



## Technical and Scale Efficiency of Automobile Firms in Pakistan

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**Abstract:** *The current study aimed at exploring the efficiency level of automobile firms in Pakistan. For this purpose, the current study has collected the data of 18 automobile and automobile parts firms from the year 2011 to the year 2015. To analyse the data, the current study has used the data envelopment analysis. Three models were used to calculate the firm efficiency such as constant return to scale, variable return to scale and scale efficiency. The results of the study have revealed that most of the automobile firms are not efficient during these years. In addition, the results were consistent based on the three efficiency models.*

### Background of the Study

The purpose of the current study is to examine the technical efficiency of automobile firms in Pakistan. In Pakistan, the automobile sector has been growing rapidly in the previous years (Ministry of Finance, 2017). The growth of different sub-sectors in the automobile industry has remained notable such as trucks, tractors, cars & jeeps and LCVs registered with growth rate of 53.9 percent, 44.6 percent, 23.1 percent and 31.2 percent, respectively (Ministry of Finance, 2014-15). Likewise, the growth of these subsector increased in the recent years with 72.9 percent in farm tractors, 39.3 percent in trucks, 4.68 percent in jeeps & cars, 21.4 percent in motor cycles, 19.7 percent in buses during July-March of the year 2017 (Ministry of Finance, 2017).

The efficiency of any sector indicates whether the firm can produce maximum output from the given inputs. The growth in automobile industry of Pakistan is based on the growth in their total sales; however, it may not necessarily reflect their ability in transforming their resources into their sales. The purpose of the current study is to assess the efficiency of automobile sector in Pakistan by examining the technical efficiency using data envelopment analysis. Previous studies have reported the efficiency of financial sector and non-financial sectors (Ahmed, 2008; Bayyurt & Duzu, 2008; Din et al., 2007; Mahajan et al., 2014; Qayyum & Riaz, 2012). Miller and Noulas (1996) reported the technical efficiency of banks using data envelopment analysis by taking the sample of 201 large banks from 1984 to 1990. According to the results of their study the large banks with high profitability are more efficient.

Akgöbek and Yakut (2014) examined the efficiency of Turkish manufacturing sector using data envelopment analysis. Bayyurt and Duzu (2008) examined the efficiency of manufacturing sectors in Turkey and China by using data envelopment analysis. The results of their study reported that manufacturing firms in China are more efficient than the manufacturing firms in Turkey. Likewise, Memon and Tahir (2011) measured the efficiency of manufacturing firms in Pakistan using data envelopment analysis. The results of their study demonstrated that only one company out of the sample firms was efficient. Moreover, Lundvall and Battese (2000) measured the efficiency of 235 manufacturing firms in Kenya. Furthermore, they reported that firm size is related to the efficiency of firms. However, there is lack of research on the efficiency of automobile firms in Pakistan therefore the current study has measured the efficiency of Pakistani automobile firms.

### Data and Methodology

The current study has used the data for automobile firms in Pakistan. The numbers of firms included in the current study are eighteen representing automobile and automobile parts firms. The data collected for the current study ranges from the year 2011 to 2015. To measure the efficiency, data envelopment analysis has been employed. The efficiency of firms is measured by calculating the year wise efficiency scores for individual firms. Data envelopment analysis has been used by many previous studies to measure the technical efficiency (Chen & Chen, 2011; Din et al., 2007; Mok et al., 2007; Qayyum & Riaz, 2012).

To measure the firm efficiency, the current study has used the input and output variables following Chen and Chen (2011). The input variables used in the current study are total assets, operation costs, and selling and administrative expenditures, and the output variable is net sales. Total assets include total current assets and total fixed assets; operation costs include raw material and labour costs; selling and administrative expenditures include employee salaries and sale promotion expenditures. The output variable used in the current study is net sales which is defined as sales revenues subtract sales returns and allowance.



The current study has calculated the efficiency scores based on three models. The first model is based on the constant return to scale model. The second model is based on variable return to scale. The third model is the scale efficiency. The scores calculated by these models are used to measure the efficiency of firm. The score of 1 represents that a firm is efficient whereas score less than one

represents that the firm is inefficient. The firm efficiency can be measured using technical efficiency, scale efficiency and allocative efficiency. Since, the data availability for production cost is difficult to obtain, the current study has used the technical efficiency and scale efficiency to measure the firm efficiency of automobile firms in Pakistan.

### Findings

**Table 1:** *Efficiency Scores for Automobile Firms based on Constant Return to Scale*

DMU	Constant Return to Scale					Average
	2011	2012	2013	2014	2015	
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	0.294	0.012	0.014	0.703	0.215	.2476
4	0.857	0.748	0.779	0.789	0.633	.7612
5	0.892	0.891	0.938	0.845	0.937	.9006
6	0.886	0.865	0.884	0.904	0.98	.9038
7	1	0.88	0.953	1	1	.9666
8	0.905	0.879	0.909	0.918	0.903	.9028
9	1	1	1	0.991	1	.9982
10	1	0.986	1	1	1	.9972
11	1	1	0.956	0.948	0.958	.9724
12	0.971	0.985	0.919	0.937	0.904	.9432
13	1	1	0.953	0.918	0.954	.965
14	0.984	1	0.99	0.989	1	.9926
15	0.967	0.961	0.899	0.926	0.872	.925
16	0.938	0.961	1	0.933	0.911	.9486
17	0.931	0.914	0.96	0.966	0.963	.9468
18	0.961	0.962	0.941	0.871	0.905	.928

The table 1 reports the efficiency scores for all automobile firms based on the constant return to scale model. The table 1 reports the efficiency scores for eighteen automobile Pakistani firms. Results indicate that 7 firms were efficient and 11 are inefficient during the year 2011. Likewise, the number of efficient firms is 6 and inefficient firms are 12 for the year 2012. For the year 2013 and year 2014, the number of inefficient firms is high. For instance, for the year 2013, the number of inefficient firm is 13 and efficient firms are 5. Similar percentage of efficient and inefficient firms is found in the year 2014 indicating 14 inefficient and 4 efficient firms. Moreover, the number of efficient firms is 6 for the year 2015 whereas the number of inefficient firms is 12. The scores based on the constant return to scale model implies that most of the automobile firms are not efficient during the last five years. Based on the average scores of firm efficiencies only DMU 1 and DMU 2 are efficient in the last five years.

