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Analysing Efficiency of Listed Automobile Companies in India using DEA

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Abstract

In this research paper, we evaluate the relative efficiency of six National Stock Exchange (NSE) listed automobile companies. In doing so, we rely on various financial indicators like net profit and operating profit that describe the health of a company from various perspectives. The calculation of financial ratios were done using the historic data of the companies. Historic data have been sourced from the annual financial statements published by the companies. For analysing the data, Data Envelopment Analysis has been used. DEA shows several advantages and the evaluating results are more objective and systematic when compared to traditional methods. The results show that several listed corporations are operating inefficiently, which suggests that costs can be reduced significantly. So, measures for improving efficiency are also discussed.

Keywords: *Automobile industry, DEA, Relative efficiency.*

I. INTRODUCTION

The growth of the Indian automobile industry has been phenomenal since 1898 when the first automobile touched the Indian streets. However, currently, India is on the verge to rewrite history. Indians own more than 4 crore passenger vehicles and Indian factory-made cars and automobile ancillary products are being exported to other countries. In the year 2003-04, India crossed the milestone of export of one billion USD worth of automobiles growing at a rate of fifty-six percent. In the year 2010, India became the third-largest exporter of cars in the world. The key reasons behind this increase of the auto business in India are the easement of state norms, appurtenant policies measures to boost foreign investment, reduced import tariffs, easy technology transfer and easy banking with convenient EMI options. With many foreign brands collaborating with domestic makers, the Indian consumer is currently flooded with options. Moreover, rapid economic growth led to increased market demand for commercial vehicles. The ever-increasing income of the Indian middle class and improved vehicle export have led to a steady rise in automotive sales. But 2019, paints a grim picture for the automobile sector in India. Although the Indian automobile market is fourth-largest in the world in terms of sales in 2019, companies have seen a steady decline in the number of vehicles sells. Macroeconomic factors like the USA – China trade war and the NBFC crisis are partially responsible for this slowdown. Other factors include the transition of Indian automobile to Bharat Stage VI emission norms.

The listed corporations of the automobile industry, therefore, become a focus attaching abundant attention. So, it's a purposeful work to analyse the performance of listed firms, which may facilitate them to identify performance gaps and to create an edge using the smallest amount of potential resources. The normal methodology focuses on financial ratio analysis, usually in the form of a single index to analyse the corporations' capability of payment and profitability. However, the results cannot depict the complete scenario for the businesses. In reality, the profitability and efficiency of a company depend on multiple factors and they influence multiple outputs. Data Envelopment Analysis (DEA) is used for analysing the efficiency and performance of each decision-making units (DMUs) with respect to each other, having identified more than one inputs and outputs. It allows us to find the most efficient DMUs and

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their efficiencies are used as the benchmark for inefficient DMUs for a certain combination of inputs. As compared to traditional methods, DEA shows many benefits. One, DEA allows more than one input and output having different units in a noncomplex manner. Two, no hassle of assuming a starting function that joins input and output variables. Hence, in this paper, we are applying DEA to examine the relative performance of six automobile companies listed in the National Stock Exchange (NSE) and discuss strategies to improve efficiency. The six automobile firms selected are Maruti Suzuki Republic of India Ltd., TATA Motors, Bajaj Auto, Ashok Leyland, Eicher Motors and TVS Motor Company. These firms represent passenger vehicles, commercial vehicles, 2-wheeler and 3-wheeler segments of the auto business.

II. LITERATURE REVIEW

A. Significance of different financial ratios

In 2013, Dursun Delen, Cemil Kuzey, and Ali Uyar [5] used decision tree analysis to analyse the impact of different financial ratios on ROE and ROA. Using published literature, financial ratios were identified which could have a significant influence on ROA and ROE. EFA was used to understand the aggregate measures of the identified financial ratios.

B. Analysing two companies in the same sector using financial ratios

In 2016, Shivam Mathur and Krati Agarwal [7] used financial ratios to compare two leading automobile companies of India, Tata Motors and Maruti Suzuki. This research aimed to analyse the financial efficiency of TATA Motors and Maruti Suzuki based on key ratios/parameters. It used Net Sales, Net Profit and Gross profit values of these two companies from the year 2012 to 2014. These ratios were used to compare the financial performance of the two companies.

