Performance Evaluation in the Firms of Turkish Textile Sector

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Abstract. In today’s global competitive environment, firms are carried out various activities in order to increase their effectiveness. Performance measurement is a critical assessment tool to improve the business effectiveness. Malmquist total factor productivity calculation is an important method used to determine the success levels of firms. Various output and input data are used in this method. Accordingly, the evaluating the performances of the firms in the textile sector, which are among the top first and second 500 companies declared yearly by the Istanbul Chamber of Industry (ISO), have been calculated through the Malmquist total factor productivity index. Data from seventeen firms are used in the study based on from 2014 to 2018 years. Net assets, equity capital and employee numbers are selected as input factors. And also, net sales, gross value added, pre-tax profit and export data are selected as output factors.

Keywords: Performance evaluation · Productivity · Efficiency · Malmquist index · Textile sector

1 Introduction

Malmquist total factor productivity index method can be used to analyze whether the resources of enterprises are used effectively on a yearly basis. On the other hand, Data Envelopment Analysis (DEA) method enables us to evaluate whether enterprises use resources efficiently depending on input and output factors. Since the Malmquist Index contains the time dimension, the Malmquist Total Factor Productivity Method is one of the alternatives to eliminate this deficiency of the basic DEA method. Malmquist method is one of the alternatives that can be used in decision-making more effectively.

The change in the total factor productivity of the textile firms in the first and second 500 largest firms announced annually by ISO will be examined using the Malmquist total factor productivity index in this study. Our study is organized as the literature review, the data and the methodological framework, the empirical findings obtained from our analysis and the conclusion, respectively.

Malmquist total factor productivity index is a method that is used for measuring the changes in total factor productivity of firms’ by time. More technically, Malmquist Total Factor Productivity index is defined as it measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common industrial data. The distance function is a measurement that defines the
production technologies for multiple inputs and multiple outputs without any need for optimizing the objectives. Input distance function defines the production technology according to the most contracted input vector when the output vector is given. Output distance function also defines the production technology according to the most expanded input vector when the input vector is given.

2 Literature Review

Many studies examining efficacy and total factor productivity in various sectors are included in the literature. In this study, the literature review focuses on the analysis of input and output parameters used in both different sectors and studies. As a result of the research, the information related to the studies performed is presented in the Table 1.

| Reference | Year | Sector | Input | Output |
|-----------|------|--------|-------|--------|
| [16]      | 2018 | Manufacturing firms in Bangladesh | Total annual cost<br>Total annual cost of raw materials<br>Total annual cost of electricity<br>Permanent full time workers | Total annual sales |
| [8]       | 2017 | Automobile/Automobile parts firms in Pakistan | Total assets<br>Operation costs<br>Selling<br>Administrative expenditures | Net sales |
| [17]      | 2017 | Taiwan’s information and communication technology industry | Number of employees<br>Fixed assets<br>Operating expenses<br>R&D expenses | Net revenue |
| [4]       | 2017 | A textile firm operating in the Aegean Region | Number of employees<br>Total amount of raw materials<br>Number of machines | Number of products<br>The number of customers |
| [6]       | 2017 | Turkish automotive industry | Net assets<br>Equity capital<br>Employee numbers | Net sales<br>Pre-tax profit<br>Export |
| [10]      | 2017 | Province-level regions of China Industry | Employment<br>Fixed-assets’capital stock<br>R&D cost | Gross output<br>Export |
| [3]       | 2016 | Turkish SMEs | Short-term liabilities<br>Long-term liabilities<br>Equity | The sales revenue<br>Net profit |
| [2]       | 2016 | Defense industries of 21 Country | GDP<br>Expenditures<br>Import<br>Employment<br>Logistic performance index | Total sales<br>Export<br>Profit |
| [15]      | 2016 | Turkish casting sector | Number of employees<br>Total liabilities<br>Equity<br>Total expense<br.Fixed assets | Total sales<br>Export<br>Profit |
| [14]      | 2016 | The sectoral based grouped first 500 and second 500 companies published by ISO | Sales Revenue/Total Assets<br>Capital/Total Assets<br>Financing Expenses/Total Liabilities<br>Liquidity/Equity<br>Salary and Fees/Sales Revenue<br>Sales Revenue/Current Assets<br>Number of firms | Return on equity<br>Return on assets before depreciation<br>Return on assets<br>Sales profitability |
3 Material and Method