**Table 2:** *Efficiency Scores for Automobile Firms based on Variable Return to Scale*

DMU	Variable Return to Scale					Average
	2011	2012	2013	2014	2015	
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	0.834	1	1	0.724	0.793	.8702



DMU	Variable Return to Scale					Average
	2011	2012	2013	2014	2015	
4	1	1	1	1	1	1
5	0.918	0.923	0.95	0.853	0.951	.919
6	0.9	0.908	0.904	0.915	0.995	.9244
7	1	0.885	0.956	1	1	.9682
8	0.911	0.896	0.914	0.92	0.908	.9098
9	1	1	1	1	1	1
10	1	1	1	1	1	1
11	1	1	0.959	0.972	1	.9862
12	1	1	0.992	1	1	.9984
13	1	1	0.966	0.932	0.97	.9736
14	1	1	0.999	0.992	1	.9982
15	1	1	0.947	0.974	0.957	.9756
16	0.939	0.973	1	0.935	0.911	.9516
17	0.935	0.92	0.964	0.968	0.968	.951
18	0.983	1	0.978	0.943	0.969	.9746

The table 2 reports the efficiency scores for all automobile firms based on the variable return to scale model. The table 2 reports the efficiency scores for eighteen automobile Pakistani firms. Results indicate that 11 firms were efficient and 7 are inefficient during the year 2011. Likewise, the number of efficient firms is 12 and inefficient firms are 6 for the year 2012. For the year 2013 and year 2014, the number of inefficient firms is high. For instance, for the year 2013, the number of inefficient firm is 11 and efficient firms are 7. Similar percentage of efficient and inefficient firms is found in the year 2014 indicating 11 inefficient and 7 efficient firms. Moreover, the number of efficient firms is 9 for the year 2015 whereas the number of inefficient firms is also 9. The scores based on the variable return to scale model implies that most of the automobile firms are not efficient during the last five years. Based on the average scores of firm efficiencies only DMU 1, DMU 2, DMU 9 and DMU 10 are efficient in the last five years.

**Table 3: Efficiency Scores for Automobile Firms based on Scale Efficiency**

DMU	Scale Efficiency					Average
	2011	2012	2013	2014	2015	
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	0.352	0.012	0.014	0.971	0.27	.3238
4	0.857	0.748	0.779	0.789	0.633	.7612
5	0.972	0.965	0.988	0.99	0.985	.98
6	0.983	0.953	0.979	0.989	0.985	.9778
7	1	0.995	0.997	1	1	.9984
8	0.993	0.981	0.995	0.998	0.995	.9924
9	1	1	1	0.991	1	.9982
10	1	0.986	1	1	1	.9972
11	1	1	0.997	0.976	0.958	.9862
12	0.971	0.985	0.927	0.937	0.904	.9448
13	1	1	0.986	0.985	0.984	.991
14	0.984	1	0.991	0.997	1	.9944



DMU	Scale Efficiency					Average
	2011	2012	2013	2014	2015	
15	0.967	0.961	0.949	0.951	0.912	.948
16	0.998	0.988	1	0.998	0.999	.9966
17	0.996	0.993	0.996	0.998	0.995	.9956
18	0.977	0.962	0.962	0.924	0.934	.9518

The table 1 reports the efficiency scores for all automobile firms based on the scale efficiency. The table 1 reports the efficiency scores for eighteen automobile Pakistani firms. Results indicate that 7 firms were efficient and 11 are inefficient during the year 2011. Likewise, the number of efficient firms is 6 and inefficient firms are 12 for the year 2012. For the year 2013 and year 2014, the number of inefficient firms is high. For instance, for the year 2013, the number of inefficient firm is 13 and efficient firms are 5. Likewise, percentage of efficient firms is 4 and inefficient firms are 14 for the year 2014. Moreover, the number of efficient firms is 6 for the year 2015 whereas the number of inefficient firms is 12. The scores based on the scale efficiency model imply that most of the automobile firms are not efficient during the last five years. Based on the average scores of firm efficiencies only DMU 1 and DMU 2 are efficient in the last five years in consistent with the constant return to scale model.

### Conclusion

The automobile sector has been growing rapidly in Pakistan during last years. However, the efficiency of these automobile firms remained low during

previous years. The current study aimed at exploring the efficiency of these firms by using the data envelopment analysis. Three different models of firm efficiency were employed for calculating firm efficiency. The results of the constant return model indicate that most of the automobile firms are inefficient from the year 2011 to year 2015. For instance, the average efficiency scores indicate that only two firms are efficient from the year 2011 to 2015.

The variable return to scale model also showed low percentage of efficient firms. For instance, only four firms were efficient from the year 2011 to 2015. Moreover, the number of efficient firms is low based on the scale efficiency model. The average number of efficient firms based on the scale efficiency is also low consistent with the constant return and variable return to scale models. For instance, average efficiency scores indicate that number of efficient firms is two from the year 2011 to 2015 whereas the number of inefficient firms is sixteen during these years. Based on the results of the current study, the management of the automobile firms may focus on increasing the efficiency of the automobile firms in Pakistan.

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