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Fuzzy Multi-Objective Two-Stage DEA Model for Evaluating the Performance of Companies Listed on Tehran Stock Exchange

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ABSTRACT

The aim of this study is to provide a new two-stage DEA model with fuzzy multi-objective programming approach for evaluating the performance of companies listed in the Tehran Stock Exchange. In this study, a two-stage DEA model, different from the traditional model, we introduce for performance analysis. In this regard, the stable operation of companies, into two sub-process, have divided, which includes the profitability (first phase) and the value creativity (the second phase), which can be used to identify the status of the company's operations and potential for future growth. Therefore, the profitability, including two entrances (the ratio of total debt, the ratio of total equity) and two outputs (ROA, ROE) and the value creativity (the second stage) includes two outputs (the ratio of book value to market value of B / M, the cost income ratio E / P) consider, that is, the outputs of the first stage are inputs for the second stage. The decision matrix proposed in this study, can clearly define the benchmark that can be emulated by inefficient companies and help managers to develop appropriate strategies needed to enhance their overall efficiency. The results show that due to general inefficiency, ineffectiveness was in one of the two sub-processes. The results show that the multi-phase two-stage DEA model is able to identify the causes of inefficiencies and provides a scale to compare performance.

Keywords:

DEA two-step, fuzzy multi-phase, value creativity, profitability.

1. Introduction

A critical aspect of management is the decision whereby the best set of projects, or investments, is selected from many competing proposals. In many cases, the stakes are high because selecting projects is a significant resource allocation decision that can materially affect the operational competitive advantage of a business (Chen &Cheng, 2009).What makes project selection challenging is that the valuation process is oftentimes plagued with high degrees of uncertainty due to long payback periods and changing business conditions. As a result, many researchers have used data envelopment analysis (DEA) as a method by which to evaluate large sets of competing projects. (Asosheh, Nalchigar, &Jamporazmey, 2010)

DEA was initially developed by Charnes, Cooper, and Rhodes (Charnes, Cooper, & Rhodes, 1978) as an efficiency analysis tool and quickly became a popular area in operations research. DEA measures the relative efficiency of decision- making units (DMUs) which can represent projects, processes, policies, or organizations. Although all DMUs must be defined in terms of a common set of inputs and outputs, they do not need to have the same units of measurement. DEA scores efficiency on a scale from 0 to 1 and is thus capable of discriminating among the inefficient units, allowing one to rank projects from most to least efficient.

In recent decades, data envelopment analysis (DEA) largely as a performance measurement tool is used. (Fare, Grosskopf, & Weber, 2004; Barth, Lin, Ma, Seade, & Song, 2013; Halkos & Tzeremes, 2013; Paradi, Zhu, & Edelstein, 2012) Unfortunately, most studies of modeling are not perfect. For example, in the beginning, many previous studies have tried to companies with complex manufacturing processes conventional models DEA - the single-processor system as a black box in terms of the lifetime-show, but sufficient information to identify specific sources non-interactive embedded in a company does not provide. Second, using the traditional DEA model, the performance of companies with the best coefficients is calculated which may produce a large proportion of DMU efficient and leads to the resolution is poor. Third, according to Cooper, Seiford, and Tone (2007) when the input and output variables simultaneously percent (eg EPS, ROE, ROI), and raw data (eg, income, assets, profits) become, efficiency score wrong will be.

To overcome the shortcomings mentioned in this study, to improve estimation error caused by incompatible version, a series of reforms have been carried out. We have a two-stage DEA model with a variable ratio, we present to assess efficiency. This innovation model is able to fully reflect the multi-purpose operating units and sub-process relationship with the whole process. Furthermore, this study also adopts Zimmermann's (1978) multi-objective linear programming approach, in which the efficiency evaluation of all DMUs is viewed as one objective function to be maximized. It provides a common scale for comparing performances and increases discriminating power in order to more accurately measure the performance of companies. This approach deals directly with the measurement flaws of conventional DEA models and simplifies the calculation process. Consequently, it provides a common scale for comparing performance and increases discriminating power in order to more accurately measure the performance of companies.