Malmquist index measurement, first proposed by Malmquist [12], is a method for assessing the relative productivity across different regions or time periods. For each DMU (decision making unit) it is necessary to identify the same inputs and same outputs in DEA. The input and output variables used in the efficiency analyses of firms’ have been examined in the literature and some variables in the various studies are shown in Table 1. Depending on the literature, net assets, equity capital and employee numbers are used as input factors. And also, net sales, gross value added, pre-tax profits and export data are used as output factors. Data of seventeen firms are obtained from 2014 to 2018 years based on ISO. Although there are more firms operating in the periods examined, the data of some firms could not be reached and data is normalized since some companies’ pre-tax profits are negative. In these circumstances, the study is limited to 17 firms. It can be seen that 17 DMUs are suitable regarding the input-output numbers used in the study.

The Malmquist productivity index can be interpreted as a measure of total factor productivity change (TFPC). Following Fare et al. [5], this paper adopts the Malmquist productivity change index, referring the emphasis on the equi-proportionate increase of outputs, within the context of a given level of input.

The TFPC is defined as follows in:

\[
\frac{d_0^{1+1}(x^{1+1}, y^{1+1})}{d_0^1(x^1, y^1)} \times \left[ \frac{d_0^1(x^{1+1}, y^{1+1})}{d_0^{1+1}(x^{1+1}, y^{1+1})} \times \frac{d_0^0(x^0, y^0)}{d_0^{1+1}(x^0, y^0)} \right]^{1/2}
\]

where the ratio outside the brackets measures the change in relative efficiency (i.e., the change in how far observed production is from maximum potential production).
between years $t$ and $t + 1$. The geometric mean of the two ratios inside the brackets captures the shift in technology between the two periods evaluated at $x_t$ and $x_{t + M}$, that is,

Technical Efficiency Change (TEC): $d_t^{t+1}(x_t^{t+1}, y_t^{t+1}) / d_0(x_0, y_0)$

Technological Change (TC): $\left[ d_0(x_0, y_0) / d_0(x_0, y_0) \right]^{1/2} \left[ d_0(x_0, y_0) / d_0(x_0, y_0) \right]^{1/2}$

Finally, the TFPC could be due to either change in technical efficiency or change in the technology – technological progress in the industry– or both. The total factor productivity change is the product of technical efficiency change and technological change. In addition, technical efficiency change can be further decomposed into pure technical efficiency change and scale efficiency change.

The computer software DEAP2.1 [20] is used to calculate these indices. The software can measure relative efficiencies based upon DEA which is for input or output and constant and variable returns to the scale. It has also been applied to calculate the TPFC for measuring the influence of time shift in this study.

4 Results and Discussion

The Malmquist and its decomposition index within 17 textile firms during 2014–2018 is calculated by using DEAP2.1. The technical, technological, pure technique, scale efficiency and total factor productivity changes for the 2014–2018 periods are calculated for the 17 firms included in the analysis and the results are shown in Table 2, Table 3, Table 4, Table 5 and Table 6.

The TEC values are shown as in Table 2. While TEC is larger than 1, it indicates the improvement in the firm in technical terms, whereas it is less than 1 indicates that the firm is technically declining. In addition, the change in SEC (scale efficiency change), which is one of the components of TEC, and the change in PEC (pure technical efficiency change) shows whether the company uses managerial effectiveness and whether it uses the appropriate scale in production [11].