C. Automobile sector analysis using financial ratios

A study by Dr. Sarbapriya Ray (2012) [8] attempted to analyse the automobile industry's financial performance as a whole using financial ratios. The analysis has been done on the data for the period of 2003-04 to 2009-10. Data have been taken for 60 companies like Tata Motors, Maruti Suzuki, etc. Some of the important financial ratios like profitability ratios and liquidity ratios have been calculated to analyse the performance of the sector. The financial analysis gave insights into the performance of the sector and company-specific performance.

It was concluded from the study that the automobile industry has been going through rough patches between the period of 2003 and 2009. The rough phases had the typical characteristics of increased debt, reduced return on assets, and most importantly, decreased liquidity. In 2018, Aashi Agarwal and Prachi Gupta [1] attempted financial appraisal of automobile companies in India using financial ratios. The ratios were grouped into four categories - solvency, liquidity, efficiency and profitability and five companies in the automobile industry were considered. The output of the analysis was used as industry benchmarks and to analyse any peculiarities in the financial trends of the companies. The study was conducted to understand the concept of financial ratio analysis, to understand the efficiency of selected corporations in the automobile sector based on key ratios, to compare how different companies have been performing over five years (intra- firm analysis), to compare their performance concerning each other (inter-firm analysis).

D. Evaluation of standalone company in the automobile sector

In 2017, Varun Sharma and Dr. Abha Jain Nagawat [10] studied the performance of Tata Motors, using different financial ratios. The basis of the study was the financial data of Tata Motors for the period of 2006-07 to 2015-16. The data of the past ten years were considered and the efficiency of the company was studied. From the study, it was concluded that Tata Motors profitability position was fluctuating which was not good for the company which may be due to that company not selling enough to cover its fixed cost, cost of production of the company was high, the company was investing high in production and generating low income, high taxes, the heavy cost of borrowed funds, high depreciation, etc. As a result, shareholders were losing instead of gaining value and investors may avoid placing their money in the company.

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E. Analysing performance of industry leaders using different methodologies

Robert M. Hull and Nicholas Avey (2007) [6] analysed the financial performance of Ford Motors, General Motors, and Daimler Chrysler. These three companies are known as "Big Three" of the United States. For this analysis, standard methods and advanced methods of financial ratio analysis were used. The analysis aimed to examine the profitability of the three biggest automobile manufacturers in the United States. Traditional methods include DuPont model and relatively advanced valuation techniques include ROI and FCF.

F. Efficiency Evaluation using DEA

Li Yaosheng and Wang Xiping [11], in their paper, use DEA to evaluate the efficiency of 12 automobile companies listed in the stock exchange. A CCR input-oriented DEA model was used to analyse the relative performance of the 12 listed automobile corporations. This study uses two input variables (Total Assets, Operating Costs) and three output variables (Prime operating revenue, Net Profit and Earnings per share of common stock) to evaluate these companies' performance. According to the results, the twelve auto corporations can be divided into two groups: the efficient and the inefficient. For the inefficient companies, the adjusted input and output values are calculated for which the companies get to the optimum level of operation. The estimated results show that only 5 corporations, namely Jiangling Auto, Xiamen Auto, Shanghai Auto, Jianghuai Auto, and Anhui heli are efficient, while the remaining 7 corporations exhibited varying degrees of inefficiencies. And further study indicates that the majority of the inefficient corporations except for two corporations, exhibited decreasing returns to scale which means it is unproductive for these companies to expand their scale of production.

III. DATA ENVELOPMENT ANALYSIS

In DEA, the efficiency score is calculated using the below basic equation:

$$\text{Efficiency of the firm} = \frac{\text{Sum of each output multiplied by their corresponding weight}}{\text{Sum of each input multiplied by their corresponding weight}} \quad (1)$$

If we have 'n' number of decision-making units (DMUs) to be analysed where every DMU uses m number of input variables and produce s number output variables, the relative efficiency score of any random DMU_0 can be calculated by solving the below problem:

$$\text{Max} \ \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

Subject to:

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \quad , j=1,2. . .. j_0,. . . n \quad (2)$$

$$u_r, v_i \ge 0 \ , r=1,2,. . . s,i=1,2,3. . . m$$

Where

x_{ij} = i^{th} actual input of the j^{th} DMU

y_{rj} = r^{th} actual output of the j^{th} DMU

u_r = weight assigned to the output r ,v_i = weight assigned to the input i

Equation (2) can be solved by converting it to a linear program as shown in equation (3). For more details on the model development, refer to Charnes et al. (1978).

$$\text{Max} \ \sum_{r=1}^{s} u_r y_{r0}$$

Subject to:

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0 \quad , j= 1,2,3\ldots n \quad (3)$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1; v_i \ge 0; \ u_r \ge 0$$

IV. DATA AND METHODOLOGY

Six listed corporations of the automobile industry were chosen from the National Stock Exchange (NSE) as our decision- making units (DMUs). As a statistical basis for evaluation, average data for 10 years from 2009 to 2018 is used.