In summary, the findings will be discussed operational efficiency have helped companies in the Tehran Stock Exchange. First, improving prior researches, this study employs an innovative ratio two-stage production process model, which includes profitability and value creativity performance, to assess the efficiency of companies in Tehran Stock Exchange. Second, the two-stage DEA model, combined with the fuzzy multi-objective programming approach, is used to investigate not only the operating performance of companies but also how companies make strategic decisions, especially regarding operational styles in an intensely competitive environment .The theoretical foundation and research background and two-stage production process to be followed. After that, the two-stage multi-phase set with input and output variables in a two-stage DEA model can be expressed and finally, findings and conclusions expressed.

2. Literature Review

One of the most important goals of businesses is business profits and increases the wealth of shareholders (owners) in the long term. Shareholders, creditors and other related enterprises to rational decision making require reliable and relevant information about their performance and their managers. Given that shareholders and creditors firms

to allocate their limited financial resources to evaluate the performance of the enterprise in order to ensure the optimal allocation of limited resources, it is critical.

Measures the performance of management control systems are deemed as economic planning and decisions need to assess how the unit's effective control. Timely assessment of economic performance could lead to an efficient allocation of limited resources. The performance evaluation is a process through which managers at all levels, information on the performance of the Company to obtain and judge. (Roodposhti rahnama, 2014)

The economic environment and business performance in the industry, is affecting the value of securities and rates of return and consequently the value of the company. The Enterprise performance is one of the factors affecting shareholder value categories maximize shareholder wealth can be achieved. Improving the quality and quantity of business performance, the result is value creation. Because efficient business can be considered as a single profit creates value. Sales promotion, ensure continuity, increase potential profits, investment and ensuring an acceptable cash flow to invest the time it is possible that the firm and management firm that creates value, Neglect of opportunities, the ability to manage the business and economic environment, have a significant impact on the success of the enterprise and increase the rate of return will be their shares. Value creation is in the interaction with the value of the company. A reasonable assessment of the value of the company provides the necessary conditions for value creation. Enterprise value is a function of the symptoms proper functioning of management.

Understanding, where, how and why value creation and value creativity, business necessity today, depends on the following, First, the company's survival in the competitive necessity of thinking is value creation. Secondly value creation in business, how thinking reveals that the mean value chain. (Roodposhti rahnama, et al, 2014)

Hwang and Kao (2006) cover two-step analysis to evaluate the performance of management in Taiwan have used 24 life insurance companies. In this study, firstly performance is measured by marketing capabilities and the ability to profit in the second phase. Hwang and Kao, the performance of the first stage, the marketing capability, and secondly, the ability to profit independently measured using the conventional DEA And the conclusions suggest that rather than the performance of an insurance company just in general, and once the measure is better than the performance of an insurance company in two steps, measure, and this will cause performance to better manage the show data, and will help insurance companies to understand their particular advantages and disadvantages of the series.

Yang (2006) in their study of a two-stage DEA model to evaluate the efficiency of systematic and Health Canada offers the life insurance industry. In particular, the new model combining production and investment functions allow insurance companies. The results show that the life and health insurance industry in Canada during the period under review has been fairly effective.

Joseph Paradis and colleagues (2011) in a study entitled Assessment of bank branches in Canada using DEA model two-step, 860 bank branches in Canada evaluated the performance of the branches of the aspects of production, profitability, and activities of intermediary examined.

José Solana and colleagues (2016) in his research as Two-Stage Data Envelopment Analysis of Spanish Regions (Efficiency Determinants and Stability Analysis) the hypothesis tests that the efficiency of Spanish tourism regions for the period 2005-2013 is determined by a group of contextual variables. In contrast with monitoring reports based on descriptive methods, this paper uses the Data Envelopment Analysis (DEA) bootstrap semi parametric procedure to investigate efficiency determinants. An innovative analysis addresses the problem of the stability of efficiency estimates of random changes in the isolated exogenous variables. It study extends the traditional DEA analysis by exploring efficiency and productivity changes using the slacks-based measure (SBM) model and the bootstrapped Malmquist index approach to obtain total productivity growth estimates.