As indicated in Table 2, the analysis of the change in technical efficiencies shows that it has slight change during the period 2014–2018. With the exception of the year 2014–2015 (decline in efficiency, which is 4%), the textile industry has reported TECs in the study period (efficiency rose of 0.7%, 2% and 0.3% in the years 2015–2016, 2016–2017 and 2017–2018 respectively). For example, while the average TEC decreased by 4% in the 2014-2015 period; the biggest increase belongs to firm 16 (30.2%) and the biggest decrease belongs to firm 10 (−25.4%). Based on mean TEC data, it can be said that the technical efficiency performance is stable in textile sector.
While TC is larger than 1, it indicates the improvement in the firm in technological terms, whereas it is less than 1 indicates that the firm is technologically declining. The TC values are shown as in Table 3. As indicated in Table 3, the analysis of the TCs show that it has just slight decline in efficiency (which is 1.1%) during the period 2015–2016. With the exception of the year 2015–2016, the textile industry has reported TC’s in the study period (efficiency rose of 1.8%, 10% and 19.2% in the years 2014–2015, 2016–2017 and 2017–2018 respectively). For example, while the average TC decreased by 1.8% in the 2014–2015 period; the biggest increase belongs to firm 9 (33.7%) and the biggest decrease belongs to firm 4 (16%).

According to the use of Malmquist productivity index in this paper, therefore, if this amount is equal to 1, it signifies no change in performance, if bigger than 1 it shows performance advancement, and in case it is less than 1 it signifies corporation performance getting worse [13].

| Firm | Period | 2014–2015 | 2015–2016 | 2016–2017 | 2017–2018 |
|------|--------|-----------|-----------|-----------|-----------|
| 1    | 1.000  | 1.000     | 1.000     | 0.958     |
| 2    | 0.888  | 0.950     | 1.001     | 1.047     |
| 3    | 1.000  | 1.000     | 1.000     | 1.000     |
| 4    | 1.000  | 1.000     | 1.000     | 1.000     |
| 5    | 0.923  | 0.868     | 1.192     | 1.065     |
| 6    | 0.943  | 0.962     | 0.958     | 1.093     |
| 7    | 1.000  | 1.000     | 1.000     | 1.000     |
| 8    | 0.825  | 1.406     | 1.000     | 0.954     |
| 9    | 1.000  | 1.000     | 1.000     | 1.000     |
| 10   | 0.746  | 1.059     | 0.998     | 1.002     |
| 11   | 1.000  | 1.000     | 1.000     | 1.000     |
| 12   | 0.923  | 1.052     | 1.030     | 1.000     |
| 13   | 1.000  | 0.952     | 1.051     | 1.000     |
| 14   | 0.876  | 0.981     | 1.163     | 1.000     |
| 15   | 1.000  | 0.868     | 0.987     | 0.858     |
| 16   | 1.302  | 1.119     | 0.994     | 1.091     |
| 17   | 1.000  | 1.000     | 1.000     | 1.000     |
| mean | 0.960  | 1.007     | 1.020     | 1.003     |
The TFPC’s are shown as in Table 4. The analysis of the change in efficiencies (Malmquist indices) shows that productivity has been increasing during the last two period. With the exception of the year 2014–2015 and 2015–2016 (slight decline in productivity, which is 2.3 and 0.4%) the textile industry has reported productivity progress in the study period (productivity rose of 12.3%, 19.5 in the years 2016–2017 and 2017–2018 respectively). For example, while the average TFPC decreased by 2.3% in the 2014–2015 period; the biggest increase belongs to firm 9 (33.7%) and it is apparent that the main source growth for the TFPC is attributed to the technological efficiency change (see Table 2). On the other hand, in the same period, the biggest decrease belongs to firm 10 (24.7%) and it is apparent that the main source downsizing for the TFPC is attributed to the technical efficiency change (see Table 2). With this comparison using Table 2 and Table 3, the source of the change in firm activities is determined on an annual basis.

