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Application of TOPSIS Technique for Financial Performance Evaluation of Technology Firms in Istanbul Stock Exchange Market

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Abstract

For nearly thirty years, technology has been the fastest-growing sector in Turkey where firms centering on software creations, information technology and electronic products prevail. In today's increasingly competitive environment, an accurate and appropriate evaluation of financial performance bears considerable significance for a firm that targets to successfully maintain her market position and protect their market shares against potential risks in the future. This paper aims to propose a multi-criteria decision-making model to measure and compare the financial performance of thirteen technology firms trading in Istanbul Stock Exchange. These firms are examined and assessed in terms of ten financial ratios which are combined to obtain a financial performance score by using Technique for Order Preference by Similarity to Ideal Solution Methods (TOPSIS). TOPSIS helps to rank these firms for three-year time period between 2009 and 2011. This study will find out whether the ranking results of TOPSIS and the ranking results of the firms' market value in question overlap or not.

Keywords: Performance Measurement, TOPSIS, Technology Sector

1. Introduction

Today, it is supported by several studies in literature that technology areas in the world ceaselessly expand and a firm's success depends on its particular ability in competitiveness in the international market arena. A few examples of these studies are the studies of Soete (1981), Magnier and Youjas-Bemate (1994) and Fagerberg (1996). Moreover, Turkey's increasing investment in this area is the consequence that derives from the requirements of the market conditions.

Technology sector continually expands its area with information technology. Technology firms that are listed on Istanbul Stock Exchange Market (ISEM) produce software and hardware. Furthermore, they have begun to collaborate mobile network, energy, defence and telecommunication with increased interest on information technology. Technology and information technology firms are telescoped each other and this situation is a result of which technology and information technology firms are the same firms in ISEM.

Although information technology market in Turkey does not have a larger size than the one in Europe and the other countries in the world, it has growth potential when compared to the large-scale markets. The number of

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technology improvement regions in 2005 increased from twenty to thirty in number in 2010 and this stands as a testimony of Turkey's growth potential.

Therefore, technology firms which do business in a challenging competitive environment frequently use financial analysis and analyse their market positions to improve their financial performances for the future. According to Tozum (2009), traditional ratio analysis is insufficient to measure firms' financial performances and they should use multi-lateral ways. As a multi-lateral way, this paper applies Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to evaluate financial performance of thirteen technology firms with calculated financial ratios by using financial statements.

There are many applications that use TOPSIS in the literature proposed by various authors. Feng and Wang (2000)develop a performance evaluation model for Taiwanese domestic airlines that include the consideration of financial ratios. The TOPSIS method is used in conjunction to calculate performance scores of outranking five major airlines. The final result shows that performance evaluation for airlines can be more comprehensive if financial ratios are taken into account. By using the inventory turnover, net income ratio, earnings per share and current ratio as the standards of evaluation, Tien-Chin and Hsu (2004) evaluated ten companies in Taiwan Stock Market that produce computers. They applied entropy method to determine the objective weights for each evaluation standard, and by using the TOPSIS method to compute the relative performance index of each project and to sort the results. Demirelli (2010) determined the performance of state-owned commercial banks that extensively operate nationwide by using TOPSIS in Turkey during the period of 2001-2007. In this research, many financial ratios are used in equal weights while calculating performance scores. Because of local and global economic crises, the performance scores of commercial banks fluctuated.

The TOPSIS method can also cooperate with another multi-criteria decision-making model to evaluate the performances of the firms by using financial ratios. The results of TOPSIS model and hybrid models are comparable. Yalcin et al. (2012) propose a new financial performance evaluation approach to rank the companies of each sector in the Turkish manufacturing industry. The companies are ranked according to their own manufacturing sectors by using TOPSIS and VIKOR comparatively. The results show that the ranks of the companies obtained via these methods are almost the same with respect to their own sectors. Ertugrul and Karakasoglu (2009) use a fuzzy multi-criteria decision-making model to evaluate the financial performances of Turkish cement firms through an analytical hierarchy process and TOPSIS methods together. In their studies, cement firms are evaluated by taking into consideration only some of the traditional accounting-based financial performance measures.

After the introduction section, this paper is organized as follows: In the second section, the ratios used in the performance evaluations of the firms are briefly explained. In the third section, TOPSIS method and its steps are summarized. An application in technology sector is given in the fourth section. And in the final section, the results of the application are presented and suggestions for the future studies are clarified.

