Analyzing Financial Statements of Firms Accepted in Tehran Stock Exchange by Using Window Data Envelopment Analysis Approach
(Based on Input-Oriented CCR Model)

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ABSTRACT

The investors notice financial statements of the companies to make decisions about investment. Although the ratio analysis is always considered as one of the best financial statement analysis methods, its interpretation is often difficult and controversial. In fact, each group of ratios can only show a single financial dimension and in analyzing financial statements we cannot easily integrate the results of different groups of financial analyses. We cannot express our outlook about the totality of financial statements either. Also, these ratios show the temporary financial performances of the companies (only one fiscal year), while the study of the trend of performance changes is highly effective in predicting the future status of the organization and making decisions. Thus, in the present research we have used the window analysis of input-oriented CCR to study the performance changes trend and the analysis of financial statements of 100 firms accepted in Tehran Stock Exchange during the years between 2006 and 2011. We concluded by model analysis that from among 100 companies under investigations, Daropakhsh Company has had the best performance and Sea Industry Company has had the worst performance during the study period. Also the total average of window for the companies Bama and Maodeen Bafgh equaled 0.994217, but due to the fact that the annual average amounts of Maodeen Bafgh Company were more than Bama Company, Maodeen Bafgh Company ranked 10th and Bama Company ranked 11th .

KEYWORDS: Financial statements' analysis, Financial ratios' analysis, Financial performance assessment, Window data envelopment analysis, Input-oriented CCR method.

1. INTRODUCTION

The investors have always considered the financial performances of companies in order to recognize the desirable investment opportunities. In fact, the assessment of the financial status of a company is vitally important in its decision making processes because a company may encounter bankruptcy due to financial crises even if it has good products, regular quality control, and an orderly and cooperative organizational structure [20]. One of the main approaches in assessing the companies is to use its financial statements. The analysis of financial statements often begins with utilizing the financial ratios based on balance sheet information, income statement, and cash flow statement. Financial ratios show both the strengths and weaknesses of the companies compared to other companies in the same industry, pioneering companies, as well as the previous year performance of the same company[19]. Although the ratio analyses to assess the financial status of the companies date back to long years ago, its interpretation is often difficult and controversial. One of the problems in using financial ratios to assess the financial status of the companies is that each set of financial ratios assesses only one dimension in a way that a group of them assesses the liquidation ability, another group the profitability and another part the growth capability, and finally another group assesses the operation type of an organization[6]. Also the financial ratios are calculated in a specific date and the future trend (of changes) is not considered in calculations. In fact the ratios are calculated based on the historical information and their generalization capability does not seem reasonable if the conditions change. Therefore, using a method which can summarize a set of data (financial ratios) in the form of short information and units which can express the performance changes of the companies will be beneficial. The present study is going to use window data envelopment analysis method to resolve this problem. In fact in this method all ratios are translated into a criterion called "efficiency" regarding some of the ratios as input and some as output and besides considering the time factor in calculation, it is able to present useful information about the trend of performance changes. On the whole, the assessment of performance based on time is an appropriate tool for managers to control the organization permanently. Also the investors can study the performance changes to predict the future status of the organization and thus make investment decisions.

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LITERATURE REVIEW

In late 1970s the data envelopment analysis was introduced by Charnes and Cooper as a method to identify the relative efficiency of the cooperating decision making units. In fact the discussion started in 1978 in a PhD dissertation by Rhodes. He assessed the development and progress of national schools in the United States using the guidelines presented by Charnes and Cooper[11]. After that several other models were devised and each of them had certain functions. Window analysis model is one of these data envelopment analysis models. This method was first posed by Charnes, Clark, Cooper and Golany in 1985[22]. The discussion about data envelopment analysis was started in Iran in 1993 in a PhD dissertation by Dr. Alirezaee advised by Dr. Jahanshahloo. Although it is outdated, it has had a lot of uses in scientific-applied researches. While several different studies have dealt with assessing the financial performance (financial statements' analysis) in firms accepted in Tehran Stock Exchange through using principal DEA models, according to the studies carried out none of them have utilized window CCR.

