



Application of the Two-Stage DEA Model for Evaluating the Efficiency and Investigating the Relationship between Managerial Ability and Firm Performance

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ABSTRACT

The aim of this study is to investigate the relationship between managerial ability and firm performance. First, we introduce a new two-stage DEA model with a fuzzy multi-objective programming approach for evaluating the performance of companies listed on the Tehran Stock Exchange. 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), that is, the outputs of the first stage are inputs for the second stage, which can be used to identify the status of the company's operations and potential for future growth. Second, In order to measure the ability of managers, we use the model provided by Demerging. Finally, the relationship between managerial ability and firm performance are also investigated by means of the truncated-regression model. The results show that there is a positive relationship between the ability of management and firm performance. It means that managerial ability to be significantly related to the performance of the company. In this sense, the performance of the company improves by increasing managerial ability to better use resources and consequently increase overall efficiency.

1 Introduction

The economic environment and the performance of the economic firm in the industry affect the value of the securities and its efficiency and consequently, the firm value is effective. The performance of the enterprise firm is one of the most effective factors on firm stock value, which is realized by maximizing shareholder wealth. The promotion of the quantity and quality level of enterprise performance is the result of earnings. The promotion of selling, guaranteeing the continuation of activity, increasing potential profits, investing and ensuring the acceptable cash flow for the investor when the firm's economic firm and firm management will have a significant impact on the success of the enterprise firm and increasing their stock returns, creating value in interactive interaction with firm value [12]. A rational evaluation of the value of the company provides the conditions for creating value. The value of the company itself is a function of the value of the firm, which indicates the proper performance of management. It is very important to provide motivational factors with the goal of creating value for management. Financial assets are the tools of management. In the possession of an efficient portfolio can be effective in enhancing the company's value and increasing the value of the company's value. In order to have an efficient portfolio, the evaluation process can be very helpful and effective. What is

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more important is the existence of a reciprocal relationship between value creation and evaluation of financial assets that attract the attention of management [26]. The main purpose of strategic financial management is to improve the company's value, which is in practice the value of the company's value (financial assets) and through applying different strategies and policies in decision-making and execution of financial management tasks. Firms face various factors that are impossible to predict during their economic life and are managers who take the necessary final decisions. Managers should have the ability to identify the position and specific characteristics of the company in order to choose the best decision for the company. The influence of managerial ability in corporate policies is ignored under the assumption that managers of entities are homogeneous, which represent a limited role for the manager's specific influence on economic outcomes. Only recently a number of studies have challenged the view that managers play a significant role in the selection and performance of their company. (Bamber et al. [5], Chemmanur et al. [7], Demerjian et al. [11], Choi et al, [9], Andreou et al. [4], Francis et al. [15]). In accounting literature, the ability of management is one of the dimensions of human capital that is classified as intangible assets. Today, an intangible asset is a powerful resource for increasing business performance [33]. Standard of Accounting in Iran No. 17 defines an intangible asset as an identifiable monetary asset without physical existence to be held for use in the production or supply of goods and services or rent to others or for other administrative purposes. Abstract one of the human capital, which plays an important role in converting the company's resources into income and creating wealth for shareholders, are managers of business firms. Managers' ability to engage in firms can be one of the most important and determinant factors in the success or failure of the firm's performance. This information can be valuable and important to investors, analysts and consumers of financial statements [26]. The efficient capital market is one of the pillars of the economic growth of each country, and it has to be considered sufficient for a dynamic economy to have this market and its elements. Stock Exchange firms are one of the elements that play an important role in such markets and their performance directly impacts the market, thus determining their efficiency. Data envelopment analysis is one of the types of performance measurement methods, the traditional model of data envelopment analysis uses only one general process to assess the efficiency of multiple inputs and output processes, and these models are unable to assess the performance of processes and sub-processes in the organization, so performance evaluation results may hinder the achievement of managerial information with value [19,20,22]. The present study examines the efficiency of performance using a two-stage data envelopment analysis model that outputs the first stage, the inputs of the second stage in measuring performance [28].

2 Theoretical Fundamentals

Profitability as the most important factor in decision-making has always been considered by stakeholders in the company's profitability. Also can be a basis for evaluating the performance of the managers. The ability to predict the profitability can be very useful to help decision-makers [31]. 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 creditor 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 obtain and judge [30]. 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 [29]).