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After the units of assessment are identified, we need to define parameters that can be our inputs and outputs for the DEA model. One of the most critical tasks for efficiency analysis using DEA is choosing the input and output variables. Various factors affect the choice of variables, some of which are requirements of the mathematical model, methodology chosen and the availability of the data and its quality. There is no standard template for variable selection. Usually, input variables should be able to capture the resources which have to be minimized like labour, expense, assets, etc. The output variable should capture the important outcomes based on which the decision-making units are to be assessed like net profit. In this study, we are using two input and two output variables to evaluate these companies' performance. Two inputs chosen for the DEA analysis are Total Assets and Total Expenses. Two outputs include Operating profit and Net Profit/Share. Total Assets, Total Expenses, and Operating profit are measured in Rs Crore. Table-I lists the data used for the analysis. Input oriented CCR model was used to examine the performance of the six listed companies.

In the input-oriented CRS model, it is programmed to calculate how much a company can reduce the use of input and still able to sustain the same level of output. Hence, the input decreases and output remain the same making the company more efficient. For the DMUs which are inefficient, the optimum level of input and output can be calculated using the below equations:

Optimum Input = Score * Old Input – Corresponding Input Slack (4)

Optimum Output = Old Output + Corresponding Output slack (5)

V. RESULT

The results are presented in Table 2. According to the results, the six auto corporations can be divided into two groups: the efficient and the inefficient.

A. Efficiency Analysis

It is evident from Table II that only DMU 5 is efficient since only for DMU 5 the value of the efficiency score is equal to 1 which is the optimal score. This means that only 1 corporation, namely Eicher Motors is operating on the CRS frontier, while the remaining 5 DMUs exhibited varying degrees of inefficiencies. This means that these inefficient DMUs are not utilizing their available resources to the fullest which is leading to wastage and consequently reduction of efficiency. They are losing their competitive edge because of underutilised resources. So, they need to rearrange input to improve their performance.

B. Process improvement

As we saw in the previous section, only one DMU was efficient and all other DMUs were inefficient. Using DEA, we can find the optimum level of all the inputs and outputs for an inefficient DMU. Adjusted inputs and outputs will increase the efficiency of the DMUs. Equation (4) and (5) can be used to calculate the optimum level of inputs and outputs for each inefficient DMUs. For example, DMU3 (Bajaj Auto) is inefficient, however, it can move its performance to best practice by either decreasing its inputs or increasing its outputs. Concretely, the input values should be decreased to:

Total Assets = 0.7923*16035.21 = 12706.696;

Total Expenses = 0.7923*17150.225 -2364.729 = 11223.394

or the output values of Operating Profit and Net Profit/share should be increased to Rs 4023.87 Crore and Rs 1120.162 respectively. Table IV provides the adjusted inputs and outputs for all the inefficient companies.

It can be seen that the efficiency of DMUs is improved by either decreasing the input or increasing the output. But it is not always possible to reduce input for a firm. For example, for Indian automobile companies, research and development cost for the transition to BS-VI is a huge expenditure and it can not be avoided. Hence total expense can not be reduced easily in some scenarios.

C. Scale returns analysis

According to the value of lambda, we can judge the scale returns of DMU. If lambda=1, it means the DMU is CRS (constant returns scale). If lambda <1 in the CCR model, it indicates IRS (increasing

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returns scale), while lambda >1 indicates DRS (decreasing returns scale).

It can be observed from Table 2 that the efficient corporation also has a constant returns-to-scale (CRS). This means that at the present output level, the inputs have reached the optimal value. Among the inefficient corporations, only one corporation, namely, TVS Motors, exhibit IRS, while the remaining of the inefficient companies showed decreasing returns to scale, which means it will be counterproductive to further expand services.