2. Financial Ratio

Ascertaining the competitiveness of the firms in their own sectors and evaluating their financial performances play an important role for the sector's improvement. Financial reports provide operation and profit information of firms. So, selected financial ratios that have been calculated from financial reports are popular tools to analyse a firm's performance and financial situation. In the literature, the following types of ratios are frequently used and ten financial ratios are chosen as the evaluation standards in this application:

Current Ratio is a firm's ability to counter balance current assets with the current liabilities. Determining a firm's ability to pay current debts is a key measure and also a good measure of the adequacy of working capital (Price et al., 1993). (Current Assets/Current Liabilities)

Acid Test Ratio measures immediate liquidity. It is a more plausible measure of liquidity than the current ratio. This ratio is calculated by deducting inventories from current assets and dividing the remainder by current liabilities (Ercan and Ban, 2005) (Current Assets-Inventories) / Current Liabilities].

Total Debt Ratio is a ratio that signifies percentage of debt a firm has qualified to its assets. The calculation of total debt ratio gives you an insight into the power of the company along with the potential risk that the company faces in requisites of its debt load (www.debtratioinfo.com , 2009). [(Total Assets - Shareholder's Equity) / Total Assets]

Debt Equity Ratio is the measure of a firm's financial leverage which is calculated with the division of the company's total liabilities by stockholders equity share (www.debtratioinfo.com, 2009)(Total Debt / Shareholder's Equity)

Current Assets Turnover points out the number of times current assets are renovated during the accounting period. It is the measurement of current asset management efficiency (Akdogan and Tenker, 2010). (Net Sales / Current Assets)

Fixed Assets Turnover assesses the effectiveness of the use of fixed assets in generating revenue (Coltman and Jagels, 2001). (Net Sales/ Fixed Assets)

Net Profit Margin measures how profitable a firm's sales are after all expenses, including taxes and interest, are deducted (Akguc, 2010).(Net Revenue / Net Sales)

Return on Equity measures a firm's efficiency at generating profits from every unit of shareholders' equity. It is a more beneficial ratio for comparing the profitability of a company to other firms in the same industry than the others (Akguc, 2010). (Net Income / Shareholder's Equity)

Working Capital Turnover is the ratio net revenues to working capital, indicates how efficiently a company is using working capital. You can see if you are under trading or overtrading your working capital with a few simple calculations (Jackson, 1988). [Net Revenue/ (Current Assets- Short Term Liabilities)]

Return on Assets measures how productively a company uses its assets to make profits. A high ratio depends on managing asset investments to produce the greatest amount of revenue and controlling expenses to keep net income high. ROA is the most comprehensive measure of profitability since it takes into account both the profitability of each dollar of revenue and sales volume (Ercan and Ban, 2005). (Net Profit / Total Assets)

3. Methodology

As an approved variation of Multi-Criteria Analysis methods, this paper uses the TOPSIS method, which was developed by Hwang and Yoon in 1981. The TOPSIS is based on the rank of alternatives to obtain the best alternative selection, which is the closest to the ideal solution. In other words, the best alternative has the most distant solution from the anti-ideal solution. The TOPSIS method takes into consideration the distance from both sides. The process of the TOPSIS begins to make original data matrix by using criteria value for each alternatives. The TOPSIS transforms this original matrix into normalized matrix and it has five steps after these applications over matrix to determine the ranking of firms.

Step 1. Normalization of alternative values: Normalization aims at maintaining comparable scales (Hwang and Yoon,1981). There are many choices of normalizing the alternatives' values. This paper will use vector normalization, which utilizes the ratio of the original value (xij) and the square root of the sum of the original indicator values. This procedure is usually utilized in TOPSIS (Yurdakul and Ic, 2003). The formula is as follows:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}}$$ where i is the ith firms, j the jth evaluation indicator, rij the indicator value after vector

normalization for the$i$th technology firm and jth evaluation indicator, xij the original value of indicators for the ith technology firm and jth evaluation indicator and m the number of technology firms.