### Table 3. Period-based TC values of firms

| Firm | Period          | 2014–2015 | 2015–2016 | 2016–2017 | 2017–2018 |
|------|-----------------|-----------|-----------|-----------|-----------|
| 1    | 1.116           | 1.247     | 1.087     | 1.075     |
| 2    | 1.071           | 1.006     | 1.110     | 1.120     |
| 3    | 0.989           | 0.935     | 1.127     | 1.355     |
| 4    | **0.840**       | 0.948     | 1.009     | 1.204     |
| 5    | 1.059           | 1.156     | 1.006     | 1.203     |
| 6    | 0.956           | 0.886     | 1.188     | 1.086     |
| 7    | 0.987           | 1.088     | **0.900** | 1.150     |
| 8    | 1.150           | 0.926     | **1.285** | **0.887** |
| 9    | **1.337**       | 0.915     | 1.111     | **1.701** |
| 10   | 1.010           | 1.086     | 1.179     | 1.266     |
| 11   | 1.047           | 1.001     | 1.105     | 1.097     |
| 12   | 0.965           | 1.033     | 1.129     | 1.093     |
| 13   | 1.001           | 0.829     | 1.101     | 1.132     |
| 14   | 0.965           | 1.059     | 1.207     | 1.255     |
| 15   | 0.946           | 1.118     | 1.078     | 1.295     |
| 16   | 0.859           | 0.887     | 1.069     | 1.413     |
| 17   | 1.106           | 0.812     | 1.070     | 1.121     |
| Mean | 1.018           | 0.989     | 1.100     | 1.192     |
The Malmquist Index summary of firm means are shown as in Table 4. By comparing these data, the source of the change of average firm productivity is determined rather than the source of the annual change of firm productivity. In this scope, although there is a decrease in the technical efficiency and scale efficiency, an increase occurred in the technology and pure efficiency. When considered on the basis of firm, in 16 (94%) of a total of 17 firms, it is identified that total factor productivities increased. The number 9 firm is whose total factor productivity increases the most with the increase of 23.3%, as seen in the Table 5. It is apparent that the main source growth for the TFPCs are attributed to the technological efficiency change. The number 4 firm is whose total factor productivity decreases the most with the decrease of 23.3%. It is apparent that the main source downsizing for the TFPC is attributed to the technological efficiency change. In addition, the number 16 firm is whose technical efficiency increases the most with the increase of 12.1%. It is apparent that the main source growth for the TEC is attributed to the pure efficiency change. The following comments can be made for some firms whose situation is different. For example, it is apparent that the main source growth for the TEC of firm 16 is attributed to the PEC. On the other hand, it is apparent that the main source downsizing for the TEC of firm 6 is attributed to the SEC.

The PEC measures the ability of decision-making units to convert their inputs to outputs. In addition, the change in PEC and the change in SEC, which is one of the components of TEC, is greater than 1, which means that the firm is successful in
managerial efficiency and production in appropriate scale. In this context, the firm 6 should increase the success of production on the appropriate scale.

The Malmquist Index summary of annual mean values are shown as in Table 5. As indicated in Table 5, the analysis of the change in efficiencies (Malmquist indices) shows that productivity has been increasing during the last two period. The Malmquist productivity change experienced by the textile industry as a whole has averaged 6.9% per year and suggest improvement in performance of TFPCs from 2014-2018. As the result showed over the sample period, the average annual rate of technical efficiency change is −0.3% while the rate of technological change is 7.2%. As indicated in Table 5, with the exception of the year 2014–2015 and 2015–2016 (slight decline in productivity, which is 2.3 and 0.04%) the textile industry has reported productivity progress in the study period (productivity rose of 12.3%, 19.5 in the years 2016–2017 and 2017–2018 respectively).