Dastgir et al (2012) analyzed the financial statements of 100 firms accepted in Tehran Stock Exchange by using window data envelopment analysis model based on output-oriented BCC model during the period between 2005 and 2010. The results showed that from among the companies involved in the sample, none of them was able to preserve %100 of their efficiency during the time period mentioned.

Alikhan et al (2011) analyzed the financial statements of 33 firms in drug production industry in India by using window data envelopment analysis. They tested the data related to the research during a 5 years period between 2000 and 2004. In this research the period under investigation was divided into 4 windows each containing 3 parts (each window entailing 3 fiscal years) and each window was considered as an independent unit. The research results showed that window data envelopment analysis was a useful and reliable tool to analyze financial statements during the time pass.

Gu & Yue (2011) studied the relationship between the changes of efficiency and stock return in banks accepted in Stock Exchange in China. Their research contained 3 independent parts. First by utilizing window data envelopment analysis they estimated the efficiency of banks accepted in Stock Exchange in China by using the seasonal data during a time period between 2008 and 2010. Then they calculated the stock returns of these banks for the whole seasons of the research period. Finally, the relationship between seasonal changes of efficiency and their stock returns was investigated. Their research results showed changes in net technical efficiency and stock returns in addition to the expression of a positive and strong relationship between net technical efficiency and stock returns.

Sokhanvar et al (2011) studied the efficiency trend of electricity distribution companies in Iran by using window data envelopment analysis. In this study the companies were divided into two groups of low circuit density (group 1) and high circuit density (group 2). The research results showed that the average window efficiency of groups 1 and 1 regarding the outskirts, considering both assumptions of constant and returns to scale have rising and falling trends compared to the scale, respectively. However, the average window efficiency of the companies in group 2 has been higher than all windows in group 1. The electricity distribution companes in Shiraz, Golestan, and Mazandaran in group 2 have had inappropriate performances regarding the groups' out of boundary and in boundary features and the performance of companies having higher circuit density had less differences with the superior potential performances beyond the boundaries. They also found out that increasing the networks' load coefficient will result in efficiency reduction and increasing transformation's load coefficient will result in increasing the efficiency in long-term. And also the privatization in short-term has not any meaningful effect on efficiency but in long-term there would be positive and meaningful effects.

Mollaee et al (2011) studied the assessment of the efficiency of research and development centers. They first used the literature in the field and the outlooks of scholars in research centers to achieve some assessment criteria and used window data envelopment analysis during the years between 2002 and 2007 to determine the efficiency of each organization and finally the ranked these research centers.

Fazeli (2011) studied the yield measurement and ranking of water industry companies in Iran during the years between 2006 and 2008. First he used the research literature and the outlooks of the scholars in the industry to recognize the effective factors in water industry and after collecting the related data he used window data envelopment analysis to measure the changes in yields during the pass of time. Then he entered some questionnaires into the model by using couple comparisons method, to implement the priorities and preferences of the managers in the industry and distributed them among the scholars of the industry and the results were entered in the form of relative weight limitations. Then the researcher used Anderson-Pearson's ranking method to rank the companies completely.

Fallah Delcheh & Mehregan (2010) studied the ranking and the trend of efficiency of 10 subunits of textile, leather, and clothing industries during the years between 1994 and 2007 by using window data envelopment analysis. The results showed that the production of mechanical carpets and floor coverings with an average of %89 and tanning and preparing the leather with an average of %83 appropriated the highest and the

lowest amount of technical efficiencies during the period between 10 different units. Also in dynamic studies of the units during the specified time period the average efficiency trend was accompanied with a soft rising slope except for the ends of the period.

Yang & Chang (2009) studied the yield of telecommunication companies in Taiwan by using window data envelopment analysis. The research results showed that the merging of companies will result in increasing yield and decreasing technical efficiency in short term and the adjustment of strategies such as increasing market share or improving financial portfolios and helps the company to achieve a better scale.