Step 2. Determination of ideal (A^+) and negative ideal (A^-) solution:

$$A^+ = \left\{ \left(\max_i r_{ij} \mid j \in J \right), \left(\min_i r_{ij} \mid j \in J^{'} \right) \mid i = 1, 2, \dots m \right\} = \left\{ A_1^+, A_2^+ \dots, A_j^+, \dots, A_k^+ \right\}$$

$$A^- = \left\{ \left(\min_i r_{ij} \mid j \in J \right), \left(\max_i r_{ij} \mid j \in J^{'} \right) \mid i = 1, 2, \dots m \right\} = \left\{ A_1^-, A_2^- \dots, A_j^-, \dots, A_k^- \right\}$$

$J = \{ j = 1, 2, ..., k \mid k$ belongs to benefit criteria $\}$ benefit criterion implies a larger indicator value and a higher performance score. $J' = \{ j = 1, 2, ..., k \mid k$ belongs to cost criteria $\}$ cost criterion implies a smaller indicator value and a higher performance score.

Step 3.Calculation of the separation measure: The separation of each airline from the ideal one (S_i^+) and the worst one (S_i^-) is then respectively given by

$$S_i^+ = \sqrt{\sum_{j=1}^{k}(r_{ij} - A_J^+)^2} \quad S_i^- = \sqrt{\sum_{j=1}^{k}(r_{ij} - A_J^-)^2} \qquad i=1,2,.....m$$

Step 4.Calculation of the relative closeness to the ideal solution (C*) :

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-} \quad 0 < C_i^* < 1$$

Step 5. Ranking the preference order according to the descending order of C_i^*.

4. Application

In this paper, the financial data of thirteen technology companies, which are listed in ISEM for three-year time period between 2009 and 2011, are used. First of all, ten financial ratios as criteria are calculated from their balance and revenue sheet for each firms by using a ratio analysis method. Then, decision matrices (13 x 10) are formed separately for the 2009, 2010 and 2011 years by using calculated ten financial ratios such as Current Ratio, Acid Test Ratio, Total Debt Ratio, Debt Equity Ratio, Current Assets Turnover, Fixed Assets Turnover, Net Profit Margin, Return on Equity, Working Capital Turnover and Return on Assets (C1, C2,…C10 as the same order) and thirteen decision points (firms). After this, the equal weights are given for each of ten criteria because ratios are of the same significance for this paper and linguistic variables are not used. Total of weights must be one. So, the equal weight for each one is determined as 0,1. Finally, by using the TOPSIS method, the ranking of the firms according to their general performances is obtained. The ratios for 2009 in Table 1 are used for creating decision matrix.

Table 1. Original Data Matrix (for 2009)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Alcatel	1,328	1,181	0,722	2,601	1,909	20,391	0,032	0,032	7,733	0,055
Anel	0,873	0,819	0,682	2,15	0,769	0,4932	-0,071	-0,07	-5,28	-0,02
Arena	1,457	0,843	0,651	1,867	4,322	77,776	0,025	0,025	13,78	0,103
Armada	1,495	0,962	0,652	1,872	3,103	96,384	0,015	0,015	9,37	0,044
Aselsan	2,394	1,709	0,734	2,765	0,546	1,7728	0,177	0,177	0,938	0,074
Datagate	1,439	1,013	0,694	2,273	4,229	2191,6	0,014	0,014	13,86	0,061
Escort	0,478	0,157	0,206	0,259	3,664	0,3913	0,107	0,107	-3,36	0,038
Indeks	1,296	0,852	0,742	2,873	2,681	34,974	0,016	0,016	11,74	0,04
Karel	2,429	1,677	0,35	0,538	1,008	2,9002	0,137	0,137	1,713	0,102
Link	3,113	3,095	0,128	0,147	1,189	0,6493	-0,312	-0,31	1,752	-0,13
Logo	1,803	1,78	0,195	0,243	1,174	0,5062	-0,315	-0,32	2,635	-0,11
Netaş	2,083	1,939	0,394	0,651	0,667	2,0242	0,117	0,117	1,284	0,059
Plastik K.	8,909	6,783	0,176	0,213	2,337	4,323	0,05	0,05	2,632	0,075

Table 2. Normalized Matrix (for 2009)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Alcatel	0,121	0,137	0,369	0,409	0,212	0,009	0,059	0,059	0,286	0,199
Anel	0,080	0,095	0,349	0,338	0,085	0,0002	-0,132	-0,132	-0,195	-0,076