3 Literature Review

Hwang and Kao [18] 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 understand their particular advantages and disadvantages of the series. Yang [38] in their study of a two-stage DEA model to evaluate the efficiency of systems and Health Canada offers the life insurance industry. In particular, the new model combining production and investment functions allows insurance companies. The results show that the life and health insurance industry in Canada during the period under review has been fairly effective. Andreou et al. [3] indicated that management's ability to handle there is a positive and meaningful relation to the company's performance. They also showed that the ability of management has a negative and significant relationship with information asymmetry. Demerjian et al, [11] showed that the quality of corporate profitability has a positive and significant relationship with its management ability. High ability managers will lead to higher incomes, higher interest quality, less error in poor financing through borrowing. Chen et al, [8] found that managers ' ability is one of the major components of success in making innovation decisions and has a positive association with the market value of firms. Jose Solana and colleagues [35] 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 isolat-

ed exogenous variables. It is studied 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 [1] 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 the multi-stage DEA model. This research demonstrates the utilization of multi stage DEA model with an undesirable output, which stems from consecutive z_i . The result is also compared with multiplicative and additive z_i . This research concludes that additive z_i performs the best based on this research's data set and conversely, multiplicative z_i performing negatively. The consecutive z_i also highly affected by the latter stage, which may suggest that this type of interaction will not accurately in representing the overall especially if it involves no-stages. Saglam [37] in a study entitled a two-stage performance assessment of utility-scale wind farms in Texas use data envelopment analysis and Tobit models are applied to evaluate productive efficiencies of the 95 large utility-scale wind farm electricity generation in Texas, by using pre-determined three input and two output variables. The slack analysis and projection data are obtained from inefficient wind farms to find out the benchmarking input-output variance. 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 farm was 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 [24] 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. Hosseini and colleagues [16] 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 costs, book value, the output value of the stock market.

Table 1: Descriptive Statistics

Variables	Mean	S.D	Maximum	Minimum
Total liability ratio	0.6328	0.21542	1.17	0.03
Total equity ratio	0.3605	0.22130	0.97	-0.23
ROA	11.4867	13.30826	44.21	-18.11
ROE	5.1392	201.52745	100.37	-1516.42
B/M ratio	0.4193	0.26138	0.91	-0.46
E/P ratio	0.0876	0.13128	0.28	-0.54
Managerial ability	0.4206	0.29881	1.19	-0.56

Lotfi Zadeh et al. [17] 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 outputs (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.

4 Proposed Methodology

We examined 60 firms listed on the Tehran Stock Exchange was treated as a decision making unit (DMU). We primarily obtained input and output data from Tehran Stock Exchange database and from Financial Statements published during the period 2013-2017. The descriptive statistics of all inputs and outputs are listed in Table 1.

4.1 Two-Stage Production Process

Today, data envelopment analysis is widely used to measure the relative performance of a set of decision units operating similar inputs to produce similar outputs. The results of these measurements show how each decision unit operates in converting inputs into outputs. One important issue of inefficient units is what the factors that create these deficiencies are.

In order to answer this question, most efforts have been spent on the breakdown of the overall efficiency of constructive components so that they can identify deficient sources. A type of differentiation focuses on the DEA model structure. This study investigates the efficiency of performance in a two-stage production process, which is the outputs of the first stage, the inputs of the second stage, and differs from previous works which consider the process of total production and the two sub-processes independently. This study considers the disciplinary connection between the two processes in the measurement of efficiency. As observed in Fig. 1, the stable operation of companies, into two sub-process, have divided, which includes the profitability (first phase) and the value, creativity (the second phase), that is, the outputs of the first stage are inputs for the second stage, which can be used to identify the status of the company's operations and potential for future growth. This study matches the two - step conversion process of Seiford and Zhu's [34] makes a more accurate two - step innovation ratio by replacing market functionality by replacing values in the second stage as well as replacing the variables with a ratio.

In the first phase, there are two inputs consist of (X_1 : total liability ratio; X_2 : total equity ratio) to produce two outputs (Y_1 : return on asset (ROA); Y_2 : return on equity (ROE)), which are deemed as inputs to the second stage to produce two outputs, also named as intermediate variables. Both inputs and outputs are first introduced to assess the efficiency of the use of assets as well as resolving the overlap problem between assets and stocks. Profitability in this phase is measured. The total liability ratio (X_1) 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 (X_2) 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 the 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 phase, 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 phase composed of two-inputs (Y_1 : ROA; Y_2 : ROE) and two-outputs (Z_1 : book-to-market equity ratio (B/M); Z_2 : earnings to price ratio (E/P)) to

reflect a company's future growth. Overall, the total value of the company is made up of its ability to generate profits and its attractiveness on the stock market, which reflects the firm'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) has been defined as value stocks and others as growth stocks [14].