Adam and Maznah (2017) Research has been tested as a two stage data envelopment analysis model with undesirable output. The existing multi stage DEA models do not focus on the integration with the undesirable output, in which the higher input will generate lower output unlike the normal desirable output. This research attempts to address the inclusion of such undesirable output and investigate the theoretical implication and potential application towards the development of multi-stage DEA model.

This research demonstrates the utilization of multi stage DEA model with undesirable output which stems from consecutive z_i . The result is also compared with multiplicative and additive. This research concludes that additive z_i performs the best based on this research's data set and conversely, multiplicative z_i performs negatively. The consecutive z_i also highly affected by the latter stage which may suggest that this type of interaction will not accurate in representing the overall _, especially if it involves n-stages.

Umit saglam (2018) in a study entitled a two-stage performance assessment of utility-scale wind farms in Texas using data envelopment analysis and Tobit models are applied to evaluate productive efficiencies of the 95 large utility-scale wind farms' electricity generation in Texas, by using pre-determined three input and two output variables. The slack analysis and projection data are obtained for inefficient wind farms to find out benchmarking input-output variables. The sensitivity analysis is provided for the robustness of the DEA models with different combinations of input and output variables of the original model. DEA results indicate that half of the wind farms were operated efficiently in Texas during 2016. 13 wind farms were performed at the most productive scale size, 10 wind farms should reduce their operational size to improve production efficiency, and 72 wind farms have the notable potential to increase their production efficiency by expanding operational sizes with modern wind turbine technologies.

Momeni and Shahkhah (2010) in his research as the insurance company's performance evaluation by using a two-stage DEA management examined. In this study introduces two stages: At first, marketing capability, and secondly, the ability of profitability. The first phase inputs, operating costs and insurance costs and output, and input Secondly, direct premiums and reinsurance premiums and printouts, insurance benefits, and investment gains. The result showed the inefficiency due to inefficient companies often because of weakness in the second stage.

Dastgir and colleagues (2015) in his research as an analysis of financial statements of companies listed on Tehran Stock Exchange Using data envelopment analysis window to review and rating of companies using analysis window in time they paid. As a result of their study showed that during the study period only one company has been able to maintain its performance.

Hosseini and colleagues (2016) fundamental stock analysis using the two-stage DEA examined. Using a two-stage DEA considered in the first step of inputs including accounts receivable, inventory, fixed assets, operating costs and other assets, output, income, and in the second step of inputs including projected revenue, operating cost, book value, the output value of the stock market.

Hossein Lotfi Zadeh et al (2014) overall performance and two-step help common set of bank branches were weighted using fuzzy. They are two stages used which contain resource includes two inputs (Score personnel, the cost of interest payments) and five output (deposits) and other resources and the allocation of resources (second stage) and four outputs (loans, dividends received, compensated and non-current receivables) is. They concluded that the combined weight of the lower average efficiency of branches of different weights.

3. Methodology

In terms of purpose, this research will be placed among the applied research. That part of the study to collect data that is relevant to the theoretical foundations of research, papers and journals have been used in Persian and Latin. For the other study, the data and information needed for input and output of the archive in trading on the stock exchange and software companies has been referred.

3.1. The population and sample research

The study population has consisted of all companies listed on the Tehran Stock Exchange during the period 2013-2017. This community of 60 companies (each company is considered as a decision making unit DMU) was selected with the following conditions:

1) The financial period of the company that is leading to the end of March each year.
2) Companies that their data is fully available for the mentioned period.
3) Companies that do not change during the study period of financial and operational interruptions.
4) Not of investment firms and financial intermediation and financial services.

3.2. Two-stage production process

Comparing with traditional DEA models, the production process is deemed as a black-box, where the inputs and outputs are the focus of inquiry and what goes on inside the box is typically ignored. In contrast to the black-box production technology, some production systems have a connecting structure, such as when production by one division or sub-process results in an intermediate output that is an input to another sub-process. In addition, according to Favero and Papi (1995) study, there are three approaches can be used to the input and output specification, namely production approach, intermediation approach and, the asset approach. Different methods are applied to different conditions, so it is essential to carefully analyze the characteristics of measurement object. (Wang&Liu, 2014)

In this research, we construct a two-stage DEA model; differ from the traditional one, to analyze the performance of companies. We believe that it is more appropriate to take into account the performance of the sub-processes, and could provide more accurate information for investors to make a wise decision.