Karimi et al (2008) studied the efficiency of wheat cultivation regarding the two factors of time and risk by using interval data envelopment analysis and window data envelopment analysis. In this research project they used the two mentioned models to measure the efficiency in water wheat production in 8 big provinces of the country during the years between 1999 and 2004 and the results showed that Khozestan had the highest and the provinces of Hamedan and Eastern Azerbaijan had the lowest yields. Also by considering the risk conditions, Fars province had the highest and Kordestan province had the lowest efficiency in wheat production.

Akbari & Dinmohammadi (2007) measured the efficiency of Milk Production Company during the years between 1998 and 2003 by using window data envelopment analysis. The inputs of this model were work force, raw materials, overload, and capital and the outputs were milk revenues, other revenues, and total revenues. They studied efficiency regarding four scenarios. First scenario: four input and one output (milk's revenue and other revenues), Second scenario: four input and one output (total revenue of the company resulting from total milk revenue and other revenues), Third scenario: four input and one output (milk revenue, Fourth scenario: four input and one output (other revenues). The results of this research showed that in first and second scenarios, the production companies of Faka, Malard and goldasht (Golshahr & Goldasht at the same level) gained the first to third ranks, respectively. In third scenario, the Faka Company was in first rank and the companies Malard and Golshahr were placed in second to fourth ranks. Also in fourth scenario the companies Malard, faka, Golshahr and Goldasht (Golshahr & Faka at the same level) gained the first to third ranks.

Financial statements analysis

Financial statements show the summery of operational activities, financing and investing activities of the company during a financial period [17]. The decision makers get the financial statements of a company and by comparing activities try to analyze them. The financial statements' analysis helps the decision makers to get an overall outlook about consistency and the competitive status of the company [9]. The necessity of analyzing (interpretation) of financial statements has resulted in emergence and development of methods and techniques to meet the needs of users of financial statements in a way that they can identify the relationships between the figures mentioned in financial statements and compare, interpret and approve them[14]. In fact the analysis of financial statements is divided into three groups of horizontal analysis, vertical analysis, and financial ratios analysis. In horizontal analysis an item in the financial statements of the current year is compared with the same item in financial statements of the previous years in which the goal is to determine the increase or decrease of that item during the different financial periods. Also vertical analysis is expressed in comparing each item in financial statements with a basis number in the same financial statements [3]. The ratio analysis is among the most common techniques in supplying the information needs of the different users which has been considered in all financial management books as one of the important analysis and interpretation techniques of financial statements [15]. The analysis of different financial ratios will present useful information about the financial position of the entity which can not be extracted from financial statements alone [14]. In fact the ratios assess the relationship of some variables and this assessment prepares an outlook about the different aspects of business units such as profitability, liquidity, capital sufficiency, quality of assets, and management risk [17]. Due to the easy calculations and easy understanding, ratio assessment has had broad applications. In fact each group of financial ratios can assess a part of activities of a business entity and also the number of financial ratios which can be extracted from financial statements is great and mostly they are confusing and contradict each other[24]. Also financial ratios are calculated in a certain date and the future trends (changes) are not included in calculations. Meanwhile, the study of the performance changes trend is very effective in predicting the future status of the organization and making financial decisions. Thus, the ratio analysis is unable to do multi-dimensional assessment and present performance changes trend and determine desirable units.