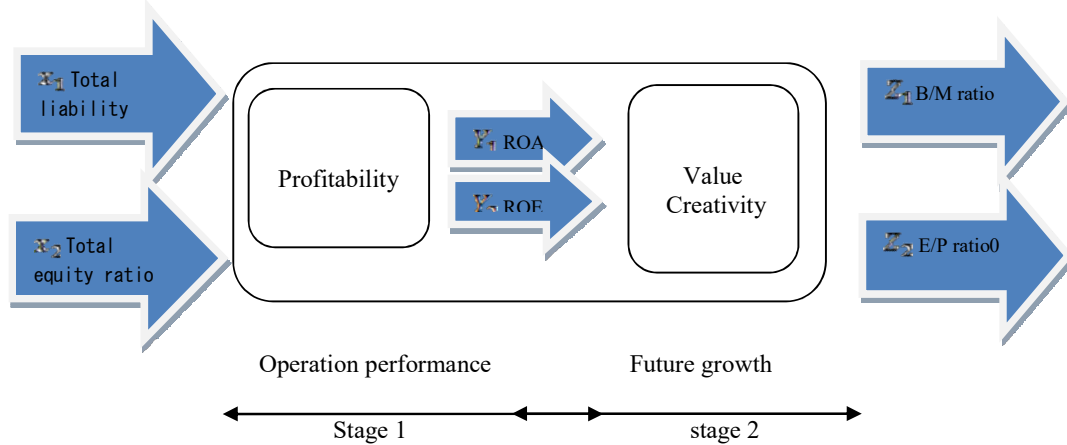


Fig 1: Model Process Steps

Stattman [36] showed that firms with high B/M equity ratios outperform those that have low B/M equity ratios. Basu [6] 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 research, it can properly reflect the relationship between the two variables with future growth of the company in a more solid manner.

4.2 The Fuzzy Multi-Objective Two-Stage Model

Data Envelopment Analysis is a powerful tool for evaluating the performance of organizations in their relative performance conditions [13]. The data envelopment analysis model is a method that computes the relative performance of a set of decision - making units using inputs and outputs and classifies the units investigated in the efficient and inefficient units. In fact, the data envelopment analysis (DEA) for a given set of input and output variables assigns a certain score to each of the surveyed units. In this method, the efficient boundary is made experimentally and then, the units stationed on the border are known as efficient units and units located below the border as inefficient units. The two-stage DEA model is, in fact, a modification of the data envelopment analysis model by considering two subs - processes within the entire process. With this framework, the efficiency of the entire process can be decomposed into two subs - 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 DMU_j ($J = 1, \dots, n$), m inputs x_{ij} ($I = 1, \dots, m$) are used to produce intermediate products z_{pj} ($P = 1, \dots, q$) in the first process and are then consumed in the second process to generate outputs y_{rj} ($R = 1, \dots, s$). For this study, we transform the relational two -stage DEA model into the multiple objectives network DEA model, called Model (1).

We adopt Zimmermann's [39] 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 θ_k that is substantially larger than or equal to some value of p " and can be quantified by the corresponding membership function.

$$\begin{aligned}
 \theta_1 &= \max \frac{\sum_{r=1}^s u_r y_{r1}}{\sum_{i=1}^m v_i x_{i1}} \\
 \theta_2 &= \max \frac{\sum_{r=1}^s u_r y_{r2}}{\sum_{i=1}^m v_i x_{i2}} \\
 \theta_n &= \max \frac{\sum_{r=1}^s u_r y_{rn}}{\sum_{i=1}^m v_i x_{in}} \\
 \text{s.t. } & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \\
 & \frac{\sum_{p=1}^q n_p z_{pj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \\
 & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{p=1}^q n_p z_{pj}} \leq 1 \quad j = 1, \dots, n \\
 & u_r, n_p, v_i \geq \varepsilon > 0, \quad r = 1, \dots, s; \quad i = 1, \dots, m; \quad p = 1, \dots, q
 \end{aligned} \tag{1}$$

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:

$$f_j(\theta_j) = \begin{cases} 0 & \text{if } \theta_j \leq \theta_j^l \\ \frac{\theta_j - \theta_j^l}{\theta_j^u - \theta_j^l} & \text{if } \theta_j^l \leq \theta_j \leq \theta_j^u \\ 1 & \text{if } \theta_j \geq \theta_j^u \end{cases} \tag{2}$$

Where θ_j is the efficiency value of the Model (1), θ_j^u , θ_j^l , denote the maximum and minimum of the objective functions, respectively.