This study adapts Seiford and Zhu's (1999) two-stage transformation process framework and constructs a more accurate innovation ratio two-stage model by replacing marketability with value creation in the second stage and by also replacing variables with a united ratio. As seen in Fig. 1, the sustainable operation process of companies can be decomposed into two sub-processes, namely, profitability performance and value creativity performance, so as to identify the company's operation status and potential for future growth. Obviously, the performance of companies will be misjudged if an incorrect variable is used. Because equity is the complement of an asset, it is inappropriate to consider the two variables together. More importantly, decomposing assets into equity and liability helps companies identify the costs that cause inefficiency, and provides decision- makers with a direction for improving the efficiency of their companies.

In the first stage, there are two inputs (X1: total liability ratio; X2: total equity ratio) to produce two outputs (Y1: return on asset (ROA); Y2: return on equity (ROE)), which are deem as inputs to the second stage to produce two outputs, also named as intermediate variables. Both inputs and outputs are introduced in the first stage to assess the efficiency of asset usage as well as to resolve the problem of overlap between assets and equities.

Profitability performance is measured in this stage. The total liability ratio (X1) is the ratio of total debt (the sum of current liabilities and long-term liabilities) divided by total assets and indicates the percentage of a company's assets that are provided via debt. The total equity ratio (X2) is the ratio of shareholders' equity divided by total assets. The Equity ratio measures the proportion of the total assets that are financed by stockholders and not creditors. A low equity ratio will produce good results for stockholders as long as the company earns a rate of return on assets that is greater than the interest rate paid to creditors.

In the second stage, the value creativity performance model measures companies in Tehran Stock Exchange attractiveness in the stock market and its ability to continue as a going concern.

This stage adopts a framework composed of two-inputs (Y1: ROA; Y2: ROE) and two-outputs (Z1: book-to-market equity ratio (B/M); Z2: earnings to price ratio (E/P)) to reflect a company's future growth.

In general, the whole value of a company is composed of its ability to generate profit and its attractiveness in the stock market, which reflects the company's potential for future growth. Those companies having high ratios of earnings to price (E/P), book-to- market equity (B/M), or cash flow to price (C/P) have been defined as value stocks and others as growth stocks (Fama & French, 1992).

Stattman (1980) indicated that companies with high B/M equity ratios outperform those that have low B/M equity ratios. Basu (1977) also found that there is a positive relationship between a company's E/P ratio and future returns. Accordingly, the two outputs (i.e., B/M ratio and E/P ratio) in this study can properly reflect the linkage of the two variables with company's future growth in a tighter way.