Window data envelopment analysis

The technique for data envelopment analysis is one of the new techniques which has widely been utilized to assess the performance of units. This technique is a mathematical programming method to assess the efficiency of decision making units which have several inputs and outputs [18]. Because the method mentioned is based on a series of optimization issues, there are not any parameters for analysis. Thus, the method mentioned is considered to be a non-parametric method [7]. The data envelopment analysis model was first introduced by Charnes, Cooper and Rhodes in 1978 and was known as CCR model which is derived from the first letter of the three persons mentioned[18]. In CCR model, it is presupposed that there is a constant returns to

scale. By constant returns to scale we mean that the outputs change with a ratio that the input amounts change [17]. Six years after the presentation of CCR model the second model of this type was introduced by Banker, Charnes, and Cooper which was called BCC and was designed based on the variable return to scale[8]. The difference between the two models of CCR and BCC is related to variable or constant returns to scale. In variable returns to scale, it is supposed that the outputs do not change in proportion to the input [17]. Each of these models can be studied by using the two input-oriented or output-oriented approaches. One of the faults of the primary DEA models is ignoring the time factor in assessing the performance. In fact in these models, the measurement of efficiency is doe temporarily and it is carried out in a certain time (for example in a fiscal year). The window analysis as one of the subunits in DEA models has opened new doors to compare the units dynamically (during different time periods) for efficiency assessment [10]. In window analysis each decision making unit is considered as an independent unit which result in increasing the number of data. Thus, in issues with limited numbers of sample, this method will be a good resolution. The other advantage of window analysis is that the performance of a decision making unit will be assessed by comparing it with itself and other decision making units during the time period [5]. In fact in this method the performance of each decision making unit is assessed during the time in a way that as if each time period has a different identity. To explain it simply we can say that unlike the data envelopment analysis which studies the data solely during a specific tome like vertical analysis, window analysis like horizontal analysis assesses the data during specified time periods[4]. Window DEA model based on both models of CCR and BCC is solvable. But in this research we have used input oriented window CCR model. The reason to choose this model for performance assessment of the decision making units based on the time is that constant returns to scale shows a less number of companies to be efficient. In fact BCC pattern which is a type of variable returns to scale shows more companies to be efficient and this is less accorded with the reality [18]. Also the flexibility of window analysis model is less compared to models which have the capability of assessing the efficiency by presupposing the variable returns to scale [22]. Thus, the selection of window model seems sensible by presupposing the constant returns to scale.

Based on the research carried out by Sokhanvar et al (2011) to show the formula form of this issue, suppose that there are N decision making units (DMU) during the t time period (t=1, …, T) and all of them use r inputs to produce s outputs. Thus, the sample includes T×N observations and the decision making unit n during the period t, that is DMU^n_t has a vector of r dimensions of the inputs $(X^n_{1t}, X^n_{2t}, ……, X^n_{rt})$ and also a s dimensions vector of the outputs $(Y^n_{1t}, Y^n_{2t}, ……, Y^n_{st})$. The window started from the time K is $(1 \leq K \leq T)$ and the width of $(1 \leq W \leq T-K)$ is determined by KW and has N×W observations. The matrix of inputs and outputs for window analysis can be observed by the following vectors, respectively.

$$X_{KW} = (X^1_K, X^2_K, ..., X^N_K, X^1_K + 1, ..., X^N_K + 1, X^1_K + W, ..., X^N_K + W)$$

$$Y_{KW} = (Y^1_K, Y^2_K, ..., Y^N_K, Y^1_K + 1, ..., Y^N_K + 1, Y^1_K + W, ..., Y^N_K + W)$$

The input oriented DEA window problem for DMU^n_t under a constant returns to scale (CRS) assumption, will be as follows:

$$\theta'_K = min_{\theta,\lambda}(\theta)$$
$$s.t. \quad -x_{KW}\lambda + \theta x'_t \geq 0 \quad t = 1,...,T$$
$$y_{KW}\lambda - y'_t \geq 0 \quad t = 1,...,T$$
$$\lambda_n \geq 0 \quad (n = 1,2,...,N \times W)$$

Model (1)

The novelty and innovativeness in the research

While different researches have analyzed financial statements of firms accepted in Tehran Stock Exchange by using principal DEA models, none of them has used CCR window analysis. Thus, the present study tries to enter time factor in analyzing financial statements and recognize performance changes trend. This study has used window CCR model as one of the subunits of DEA.