$f_j(\theta_j)$, is the membership function of θ_j , which refers to the level of achievement of the efficiency ratio for the DMU_j ($j = 1, \dots, n$). 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 the transformation of the membership function, $f_j(\theta_j) = 1$ is definitely the highest achievement and $f_j(\theta_j) = 0$ 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).

$$\max_{u,v,n} \min_j^n f_j(\theta_j) \tag{3}$$

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

$$\begin{aligned} \max_{u,v,n} \quad & \min_j^n f_j(\theta_j) \\ \text{s.t.} \quad & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \end{aligned} \tag{4}$$

$$\begin{aligned} & \frac{\sum_{p=1}^q n_p z_{pj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \\ & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{p=1}^q n_p z_{pj}} \leq 1 \quad j = 1, \dots, n \\ & u_r, n_p, v_i \geq \varepsilon > 0, \quad r = 1, \dots, s; \quad i = 1, \dots, m; \quad p = 1, \dots, q \end{aligned}$$

$$\begin{aligned} \max_{u,v,n} \quad & \lambda \\ \text{s.t.} \quad & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \\ & \frac{\sum_{p=1}^q n_p z_{pj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, n \\ & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{p=1}^q n_p z_{pj}} \leq 1 \quad j = 1, \dots, n \\ & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \geq \lambda \quad j = 1, \dots, n \\ & u_r, n_p, v_i \geq \varepsilon > 0, \quad r = 1, \dots, s; \quad i = 1, \dots, m; \quad p = 1, \dots, q \end{aligned} \tag{5}$$

$$\begin{aligned} \max_{u,v,n} \quad & \lambda \\ \text{s.t.} \quad & \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0, \quad j = 1, \dots, n \end{aligned}$$

$$\begin{aligned}
\sum_{p=1}^q n_p z_{pj} - \sum_{i=1}^m v_i x_{ij} &\leq 0, & j = 1, \dots, n \\
\sum_{r=1}^s u_r y_{rj} - \sum_{p=1}^q n_p z_{pj} &\leq 0, & j = 1, \dots, n \\
\sum_{r=1}^s u_r y_{rj} - \lambda \sum_{i=1}^m v_i x_{ij} &\geq 0, & j = 1, \dots, n \\
u_r, n_p, v_i &\geq \varepsilon > 0, & r = 1, \dots, s; \quad i = 1, \dots, m; \quad p = 1, \dots, q
\end{aligned} \tag{6}$$

Since $\theta_j \in [0, 1]$ for any DMU, the membership function of the Model (4) can be simplified as $f_j(\theta_j) = \theta_j$. Then, by introducing an auxiliary variable λ we obtain the equivalent Model (5). Through simple transformation, Model (5) can be rewritten as the equivalent conventional mathematical programming problem as Model (6). The bisection method (Sakawa and Yano, [32]) can be applied to solve the linear 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 the model (7).

$$\theta_j^F = \frac{\sum_{r=1}^s u_r^* y_{rj}}{\sum_{i=1}^m v_i^* x_{ij}} = \frac{\sum_{p=1}^q n_p^* z_{pj}}{\sum_{i=1}^m v_i^* x_{ij}} = \frac{\sum_{r=1}^s u_r^* y_{rj}}{\sum_{p=1}^q n_p^* z_{pj}} = \theta_j^{F1} \times \theta_j^{F2} \tag{7}$$

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

4.3 Truncated Regression

Instead of applying Tobit regression to investigate exogenous factors that affect a firm performance, we use truncated Regression. Truncated regression models arise in many applications of statistics, for example, in Econometrics, in cases where observations with values in the outcome variable below or above certain thresholds are systematically excluded from the sample. Therefore, whole observations are missing, so that neither the defendant nor the independent variable is known. Truncated regression models are often confused with censored regression models where only the Value of the dependent variable is clustered at a lower threshold, an upper threshold, or both, while The value of independent variables is available. Estimation of truncated regression models is usually done via parametric, semi-parametric and non-parametric maximum likelihood methods [27]. We use truncated regression to examine external factors that affect firm performance.

$$\theta_j^F = \alpha + Z_j \delta + \varepsilon_j \quad j = 1, \dots, n \tag{8}$$