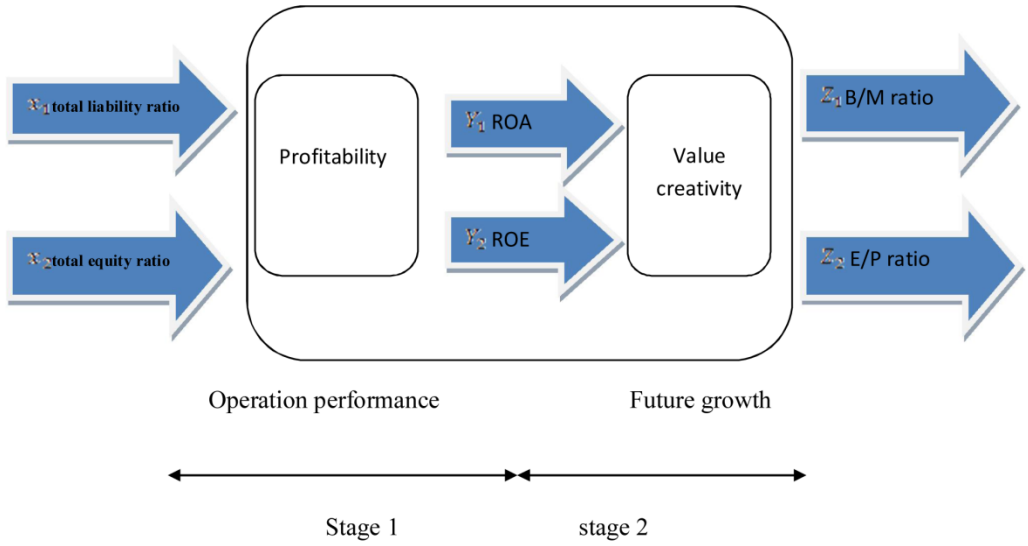

Fig.1.Model Process Steps

3.3. The fuzzy multi-objective two-stage model

For evaluation of decision- making units (DMUs) with multiple-inputs and multiple-outputs in public sector, data envelopment analysis (DEA) is now one of the most widely accepted methods to measure the relative efficiency or productivity of research institutions. Seiford and Zhu's (1999) two-stage model calculates the first stage, second stage, and the whole production process independently. However, Kao and Hwang (2008) asserted that it is inappropriate to calculate

The two sub-processes independently since a production process is composed of a series of two sub-processes and the intermediate products play an interactive role in both processes. Agreeing with Kao's argument, we adopt the concept of the relational two-stage DEA model, together with the fuzzy multi-objective approach, to evaluate the efficiency of companies in Tehran Stock Exchange. The mathematically sound fuzzy multi-objective two-stage DEA model reflects the complex operational phenomena in companies and deals directly with the drawbacks of the solution process in the conventional DEA model.

In the relational two-stage DEA model, the production process is composed of a series of two sub-processes. For any DUM_J (j = 1,. . . ,n), m inputs x_{ij} (I = 1,. . . ,m) are used to produce intermediate products z_{pj} (p = 1,. . . ,q) in the first process and are then consumed in the second process to generate outputs y_{rj} (r = 1,. . . , s). For this study, we transformed the relational two - stage DEA model into the multiple objectives network DEA model, called Model (1):

$$\theta_1 = \max \quad \frac{\sum_{r=1}^{s} u_r y_{r1}}{\sum_{i=1}^{m} v_i x_{i1}}$$

$$\theta_2 = \max \quad \frac{\sum_{r=2}^{s} u_r y_{r2}}{\sum_{i=1}^{m} v_i x_{i2}} \qquad (1)$$

$$\theta_n = \max \quad \frac{\sum_{r=1}^{s} u_r y_{m}}{\sum_{i=1}^{m} v_i x_{in}}$$

$$s.t \quad \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \qquad j = 1,\ldots,n$$

$$\frac{\sum_{p=1}^{q} n_p z_{pj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \qquad j = 1,\ldots,n$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} n_p z_{pj}} \le 1 \qquad j = 1, ..., n$$

$$u_r, n_p, v_i \ge \varepsilon \succ 0 \quad r = 1, ..., s \quad i = 1, ..., m \quad p = 1, ..., q$$

We adopt Zimmermann's (1978) fuzzy approach to determine the solution of Model (1). In this way, we solve multi-objective problems, provide an efficient solution, and acquire less additional prior or extraneous information than other approaches do. In addition, for each DMU, the single objective network DEA may have fuzzy goals. In the maximization problem for every single objective function, the fuzzy goal stated by the decision maker may be to achieve ''an objective function θk that is substantially larger than or equal to some value of p'' and can be quantified by the corresponding membership function.

The fuzzy approach utilizes the membership function to transform multi-objective programming into one objective programming. By the means of the membership function, each DMU expresses its degree of achievement with respect to the value of its objective function. Therefore, the related membership function is defined as:

$$f_i(\theta_j) = \begin{cases} 0 & if \quad \theta \le \theta_j^1 \\ \dfrac{\theta_j - \theta_j^1}{\theta_j^u - \theta_j^1} & if \quad \theta_j^1 \le \theta_j \le \theta_j^u \\ 1 & if \quad \theta_j \ge \theta_j^u \end{cases} \qquad (2)$$

Whereθ_j is the efficiency value of Model (1), and $\theta_j^u$and θ_j^1 denotethe maximum and minimum of the objective functions, respectively.

