Study of the Firms Size Effect on Their Efficiency Based on DEA Approach (Case Study: Firms in Tehran Stock Exchange During 2007 to 2011)

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Abstract

Investors and creditors expect that the performance of the firms, which they invested in them, proceed according to their expected conditions and their performance evaluation of the firms based on their type and size. Because of owners and shareholders multiplicity, direct monitoring on firm performance is not possible by shareholders, but this group can only receive benefit from performance evaluation from the firm. Therefore it is logical that by creating firm evaluation mechanisms they are up to maintane their benefit. This research studies the effect of firm size on its efficiency in the firms of Tehran Stock Exchange during 2007 to 2011 with the sample of 75 firms. For this purpose, the Data Envelopment Analysis technique has been used as the firms efficiency evaluation criteria and the amount of firm sale determined as the firm size. The results revealed a significant inverse relationship between efficiency and the size of firm.

Resumen

Los inversores y acreedores esperan que el rendimiento de las empresas en las cuales han invertido resulte en consonancia con sus expectativas y con su evaluación del desempeño de las empresas en concordancia con su tipo y tamaño. Debido a la multiplicidad de propietarios y accionistas no es posible un control directo por parte de estos sobre el rendimiento de las empresas, y tan sólo reciben reportes de evaluación del rendimiento por parte de la propia empresa. Por lo tanto, resulta lógica la creación de mecanismos de evaluación de cara al mantenimiento de su beneficio. Este trabajo estudia el efecto del tamaño de la empresa en la eficiencia en las empresas en la bolsa de valores de Teherán durante el período 2007 - 2011 con un muestreo de 75 empresas. Para ello, se ha utilizado la Técnica del Análisis Envolvente de Datos como criterio de evaluación del rendimiento de las empresas y el volumen de venta en relación al tamaño de la empresa. Los resultados revelaron una relación inversa significativa entre la eficiencia y el tamaño de la empresa.

Keywords: Efficiency, Data Envelopment Analysis, Firm size, Iran
Jel: L25, G30

1 Introduction

To attentively progress and meet goals and strategies, investors and creditors have to correctly manage and lead affairs. Succeed in such process would depend on continuously evaluating and improving company's performances. Based on assessing companies regarding fast upheavals and hike in their powers and capabilities in today world, there are a large number of studies and research carried out on performances. These studies are indicators of major differences in similarity of capacities and capabilities. As main owners of companies, shareholders seek to increase their assets through companies' desirable performances and minimizing the available resources. There are many factors bringing about volatility in financial environments including reduction of the life cycle of products, the effects of technology on companies' performance, loss of productivity, loss of liquidity, development of global exchanges, etc. In this state, to maintain and build up their wealth, investors and creditors look for information about the performance of companies and some criteria to evaluate them.

The traditional profit-based criteria have recognized defects the important of which is being manipulated by various accounting procedures and reliance on the limiting principles of conservation and retrospection. Thus, it is necessary to find some new parameters in order to sensibly study companies' performance. In this regard, data envelopment analysis (DEA) is considered as a new way to do this. The main effect of this technique is that all previous variables for assessing performance are simultaneously or individually included. In such models, raw accounting data, financial ratios, economic variables, and nonfinancial data and factors can be used (Musavizadeh, 2010). So, data envelopment analysis technique is based on freely comparing different companies active in a certain environment. Using a quantitative approach for evaluation of companies performances, this technique creates the possibility of considering all dimensions of performances to present a single criterion for evaluation of performance and condition of companies. Accordingly, we can say that data envelopment analysis technique is a step toward creating new methods for quantitative analysis in financial researches.

To determine the effect of company's sizes and efficiencies, this research is aimed at using data envelopment analysis technique as a criterion to evaluate company's performances and its relation with size. This helps gathering sufficient information about the possibility of identifying good investment opportunities for creditors and investors. To do this, a statistic sample of 75 companies from Tehran Stock Exchange during a period of 2007 to 2010 was studied. This

research is carried out in this way that after deciding on theoretical principles and research background, hypothesis and research methodology, variables are introduced and the method of calculation is presented. The relationship between research variables are then checked besides referring to test stages of research hypotheses and descriptive statistics. Since the research hypothesis on significant relation of variables is accepted, inefficient companies should present issues and finally political offers to become efficient and be rated based on the level of efficiency, reference units (model) and the level of being affected by them.

2 Theoretical Principles

In late 1980s, input resources and profit of companies were identified as the reasons for available differences between companies' performance. In recent decades, research on efficiency has been developed and in practical environments, complicated techniques have been employed. Having studied all effective factors on efficiency, Groksy (1998) suggested that company size had indirect effect on its efficiency. Based on this subject, one of the main problems is using an appropriate approach to evaluate the effects of various traits of companies on their efficiencies. The other one is considering an appropriate model to determine their efficiency with regard to different variables in large and small companies (Groksy, 1998, quoted by Halux and Tezerms, 2006, p 22).