In Eq. (8), α is the intercept, ε_j , is the residual value and z_j , is a vector of observation-specific variables for firms that we expect it is related to the firms overall efficiency score which is proxy by θ_j^F . Since the distribution of ε_j , is restricted by the condition $\varepsilon_j \geq 1 - \alpha - Z_j \delta$, Eq. (8), is modified to get Eq. (9), which assumes that the distribution before truncation is truncated with zero mean, un-

known variance and a truncation point, which are determined by different conditions:

$$\hat{\theta}_j^F \approx \alpha + Z_j \delta + \varepsilon_j \quad j = 1, \dots, n \tag{9}$$

Where

$$\varepsilon_j : N(0, \sigma_\varepsilon^2), \text{ Such that } \varepsilon_j \geq 1 - \alpha - Z_j \delta, \quad j = 1, \dots, n$$

The regression process of parametric bootstrapping is used to construct the bootstrap confidence intervals for the estimates of parameters $(\delta, \sigma_\varepsilon^2)$ and to estimate Eq. (9), by maximizing the corresponding likelihood function, and give heed to the $(\delta, \sigma_\varepsilon^2)$.

4.4 Managerial Ability

Managerial ability is an important characteristic which firms consider to the employment and pay the compensation because of managerial ability can affect the optimal use and allocation of resources. The able manager makes a decision to maximize the firm value. To reach this aim, able manager does continually strategic deciding and planning with direct to raise the firm value [2]. In order to measure the performance of the company, Demerjian et al [10] used a data envelopment analysis model. The data envelopment analysis model is a statistical model used to measure the performance of the system using input and output data. The first step requires estimating firm productivity scores, which is defined as the ratio of outputs over the inputs using the following DEA optimization problem:

$$\max_v \theta = \frac{\sum_{i=1}^s u_i y_{ik}}{\sum_{j=1}^m v_j x_{jk}}, \quad K = 1, \dots, n \tag{10}$$

In Eq. (10), s , is the outputs, m is the inputs, and n is the number of firms, while u and v represent the respective weight for the outputs and inputs, which is necessary to calculate the firm efficiency score. In this study, to measure the ability of managers using the model provided by Demerjian et al.

1) First, the performance of the company was measured using data envelopment analysis method and considering the sales variables, total sales prices, general costs, administrative and distribution and sales, fixed assets, operating leases, research and development costs, and intangible assets. As a result, the following optimization relationship was resolved in order to measure the performance of firms.

$$\max_v \theta = \frac{\text{sales}}{v_1 \text{COGS} + v_2 \text{SG \& A} + v_3 \text{PPE} + v_4 \text{OPSLease} + v_5 \text{R \& D} + v_6 \text{Goodwill} + v_7 \text{OtherIntan}} \tag{11}$$

The Ops Lease, PPE, R&D and Intant variables in the above relation were calculated based on the value of the first year it of measurement and CGS and SG&A variables according to over year t.

2) The ability of management was calculated using the efficiency obtained in the first step and the following regression equation.

$$\begin{aligned} \text{Firm Efficiency}_i &= \alpha + \beta_1 \ln(\text{Total Asset})_i + \beta_2 \text{Market share}_i + \beta_3 \text{Free Cash indicator}_i \\ &+ \beta_4 \ln(\text{Age})_i + \beta_5 \text{Business Segment Concentration}_i \\ &+ \beta_6 \text{Foreign Currency indicator}_i + \text{year}_i + \varepsilon_i \end{aligned} \tag{12}$$

In regression Eq. (12), the residual term (ε_i) , is our measure of managerial ability.

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 the 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. [25]. Accordingly, the input and output variables in a two-step DEA the Table 2 in order to have calculations.

5 Analysis and Findings

5.1 Measuring Profitability and Value Creativity Performance

In this study, 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 aim of measuring performance is to identify poor regions of an organization so that appropriate efforts can be devoted to improving performance. This study creates a decision matrix in which the vertical axis represents the efficiency of profitability (θ_j^{F1}) and the horizontal axis demonstrates the efficiency of value, creativity (θ_j^{F2}) resulting in a combination of the efficiency of these two sub-processes.