Research Variables

The necessity of each applied research is to study and shed light on the effective parameters in working areas of the research. The selection of indexes of this research is suitable with those dimensions which are used by the investors as a basis to select the coming investing alternatives. Thus, first a list of 32 financial ratios derived from principle financial statements was supplied and was presented to a number of scholars and teachers in accounting field and financial management. After they were informed about the importance and nature of the present research, they were asked to express the most important indexes (financial ratios) to assess firms accepted in TSE. Their ideas were collected and those variables which had the most frequencies were selected. These variables were as follows:

Debt ratio, long-term debt to special value ratio, current debt to special value ratio, net income to sales, return of assets, total assets' flow, capital return, immediate ratio

Regarding the fact that this research is going to study the performance assessment of units accepted in bourse by using window DEA models, first the variables should be categorized into two groups of input and output. In an operational description of the criterion for this categorization, the variables which tend to minimize them will be categorized as input and those variables of the companies which try to maximize them will be entitled as output[23]. The input and output variables of the present research are as follows:

Input variables: debt ratio, long-term debt to equity ratio, current debt to equity ratio

Output variables: net income to sales, return of assets, total assets' flow, capital return, Acid ratio

Statistical population of the research

Statistical population of the present research entails firms accepted in Tehran Stock Exchange which have all the following conditions:

➢ Those which have been accepted in bourse since 2005 and the fiscal year of them ends on 29th. Esfand (20th. of March).

➢ Those which have not changed their fiscal year during the intended periods

➢ Those which have been continuously active during the research period and their stocks were being exchanged.

➢ Those whose financial information to do the present research was presented fully during the financial period between 2006 and 2011.

➢ Those which are not included among investing or intermediary companies, banks and insurance companies.

Then by using Kokran's sampling method 100 companies were selected as our research statistical sample.

Model resolution and data analysis

In the present study 100 firms accepted in TSE were assessed to use model (1) practically. To do so, we have used 3 inputs (debt ratio, long-term debt to equity ratio, current debt to equity ratio) and 5 outputs (net income to sales, return of assets, total assets' flow, capital return, Acid ratio) the present research considered the width of each window to equal 3 (W=3). The window analysis model for each window of the total units was resolved by WinQSB. It means that to gain the efficiency amounts of each window, the linear programming model for 300 (3*100) units were resolved and because there were 4 windows in each model, a total number of 1200 (300*4) programming models were resolved. After resolving the model, the average efficiency of each window and the annual average were calculated to be considered as the indexes for ranking the units. Here only the results of assessing only 12 companies were presented in table (1) as a sample of the research results due to the limitations of the journal to present the results completely.

Conclusions

The main problem in the present research was the fact that financial statements' analysis by using financial ratios resulted from the integration of ratios was difficult due to the fact that each of the ratios could show only a single dimension of financial dimensions and these ratios only show one fiscal year performance of the companies and do not present any information about the performance changes trend and are limited. Thus, the present research showed that window analysis is able to process several financial ratios concurrently although there are some controversial signs and present the result in the form of a number entitled efficiency which shows the performance changes trend. By analyzing the window DEA model for 100 companies accepted in Tehran Stock Exchange we could conclude that Daropakhsh Company had the best performance and Sea Industries Company had the worst performance during the period under investigations. Also the average total window for Bama and Maodeen Bafgh companies equals 0.994217. But due to the higher annual average amounts of Maodeen Bafgh company than Bama Company, Maodeen Bafgh company ranked 10th and Bama Company ranked 11th.