f_i (θ_j) is the membership function ofθ_j, which refers to the level of achievement of the efficiency ratio for the DMUj. Since the efficiency ratio of the objective functions in Model (1) is between 0 and 1, the degree of the membership function will also be located within this interval. Based on transformation of the membership function, f_i (θ_j) = 1 is defined the highest achievement and f_i (θ_j) = 0 as the lowest. It is well known that the best approach to solving the conjunction of a fuzzy set is to maximize the minimum of the membership functions, which can be expressed as Model (3):

$$\max_{u,v,r,j} \quad \min f_j(\theta_j) \qquad (3)$$

Therefore, Model (1) can be rewritten as max–min form, shown below as Model (4):

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

$$\max_{u,v,r,j} \quad \min f_j(\theta_j) \qquad (4)$$

$$\frac{\sum_{p=1}^{q} n_p z_{pj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \qquad j = 1, ..., n$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} n_p z_{pj}} \le 1 \qquad j = 1, ..., n$$

$$u_r, n_p, v_i \ge \varepsilon \succ 0 \quad r = 1, ..., s \quad i = 1, ..., m \quad p = 1, ..., q$$

Since $\theta_j \xi$ [0, 1] for any DMU, the membership function of Model (4) can be simplified as f_i (θ_j) =θ_j. Then, by introducing an auxiliary variable λ we obtain the equivalent Model (5):

Max λ

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

$$\frac{\sum_{p=1}^{q} n_p z_{pj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \qquad j = 1, ..., n \qquad (5)$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} n_p z_{pj}} \le 1 \qquad j = 1, ..., n$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \ge \lambda \qquad j = 1, ..., n$$

$u_r, n_p, v_i \geq \varepsilon \succ 0 \quad r = 1,...,s \quad i = 1,...,m \quad p = 1,...,q$

Through simple transformation, Model (5) can be rewritten as the following equivalent conventional mathematical programming problem:

Max λ

$$S.t. \sum_{r=1}^{s} u_r y_{rj} - x_{ij} \sum_{i=1}^{m} v_i \leq 0 \qquad j = 1,...,n$$

$$\sum_{p=1}^{q} n_p z_{pj} - x_{ij} \sum_{i=1}^{m} v_i \leq 0 \qquad j = 1,...,n$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{p=1}^{q} n_p z_{pj} \leq 0 \qquad j = 1,...,n$$

$$\sum_{r=1}^{s} u_r y_{rj} - \lambda \sum_{i=1}^{m} v_i x_{ij} \geq 0 \qquad j = 1,...,n$$

$$u_r, n_p, v_i \geq \varepsilon \succ 0 \qquad r = 1,...,s \qquad i = 1,...,m \qquad p = 1,...,q$$

The bisection method (Sakawa & Yumine, 1983) can be applied to solve the nonlinear programming problem of Model (6) and find the common multipliers $(u_r^*, n_p^* v_i^*)$ needed to calculate the efficiency score of each DMU. The efficiency can be measured by model (7):

$$\theta_j^F = \frac{\sum_{r=1}^{s} u_r^* y_{ri}}{\sum_{i=1}^{m} v_i^* x_{ij}} = \frac{\sum_{p=1}^{q} n_p^* z_{pj}}{\sum_{i=1}^{m} v_i^* x_{ij}} = \frac{\sum_{r=1}^{s} u_r^* y_{rj}}{\sum_{p=1}^{q} n_p^* z_{pj}} = \theta_J^{F1} \times \theta_J^{F2}$$

Where θ_j^F , θ_J^{F1} and θ_J^{F2} of Model (7) represent the overall efficiency and corresponding process efficiencies calculated using the fuzzy multi-objective two-stage approach. Consequently, the fuzzy multiobjective two-stage DEA model provides a common scale for comparing performance, while increasing the discriminating power and simplifying the calculation process.