Arena	0,133	0,098	0,333	0,294	0,480	0,035	0,047	0,047	0,510	0,369
Armada	0,137	0,112	0,333	0,295	0,344	0,043	0,028	0,027	0,347	0,159
Aselsan	0,219	0,199	0,376	0,435	0,060	0,0008	0,334	0,334	0,034	0,265
Datagate	0,132	0,118	0,355	0,358	0,469	0,998	0,027	0,027	0,513	0,218
Escort	0,044	0,018	0,105	0,041	0,407	0,0002	0,202	0,202	-0,124	0,136
Indeks	0,118	0,099	0,379	0,452	0,297	0,015	0,030	0,031	0,435	0,145
Karel	0,223	0,195	0,179	0,084	0,111	0,0013	0,258	0,258	0,063	0,368
Link	0,285	0,360	0,065	0,023	0,132	0,0003	-0,587	-0,587	0,065	-0,470
Logo	0,165	0,207	0,100	0,038	0,130	0,0002	-0,594	-0,594	0,098	-0,400
Netaş	0,191	0,225	0,202	0,102	0,074	0,0009	0,221	0,221	0,047	0,211
Plastik K.	0,816	0,790	0,090	0,034	0,259	0,002	0,093	0,093	0,097	0,270

After the original matrix is created, normalization of these values is calculated by using the formula in first step of the TOPSIS method. Then, weighted normalized matrix is formed by multiplying each value with their weights.

Table 3. Weighted Normalized Matrix (for 2009)

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Alcatel	0,0122	0,0138	0,0370	0,0409	0,0212	0,0009	0,0060	0,0060	0,0286	0,0199
Anel	0,0080	0,0095	0,0349	0,0338	0,0085	0,0000	-0,0133	-0,0133	-0,0196	-0,0076
Arena	0,0133	0,0098	0,0333	0,0294	0,0480	0,0035	0,0047	0,0047	0,0510	0,0369
Armada	0,0137	0,0112	0,0334	0,0295	0,0345	0,0044	0,0028	0,0028	0,0347	0,0160
Aselsan	0,0219	0,0199	0,0376	0,0435	0,0061	0,0001	0,0334	0,0334	0,0035	0,0266
Datagate	0,0132	0,0118	0,0356	0,0358	0,0470	0,0998	0,0027	0,0027	0,0513	0,0218
Escort	0,0044	0,0018	0,0105	0,0041	0,0407	0,0000	0,0202	0,0202	-0,0124	0,0136
Indeks	0,0119	0,0099	0,0380	0,0452	0,0298	0,0016	0,0031	0,0031	0,0435	0,0145
Karel	0,0223	0,0195	0,0179	0,0085	0,0112	0,0001	0,0258	0,0258	0,0063	0,0368
Link	0,0285	0,0360	0,0066	0,0023	0,0132	0,0000	-0,0587	-0,0587	0,0065	-0,0470
Logo	0,0165	0,0207	0,0100	0,0038	0,0130	0,0000	-0,0594	-0,0594	0,0098	-0,0401
Netaş	0,0191	0,0226	0,0202	0,0103	0,0074	0,0001	0,0221	0,0221	0,0048	0,0211
Plastik K.	0,0816	0,0491	0,0090	0,0034	0,0260	0,0002	0,0093	0,0093	0,0097	0,0270

The distances between the valuation subjects and ideal and negative ideal solution are determined by taking the maximum and the minimum values for each criterion from weighted normalization matrix table.

S^+ = (0,11117; 0,13059; 0,1095; 01099; 0,1062; 0,0985; 0,1350; 0,1118; 0,1129; 0,1292; 0,1414; 0,114; 0,0683)

S^- = (0,0687; 0,0491; 0,0782; 0,0640; 0,0806; 0,0892; 0,0513; 0,0748; 0,051; 0,0432; 0,0247; 0,0485; 0,1268)

The same process for the year of 2010 and 2011 are carried out to obtain all steps of the TOPSIS method like the process in 2009. Finally, relative closeness calculation to ideal solution of technology firms is determined by using formula in the fourth step of this method. According to this calculation, the financial performance evaluation of thirteen technology firms is ended. The rankings of the firms are reached according to the performance index values.

