ´´PTE <0.7			3		3.30	
0.7 ´´PTE <0.8			7		7.69	
0.8 ´´PTE <0.9			4		4.40	
0.9 ´´PTE <1			9		9.89	
PTE = 1			50		54.95	
Total			**91**		**100.00**	
Descriptive Statistics						
Minimum	**First Quartile**	**Mean**	**Median**	**Third Quartile**	**Maximum**	**Standard Deviation**
0.1998	0.7134	0.8396	1.0000	1.0000	1.0000	0.2399
Source: Authors' calculations.						

Table 3: Frequency Distribution and Descriptive Statistics of Scale Efficiency (SE) Scores of Indian Pharmaceutical

Frequency Distribution						
SE Scores Range			**No. of Companies**		**Percentage**	
SE < 0.4			5		5.49	
0.4 ´´SE <0.5			4		4.40	
0.5 ´´SE <0.6			6		6.59	
0.6 ´´SE <0.7			7		7.69	
0.7 ´´SE <0.8			6		6.59	
0.8 ´´SE <0.9			11		12.09	
0.9 ´´SE <1			28		30.77	
SE = 1			24		26.37	
Total			**91**		**100.00**	
Descriptive Statistics						
Minimum	**First Quartile**	**Mean**	**Median**	**Third Quartile**	**Maximum**	**Standard Deviation**
0.2445	0.7329	0.8399	0.9470	1.0000	1.0000	0.2085
Source: Authors' calculations.						

Table 3 provides the descriptive statistics and frequency distribution of SE scores of Indian pharmaceutical companies. The value of SE scores = 1 implies that the particular DMU is operating at MPSS i.e. optimal scale size. On the contrary, a value of SE scores **K**1 implies that company is experiencing inefficiency because it is not operating at its optimal scale size. For our analysis, the mean value of SE scores has turned out to be 0.8399 indicating that the average level of SIE in the Indian pharmaceutical industry is about 16.01 percent. Given PTIE = 16.04 percent, this fact reveals that scale size and managerial incapacity are almost equal contributors of OTIE. The perusal of the Table 3 further tells that out of 91 pharmaceutical companies included in the sample, only 24 companies (i.e. 26.37 percent) have attained SE score equal to 1 and are operating at MPSS. Thus, it portrays that the remaining 67 pharmaceutical companies (i.e. 73.63 percent) are operating with some degree of SIE, albeit of different magnitude.

5. Conclusions

In today's competitive business environment, efficiency measurement is receiving increased attention from policy makers in all sectors of the economy. In this study, an attempt has been made to measure the financial efficiency of the Indian pharmaceutical industry using cross-sectional data of 91 pharmaceutical companies for the year 2015-16. We applied two widely used DEA models viz. CCR and BCC to calculate the best practice frontier and estimates of technical efficiency scores based on selected financial parameters. The empirical results indicate that overall technical efficiency (OTE) scores for the Indian pharmaceutical companies range from 0.1789 to 1, with mean value of 0.6946. It implies that on an average the companies in Indian pharmaceutical industry have the potential to increase their outputs by about 30.54 percent to using the same level of inputs. Since we have taken two important parameters of share value maximization as output variables in this model, it can be inferred that Indian pharmaceutical companies have huge potential to improve the shareholder value by using the same resources as before.

The decomposition of the OTE scores into two mutually exclusive non-additive components viz. pure technical efficiency (PTE) and scale efficiency (SE) reveals that 16.04 percentage points of 30.54 percent of overall technical inefficiency (OTIE) as identified by CCR model are primarily attributed to managerial inefficiency. The PTE scores for the Indian pharmaceutical companies range from 0.1998 to 1, with mean value of 0.8396. Out of 50 efficient pharmaceutical companies under BCC model, 24 companies have also been found to be relatively efficient under CCR model with OTE score equal to 1 indicating that they are globally as well as locally technical efficient. For remaining 26 companies, it may be stated that OTIE in these companies is caused not due to managerial incapability to organize the resources but rather inappropriate choice of the scale size. For our analysis, it has been observed that SE scores range from a minimum of 0.2445 to a maximum of 1. The mean value of SE scores has turned out to be 0.8399 indicating that the average level of scale inefficiency (SIE) in the Indian pharmaceutical industry is about 16.01 percent.

In sum, DEA results clearly witness that there exists a substantial room for the improvement of financial efficiency in Indian pharmaceutical industry. Given the importance of this industry for the Indian economy, it is imperative that efforts should be taken to increase the efficiency of companies whose performance is sub-optimal. There is a need to take concrete steps to eliminate the managerial inefficiencies in the process of resource utilization and correcting the scale of operations. Looking carefully into the root causes of inefficiency can help the Indian pharmaceutical industry to create more value for its shareholders. Although, there is a need to improve the regulatory policies, especially in the area of patent and price control, however, in order to boost the financial efficiency still there are untapped opportunities available within the companies internally. Fundamentals of the individual businesses are still strong and there is need to use the limited resources wisely.

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