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Table (1): The results of window data envelopment analysis

Frim/Year	2006	2007	2008	2009	2010	2011	Window Average	Rank
Bama	1	1	0.9888				0.996266667	
		1	0.9887	0.9926			0.993766667	
			0.9905	0.9945	0.9932		0.992733333	
				0.9936	0.9929	0.9958	0.9941	
Year average	**1**	**1**	**0.989333**	**0.993567**	**0.99305**	**0.9958**	**0.994216667**	**11**
Petroshimi Khark	0.9975	0.9989	0.996				0.997466667	
		1	0.9976	1			0.9992	
			0.9986	1	0.9958		0.998133333	
				1	0.9948	1	0.998266667	
Year average	**0.9975**	**0.99945**	**0.9974**	**1**	**0.9953**	**1**	**0.998266667**	**2**
Pelaskokar Saipa	1	0.9952	0.9969				0.997366667	
		0.9955	0.9992	1			0.998233333	
			1	1	0.9891		0.996366667	
				1	0.989	0.9903	0.9931	
Year average	**1**	**0.99535**	**0.9987**	**1**	**0.98905**	**0.9903**	**0.996266667**	**5**
Haffari Shomal	0.9855	0.9918	0.9977				0.991666667	
		0.9931	0.9976	0.9922			0.9943	
			0.9989	0.994	0.9986		0.997166667	
				0.9938	0.9978	0.99	0.993866667	
Year average	**0.9855**	**0.99245**	**0.998067**	**0.993333**	**0.9982**	**0.99**	**0.99425**	**8**
Daropakhsh	0.9996	0.998	0.9968				0.998133333	
		1	0.9987	1			0.999566667	
			0.9979	0.9996	1		0.999166667	
				0.9993	1	1	0.999766667	
Year average	**0.9996**	**0.999**	**0.9978**	**0.999633**	**1**	**1**	**0.999158333**	**1**
Siman Ghaen	1	0.9956	0.997				0.997533333	
		0.9969	1	0.9978			0.998233333	
			1	1	0.995		0.998333333	
				0.9994	0.9937	0.9903	0.994466667	
Year average	**1**	**0.99625**	**0.999**	**0.999067**	**0.99435**	**0.9903**	**0.997141667**	**4**
Siman Kerman	0.9937	0.994	0.9952				0.9943	
		0.9944	0.9954	0.9946			0.9948	
			0.996	0.9957	0.994		0.995233333	
				0.9954	0.9938	0.9914	0.993533333	
Year average	**0.9937**	**0.9942**	**0.995533**	**0.995233**	**0.9939**	**0.9914**	**0.994466667**	**6**
Gol Gohar	0.9922	1	0.9946				0.9956	
		1	0.9952	0.9881			0.994433333	
			0.9974	0.9886	0.996		0.994	
				0.988	0.9951	0.996	0.993033333	
Year average	**0.9922**	**1**	**0.995733**	**0.988233**	**0.99555**	**0.996**	**0.994266667**	**7**
Mehvarsazan	0.9888	0.9945	0.9892				0.990833333	
		0.9934	0.9893	1			0.994233333	
			0.9895	1	0.9979		0.9958	
				1	0.9978	0.9903	0.996033333	
Year average	**0.9888**	**0.99395**	**0.989333**	**1**	**0.99785**	**0.9903**	**0.994225**	**9**
Maodeen Bafgh	0.998	0.9988	0.989				0.995266667	
		0.9987	0.9889	0.9901			0.992566667	
			0.9912	0.992	0.9969		0.993366667	
				0.9912	0.9958	1	0.995666667	
Year average	**0.998**	**0.99875**	**0.9897**	**0.9911**	**0.99635**	**1**	**0.994216667**	**10**
Madani Amlahe Iran	0.9948	0.9971	0.9953				0.995733333	
		0.9976	0.9958	0.9966			0.996666667	
			0.9979	0.9987	1		0.998866667	
				0.9982	1	0.9941	0.997433333	
Year average	**0.9948**	**0.99735**	**0.996333**	**0.997833**	**1**	**0.9941**	**0.997175**	**3**
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Sanaati Daryaie	0.9831	0.9804	0.9776				0.980366667	
		0.9805	0.9777	0.9776			0.9786	
			0.9798	0.9794	0.9808		0.98	
				0.9786	0.9799	0.9792	0.979233333	
Year average	**0.9831**	**0.98045**	**0.978367**	**0.978533**	**0.98035**	**0.9792**	**0.97955**	**100**