2009 2010					2011	
	C* Rank	C*	Rank		Rank	C*
Alcatel	0,3821	6	0,2817	9	0,2675	8
Anel	0,2734	11	0,3430	7	0,3358	2
Arena	0,4165	4	0,3554	4	0,2865	5
Armada	0,3680	7	0,3490	5	0,2772	7
Aselsan	0,4313	3	0,4295	2	0,1669	11
Datagate	0,4751	2	0,4078	3	0,3113	3
Escort	0,2754	10	0,2616	10	0,2071	9
Indeks	0,4008	5	0,3458	6	0,2779	6
Karel	0,3109	8	0,2887	8	0,1102	12
Link	0,2503	12	0,1684	13	0,5910	1
Logo	**0,1488**	**13**	**0,2183**	**12**	**0,1940**	**10**
Netaş	0,2983	9	0,2495	11	0,1034	13
Plastik K.	**0,6496**	**1**	**0,5694**	**1**	**0,2955**	**4**

Table 4. Performance indexes for 2009-2010-2011 of the thirteen listing firms

If the performance index value is higher, it means that it is closer to the distance from ideal solution and it is further from the negative ideal solution, so it is the best inside ranking. From Table 4, Plastik Kart firm has the best performance for the three-year period. In this research, Logo firms' performance index value is the lowest one. Alcatel, Arena, Armada, Datagate, Escort, Indeks, Logo and Plastik Kart have consistent results for the following three years.

5. Conclusion

Nowadays, technology sector is an important sector. The main reason is the society's need for innovation. It is supposed that technology production will never seem to slow down according to the increasing sales and the needs of technology products. Consumption trends in the world have the understandingof fast-moving consumption. So, while Turkey was about to stay late for making investment in technology, she comprehended the importance of technology operations. Turkey has many technology firms and their profitabilities are outstanding. In the same sector, it is noteworthy to follow each other's activity and financial performance to consolidate their positions in the market.

In this study, a popular multi-criteria decision-making method is used for evaluating the performances of firms by using the financial tables. The proposed method is used in determining the ranking of the firms in the same sector by comparing the firms according to the criteria determined for each year. The comparison between the ranking results for each year offers us the way to indicate technology firms which have stable financial performances. It helps the firms to revise its financial information and analyse the best firm's financial situation. The market value of firms also gives information about the position of firms in the market. So, it is commonly used for financial evaluation and comparison of firms. Market value defines an observable market value, the stock price and obtained from the firm's financial statements. The formula of market value is composed of multiplying closing stock price at the end of the year and paid−in capital. Calculated market value can help to see the difference between financial performance results of methods. According to Table 5, the market values from 2009 to 2011 do give stable result for firms. Aselsan firm has the best performance for the three-year period. Link firm's market value is the lowest one. Alcatel, Arena, Armada, Datagate, Escort, Indeks, Logo, Link, Netaş and Plastik Kart have consistent results for the following three years.

Ranking results of TOPSIS and Market Value do not have the similar ranking results of technology firms for 2009, 2010 and 2011 in Turkey. However, the consistent firms in ranking results of TOPSIS for these years are similar to the consistent firms in ranking results of Market Value.

In this research, it is stated that ranking results of Market Value are not comparable to the results of TOPSIS for technology firms in Turkey. TOPSIS method is not enough to evaluate the financial performances of technology firms in Turkey. The reason of this matching problem is originates from the fact that the technology firms are brand-new in the stock market. Their financial position and strategies have not settled down yet.

Table 5. Ranking firms according to market value on December 30 for 2009-2010-2011

	2009		2010		2011	
	Market Value	**Rank**	**Market Value**	**Rank**	**Market Value**	**Rank**
Alcatel	125390,5013	3	125777,509	4	111845,2311	4
Anel	80500	5	72500	6	43000	9
Arena	66880	7	62240	7	75520	7
Armada	16560	12	34440	12	35040	11
Aselsan	1376060,4	1	1938245,76	1	1928836,8	1
Datagate	20500	11	39700	11	22800	12
Escort	18717	10	52077,3	10	146909,3	3
Indeks	90720	4	150640	3	128800	5
Karel	72900	6	119625	5	122400	6
Link	11825	13	28380	13	21670	13
Logo	53000	9	59000	8	37750	10
Netaş	366486,12	2	436215,78	2	794593,8	2
Plastik K.	63700	8	57557,5	9	49595	8

In future studies, other multi-criteria methods can be used to evaluate the performances of technology firms. Furthermore, the TOPSIS method can be applied to evaluate the firms in other sectors. On the other hand, it is better toconsider a greater number of criteria values and different weight calculation methods, and to develop hybrid methods to increase the power of evaluation of financial performance.

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