Table 2: 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	The 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

Table 3 shows that if the solution obtained for a single unit is 1, it means that the unit is under consideration (DMU), efficient, and if its value is smaller than 1 or equal to 0, the unit is under an inefficient check. Table 3 also shows the efficiency score of the two sub-processes (θ_j^{F1} and θ_j^{F2}) and the efficiency of the whole process (θ_j^F) the last row shows the mean of all measures. The mean of θ_j^{F1} , being greater than that of θ_j^{F2} , and the overall efficiency is not one. The overall efficiency does not reach 1 due to the inefficiency embedded in one of the two sub-processes. Overall, these firms are relatively efficient in terms of production, but they need to maintain their policies from further growth in order to increase the efficiency of value creation. In this way, sustainable development can be applied. Of course, the overall performance of none of the firms is equal to 1, and none of them have achieved

optimal performance in both subs - processes, so we analyze their efficiency scores to find out the overall inefficiency. To achieve a maximum performance in stage one or two we found that they have applied and changed resources effectively, but they are not efficient 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 companies, 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.

Table 3: 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
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	S0	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

The results show that the two - stage data envelopment analysis model identifies the causes of inefficiency and provides a joint index for performance evaluation and increases management insight against firms ' performance.

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 creation

5.2 Relationship between Managerial Ability and Firm Performance

We adopt one variable (i.e., managerial ability) and truncate regression in order to explore the relationship between managerial ability and firm performance. We estimate the following truncated-regression model:

$$\theta_j^F = \alpha + \beta_1 Ma_i + \varepsilon_i \quad (13)$$

Where θ_j^F , is the empirical result of the operating performance of the fuzzy multi-objective two-stage model and Ma is managerial ability. The results of truncated-regression model analysis are displayed in Table 4. According to the table is P-Value ≤ 0.05 , in the other words, the independent variable is significantly related to the firms' operating performance. Management can be able to undertake and carry out suitable tasks and processes and produce novel services, and thus create value for the company through enhancing the use of resources [23]. In fact, managers and their management interests, share a common role in the success of the companies. In other words, the success of the enterprise requires effective employment and the efficiency of its resources by the manager. If a company manager fails to do so, the company finally feels he will face it.

Table 4: Results of Truncate-Regression Models

Variables	Coefficient	Std. Error	Z-statistic	P-value
INTERCEPT	-1.186233	0.362224	-3.274860	0.0011
Managerial ability	1.526680	0.482830	3.161941	0.0016

5 Discussion and Conclusions

The primary objective of this paper is to examine the associations between managerial ability and firm performance. We examined 60 firms listed on the Tehran Stock Exchange was treated as a decision making unit (DMU). We primarily obtained input and output data from Tehran Stock Exchange data base and from Financial Statements published during the period 2013-2017. Firm efficiency could be used to assess managerial ability; however, this measure captures both firm specific and manager-specific efficiency drivers, and thus it likely overstates or understates managerial ability, depending on the firm-specific efficiency drivers. For that purpose, to get managerial ability we utilize the measure of managerial ability (MA score) developed by Demerjian et al, [21]. In this study, we introduce an innovation ratio two-stage DEA model, together with the fuzzy multi-objective programming approach, different from the traditional model to calculate the efficiency score. In this stage, the sustainable operation process of the company is divided into two sub-processes, namely, profitability, per-

formance and value creativity, performance, that is, the outputs of the first stage are inputs for the second stage, so as to identify the company operation status and potential for future growth. 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 creative performance, to assess the efficiency of companies listed on the Tehran Stock Exchange. Second, the two-stage DEA model, combined with the fuzzy multi-objective programming approach can thereby increasing discriminating power and simplifying the calculation process. More importantly, this approach can more accurately identify sources of inefficiency in companies. Finally, the links between managerial ability and firm performance are also investigated by means of the truncated-regression model. The results show that there is a positive relationship between the ability of management and firm performance. It means that managerial ability to be significantly related to the performance of the company. In this sense, the performance of the company improves by increasing managerial ability to better use resources and consequently increase overall efficiency. The results of this study are consistent with the findings of the research carried out by Chen et al. [8] and Andreou et al. [3] They believe that management's ability has a positive and significant impact on firm performance and value. We propose that a firm's managerial ability is useful to curtail under investment problems through gaining access to more resources that enhance firm value. Therefore, investors and managers using the optimal model of information, analysis presented in this research can identify efficient and inefficient enterprises and use it to reduce the risk of inappropriate investment and selecting the optimal portfolio. In addition, due to the importance of information, analysis related to managers' ability as a supplement of financial ratios of companies, accountants, information processing companies and investment consultant companies in the stock exchange, they are better prepared to provide information for investors and managers on the stock exchange.

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