3.4. Input and output variables in a two-stage DEA model

The efficiency of a unit is to compare the inputs and outputs together. In other words, efficiency is the result of subtracting the outputs to inputs. DEA techniques to units that have minimum input, maximum output, are assigned to efficiency rating "A". Therefore, the use of these techniques, it should variables to minimize them as "input" and the variables that maximize their aim as "output" be considered. (Namazi&Ghaffari, 2016) Accordingly, the input and output variables in a two-step DEA the table (1) in order to have calculations.

Table 1: Input and output variables in a two-stage DEA model

Model	Variable	Variable calculation
The first stage input	total liability ratio	total debt (the sum of current liabilities and long-term liabilities) divided by total assets
	Total equity ratio	ratio of shareholders' equity divided by total assets
The first stage output the second stage input	return on asset (ROA)	Net income divided by average assets
	return on equity (ROE)	Net income divided by average equity
the second stage output	book-to-market equity ratio (B/M)	Ratio of book value to market value is basically calculated as follows: The book value of equity is determined using data from the latest balance sheet. The stock market value by multiplying the number of shares outstanding in the latest market price of ordinary shares, to be determined. The book value and the market value of equity divided by the ratio obtained.
	Earnings to price ratio (E/P)	Earnings per share divided by price per share

4. Results

In this study, a two-step evaluation model based on DEA along with the fuzzy multi-phased program is used to evaluate the performance of companies in Tehran Stock Exchange.

The purpose of efficiency measurement is to detect the weak areas of an organization so that appropriate effort can be devoted to improving performance.

By combining the efficiency results of the two sub-processes, this study constructed a decision-

making matrix, in which the vertical axis represents the efficiency of profitability (θ_j^{F1}) and the horizontal axis represents the efficiency of value creativity (θ_j^{F2}).

Table (2) shows the efficiency score of the two sub-processes (θ_j^{F1}andθ_j^{F2}) and the efficiency of the whole process (θ_j^{F}).The last row shows the mean of all measures.

The mean of $\theta_j^{F1}$is greater than that ofθ_j^{F2}, and the overall efficiency is not 1. The overall efficiency does not reach 1 due to the inefficiency embedded in one of the two sub-processes. On the whole, these companies are relatively efficient in terms of profit making, but they need to recheck their policies of further growth in order to increase the efficiency of value creation. In this way, sustainable development can be put into practice. Obviously, none of the companies achieves optimal efficiency in both sub-processes, and their overall efficiency does not reach 1. To find out the reason for the overall inefficiency and provide some useful information for managers, we analyzed their efficiency scores. We found that they applied and transformed resources effectively enough to achieve a maximum performance outcome in stage one or stage two, respectively, but were not located on the efficient frontier in terms of overall efficiency. In stage 1(θ_j^{F1}) , Ten companies named Behceram, Khark Petr, Farabi Petr, Zahravi Phar, Sobhan Pharm, Qayen Cement, Jam Petr, Salemin Factory, Iran China Clay and Aluminium navard performed efficiently, but their efficiency in the second stage was relatively poorer than that of their counterparts. in stage 2(θ_j^{F2}),Five company, for example, E. Kh. Shargh., -Iran Aluminium, Pars Shahab, Darab cement and Niromohareke M, performed efficiently, but not in the first stage. The results imply that the reason for the overall inefficiency was inefficiency embedded in one of the two sub-processes.

The above findings demonstrate that the fuzzy multi-objective two-stage DEA model is capable of opening the black-box in order to identify the causes of inefficiency, and that it provides a common scale for comparing performance, thereby potentially increasing discriminating power and yielding greater managerial insights into the performance of companies so that further improvements can be made.