Table 5. Malmquist index summary of firm means

| Firm | TEC | TC | PEC | SEC | TFPC |
|------|-----|----|-----|-----|------|
| 1    | 0.989 | 1.129 | 1.000 | 0.989 | 1.117 |
| 2    | 0.969 | 1.076 | 1.000 | 0.969 | 1.043 |
| 3    | 1.000 | 1.090 | 1.000 | 1.000 | 1.090 |
| 4    | 1.000 | 0.992 | 1.000 | 1.000 | 0.992 |
| 5    | 1.004 | 1.103 | 1.000 | 1.000 | 1.044 |
| 6    | 0.987 | 1.022 | 1.000 | 0.987 | 1.009 |
| 7    | 1.000 | 1.027 | 1.000 | 1.000 | 1.027 |
| 8    | 1.026 | 1.050 | 1.023 | 1.003 | 1.076 |
| 9    | 1.000 | 1.233 | 1.000 | 1.000 | 1.233 |
| 10   | 0.943 | 1.131 | 1.000 | 0.943 | 1.066 |
| 11   | 1.000 | 1.062 | 1.000 | 1.000 | 1.062 |
| 12   | 1.000 | 1.053 | 1.000 | 1.000 | 1.053 |
| 13   | 1.000 | 1.009 | 1.000 | 1.000 | 1.009 |
| 14   | 1.000 | 1.116 | 1.000 | 1.000 | 1.116 |
| 15   | 0.926 | 1.103 | 0.930 | 0.995 | 1.021 |
| 16   | 1.121 | 1.036 | 1.121 | 1.000 | 1.161 |
| 17   | 1.000 | 1.019 | 1.000 | 1.000 | 1.019 |
| mean | 0.997 | 1.072 | 1.004 | 0.993 | 1.069 |
| <1   | 6    | 1    | 1    | 6    | 6    |
| 1    | 9    | 0    | 14   | 9    | 0    |
| >1   | 2    | 16   | 2    | 2    | 16   |

By decomposing the Malmquist index, it is possible to determine the sources of productivity growth. As explained previously, technical efficiency change (TEC) and technological change (TC) are the efficiency changes (movement of micro finances
towards the frontier - catching up) and technological changes (frontier shift) respectively. In this regard, the sources of growth or decline in textile industry are due to TEC, TC, or both. However, from Table 6, it is apparent that the main source of mean TFPC growth is attributed to the mean technological efficiency change (7.2% increase). In addition, it is apparent that the main source downsizing for the TFPC of firms are attributed to the SEC. It shows that firms in textile sector firstly should increase the success of production at appropriate scale for increase the TPFC depends on TEC.

| Periods  | TEC | TC  | PEC | SEC | TFPC |
|----------|-----|-----|-----|-----|------|
| 2014–2015 | 0.960 | 1.018 | 0.994 | 0.966 | 0.977 |
| 2015–2016 | 1.007 | 0.989 | 1.025 | 0.982 | 0.996 |
| 2016–2017 | 1.020 | 1.100 | 0.993 | 1.028 | 1.123 |
| 2017–2018 | 1.003 | 1.192 | 1.003 | 0.999 | 1.195 |
| Mean     | 0.997 | 1.072 | 1.004 | 0.993 | 1.069 |

5 Conclusion

In this study, DEA based Malmquist Total Factor Productivity analysis method is used to determine the efficiency of the firms in the textile sector among the first and second 500 firms registered to Istanbul Chamber of Industry. The TFPC values of the firms’ are examined as a priority in the scope of this aim and the changes in the TEC together with the changes in the TC are examined. According to the results of index analysis, total factor productivity of Turkish textile industry increased by 6.9%. In this scope, it is identified that total factor productivity of 94% of the firms considered in the analyses increased, while maximum increase actualized in the firm 9 (23.3%). The total factor efficiency increases by 12.3% and 19.5%, respectively, in the years of 2016–2017 and 2017–2018. Subsequently, the average annual rate of technical efficiency change is −0.3% while the rate of technological change is 7.2%. There are firms that need to improve both the TC value and the TEC value. Generally, the results show that there is stagnation in TE value in textile sector. In this context, the firms should work towards increasing its managerial effectiveness and the success of production at the appropriate scale. Moreover, the rate of technological change is (7.2%) not satisfactory. The reason of inefficiencies of some firms’ should be discovered and take action to improve them.

The results of the analysis are limited by available data, the selected variables to the firm and the period determined. Different variables and firms entering or leaving the analysis will change the results. In order to increase the efficiency of the textile sector in Turkey, firms should give importance to the technological development. Because technological developments are an important factor in increasing the productivity of both labor and capital factor.
As a conclusion, the relative performances of firms’ are explored in this study. These findings may have important implications for evaluation of crisis management success. Therefore, the study should be repeated by adding the data of 2020 to evaluate the industry performance in the Covid-19 process.

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