VI. CONCLUSION

This paper uses DEA to analyse the efficiency of 6 automobile companies listed in the National Stock Exchange (NSE). The empirical results show that only 1 corporation, namely Eicher Motors, is efficient, while the remaining 5 corporations exhibited differing degrees of inefficiencies. Also, it is seen that all the corporations have optimum Operating profit and only need to increase their Net profit per share. Since, increasing net profit per share is not easy, to achieve optimum financial efficiency, total expense and total assets need to be decreased. And further study indicates that the majority of the inefficient corporations except for one corporation, namely TVS Motors, exhibited decreasing returns to scale. Therefore we should strengthen the internal management and decrease the capital cost to improve the performance.

VII. FUTURE SCOPE

In this paper, secondary data was used for analysing the efficiency of the companies. In the future, primary research can be conducted to collect information on input variables like no. of workers, no. of units sold and consumer perception of the brand to analyse the effect of these primary factors on the profitability of automobile companies. Efficiency can also be analysed relative to different segments of the automobile sector. For example, relative efficiency can be calculated between two-wheeler, three-wheeler, passenger vehicles, and commercial vehicle companies. This study can also be carried out in other sectors like FMCG and airlines.

TABLE I
DATA FOR THE LISTED COMPANIES

	Operating Profit (Rs Crore)	Net Profit/Share (Rs.)	Total Assets (Rs Crore)	Total Expense (Rs Crore)
Maruti Suzuki	6831.14	144.15	36348.56	48386.99
TATA Motors	2524.028	5.442	54735.072	47916.052
Bajaj Auto	4023.87	122.144	16035.211	17150.225
Ashok Leyland	1585.727	3.128	13340.798	15269.068
Eicher Motors	1147.06	319.317	3621.594	3199.324
TVS Motors	679.161	7.843	4646.602	9523.235

TABLE II
RESULT OF CCR - INPUT MODEL

No.	DMU	Score	Rank	Slack Total Assets (Rs Crore)	Slack Total Expense (Rs Crore)	Slack Operating Profit (Rs Crore)	Slack Net Profit/Share (Rs.)	Reference (Lambda)
1	Maruti Suzuki	0.59343		0	9657.91	0	1757.498	5.955
2	TATA Motors	0.14696		72.684	0	0	697.195	2.2
3	Bajaj Auto	0.79232		0	2364.729	0	998.018	3.508
4	Ashok Leyland	0.37535		0	1307.407	0	438.306	1.382
5	Eicher Motors	1	1	0	0	0	0	1
6	TVS Motors	0.46154		0	2500.48	0	181.221	0.592

TABLE III
NO. OF EFFICIENT COMPANIES

No. of Efficient DMUs = 1
No. of Inefficient DMUs = 5

TABLE IV
ADJUSTED INPUTS AND OUTPUTS

DMU	Adjusted Inputs		Adjusted Outputs	
	Total Assets (Rs Crore)	Total Expense (Rs Crore)	Operating Profit (Rs Crore)	Net Profit/Share (Rs.)
Maruti Suzuki	21569.2355	19054.92987	6831.14	1901.648
TATA Motors	7967.898077	7038.868039	2524.028	702.637
Bajaj Auto	12704.69768	11223.39427	4023.87	1120.162
Ashok Leyland	5006.801489	4423.07422	1585.727	441.434
Eicher Motors	3621.594444	3199.324444	1147.06	319.3177778
TVS Motors	2144.406823	1894.492953	679.161	189.064

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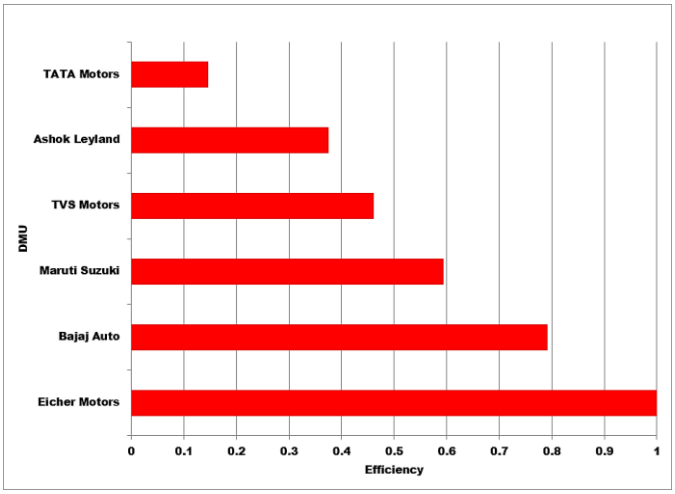

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