Table 2: The results of the performance of 60 companies studied

Company Name	Two-stage model			Company Name	Two-stage model		
	θ_j^{F1}	θ_j^{F2}	θ_j^{F}		θ_j^{F1}	θ_j^{F2}	θ_j^{F}
1-Alborz arou	0.913	0	0	31-Fars Cement	0.901	0	0
2-Pars khodro	0.909	0	0	32-Shahroud Cement	0.913	0.103	0.094
3-Behceram	1	0	0	33-Iran Transfo	0.913	0	0
4-Pars Darou	0.921	0	0	34-Iran Darou	0.922	0	0
5-Khark Petr	1	0	0	35-Alvand Tile	0.86	0.296	0.254
6-Farabi Petr	1	0	0	36-Pars Tile	0.805	0	0
7-Zahravi Phar	1	0	0	37-Saadi Tile	0.89	0.129	0.114
8-Sobhan Pharm	1	0	0	38-Iran Carbon	0.914	0	0
9-Dasht Morghab	0.909	0	0	39-Khorasan Steel Co	0.925	0	0
10-Qayen cement	1	0	0	40-Gorji Biscuit	0.919	0	0
11-Jam Petr	1	0	0	41-Pars Khazar	0.91	0	0
12-Shiraz Petr	0.943	0	0	42-Technotar	0.981	0	0
13-Shahdiran Inc	0.924	0	0	43-Iran Casting	0.907	0	0
14-Glass and Gas	0.921	0	0	44-Bahonar Copper	0.926	0.501	0.463
15-E. Kh. Shargh	0.91	1	0.91	45-Daroupakhash I	0.909	0	0
16-Sarma Afarin	0.927	0.196	0.181	46-Pars Shahab	0.918	1	0.918
17-Razak Lab	0.837	0	0	47-Isfahan Sugar	0.909	0	0
18-Isfahan cement	0.931	0	0	48-Amirkabir Steel	0.933	0	0
19-Shazand petr	0.948	0.165	0.156	49-Mobarakeh Steel	0.913	0.468	0.427
20-Iran Aluminium	0.915	1	0.915	50-Saipa	0.917	0	0
21-Iran Khodro	0.899	0	0	51-Ardebil Cement	0.916	0	0

Company Name	Two-stage model			Company Name	Two-stage model		
	θ_j^{F1}	θ_j^{F2}	θ_j^{F}		θ_j^{F1}	θ_j^{F2}	θ_j^{F}
22-Absal	0.911	0.055	0.050	52-Darab cement	0.953	1	0.953
23-Behnoush Iran	0.906	0	0	53-Kerman Cement	0.928	0.405	0.375
24-Abouraihan P	0.915	0	0	54-Iran Tire	0.992	0	0
25-Jaber Hayan P	0.914	0	0	55-Iran brake L	0.947	0	0
26-Iran Radiator	0.91	0.446	0.405	56- navard and steel p	0.944	0	0
27-Mashad Wheel	0.908	0	0	57-Niromohareke M	0.998	1	0.998
28-Salemin Factory	1	0	0	58-Aluminium navard	1	0	0
29-Iran Glass Wool	0.916	0	0	59-Bama	0.972	0	0
30-Iran China Clay	1	0	0	60-Fanavaran Petr	0.963	0	0
				Average	**0.933**	**0.129**	**0.120**

θ_j^{F} The overall efficiency

θ_j^{F1} The efficiency score obtained from the two-stage model at the first stage of profitability

θ_j^{F2} The efficiency score obtained from the two-stage model at the second stage of value creativity

5. Discussion and Conclusions

According to Peter Drucker, one of the greatest thinkers of the twentieth century, the work of an organization is to create value. In todays uncertain economic environment, most investors and businesses must be accepted by the financial sector typically represents a substantial return on investment. Therefore, it is important for business professionals the ability to create real value have a financial context. The financial value creation, financial decisions is important. Including investment decisions, operational decisions (performance) and financing decisions (efficiency) are concerned.

The main reason for analysis in this study is that we can realize a significant number of researchers to this point, the issue of operational efficiency in the financial industry over the past decade has become of considerable importance. In this study, an innovative two-stage DEA along with the multi-phased program has been used to calculate performance scores and interpret a performance index to measure the performance of 60 companies listed in the Tehran Stock Exchange. Our findings help in several ways to the efficiency of companies. First, this paper improves some shortcomings in prior researches; in other words, this study employs an innovative ratio two-stage production process model, which includes profitability and value creativity performance, to assess the efficiency of companies listed in the Tehran Stock Exchange. Second, the two-stage DEA model, combined with the fuzzy multi-objective programming approach can there be increasing discriminating power and be simplifying the calculation process. More important, this approach can more accurately identify sources of inefficiency in companies.

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