Many studies have been carried out for calculating the rate of efficiency and various methods have been offered. In evaluating performances, proposed approaches are classified in two groups of boundary and non-boundary approaches. Having more popularity, boundary approaches include five important insights such as DEA, FDH, SFA (EFA), TFA, and DFA two of which are known as nonparametric and the other ones as parametric methods. To estimate the boundary of efficiency, nonparametric methods relate to experimental data and consequently the boundaries are extracted from experimental data. However, in parametric methods, efficiency is estimated by statistical techniques and econometric methods. Accordingly, nonparametric methods, such as DEA in particular, is the simplest and most efficient way of evaluating units, because this method requires no primary hypothesis about the form of production function and efficient boundary (Wu, 2006). Data envelope analysis was first offered by Charnz, Cooper, and Rudz in 1978 for evaluating the educational progression of students at USA state schools. In this model, a constant return to scale is considered. In 1984, Benker, Charlz and Cooper generalized CCR to return to scale and it was called BCC. In this model, the return to scale is variable and may be incremental, constant, or subtractive (Aboulhasani, 2010, p 77). After presenting this basic model in DEF, the frequency was studied both in developing new models and in applying these models for evaluating the performance. This method was experimentally used in many

settings such as evaluating schools (Charnz et al., 1981), employment sectors (Levin and Moorie, 1981), criminal courts (Levin, et al., 1982), fast food restaurants (Benker and Moorie, 1986), hospitals (Benker and Moorie, 1986), university branches (Tomkinz and Greene, 1988), pharmaceutical companies (Smith, 1990), sectors for vehicle maintenance (Clarke, 1992), and bank branches (Mohammad Mostafa, 2007) (Cooke, 2009), (Abolhasani, 2010, p 77).

There are various approaches to determine the size of companies and various parameters are considered as company sizes. The reason for such approaches is people's viewpoint about balance sheet. And the main size parameters include the total sale per year, total asset and stock exchange value. In the following section, each parameter is individually introduced.

A. Total sale per year: as sale volume is affected by the structure of company, the volume of investment, company's capacity in drawing customers and other factors relating to company's performance in classifying companies into large, small and medium groups, some accounting and financial specialists considered total sale per year as size of company.
B. Total assets: some other researchers mostly in accounting area attend more to the right side of balance sheet. They believe in using total asset recorded in company's balance sheet to calculate the size of company. It should be noted that in inflationary state of Iran, balance sheet is provided based on the actual price. Such base produces an illogical size.
C. Stock exchange value: as attending to the left side of balance sheet, specialists in financial management area think that the size of company is stock exchange value. Using such parameter is suitable when stock values are determined in a competitive and dynamic market and not affected by unrelated factors. As in the period of doing this research, stock value of companies listed in Tehran Stock Exchange swung sharply; selecting such parameter would not be suitable.

3 Research Background

3.1 Foreign Researches

In a research, Haloks and Tezermes (2006) studied the relation between efficiency and company size. There were 395 companies with different levels of foreign ownership being active in Greece production sector. The needed data was obtained by annual reports of companies in

1995 to 2001. To calculate the rate of efficiency, they used input data envelope analysis with variable return to scale, used liquidity ratio, and number of staff, tangible fixed assets, intangible fixed assets, and percentages of foreign ownership as model inputs, and employed net sale and profit margin as model outputs. In this study, companies were classified into three groups of small, large and medium size companies. 252 companies were identified as small, 101 companies as medium and 42 companies as large. They found out that growth in efficiency and productivity of small foreign-owned companies is higher than medium and large companies. The more flexibility and organization in small companies were recognized as the reason of reacting to the variable structure of market and customer's interests.

In another research, Dozakin (2006) studied the performance of manufacturing companies by data envelope analysis. There were 480 companies listed in Turkey Stock Exchange and the required data obtained from 2003 reports released by these companies. To calculate the level of efficiency, output data envelop analysis with constant return to scale was used. He considered assets (book value of asset) and the number of staff as two inputs and gross value added, profit before tax, and export earnings as three outputs of this model. He stated that nine companies had efficient performance and nine companies had high grade and rate in 2003. This general analysis was carried out in 12 industries and 65 companies were introduced efficient.

3.2 Local Researches

Vahedian (2009) studied companies' efficiency based on data envelope analysis and ability to pay liabilities in due date. In this research, the accuracy and validity of results were tested by data from two groups of manufacturing companies listed in stock exchange and seven selected financial ratios. First group composed of forty companies under financial crisis and the second one included 40 companies without financial crisis. Statistical results showed that there is a significant correlation between efficiency calculated by DEA and the companies' ability to pay liabilities in due date.

Based on DEA, Mosavizadeh (2000) studied the relation between companies' efficiency and their stock return in 2003 to 2007. To increase the validity and reliability of results, efficiency were calculated in two stages, one in each industry and then in manufacturing companies. The results from industries individually indicated that machinery and equipment industry for manufacturing metallic products had the highest rate of efficiency and the lowest one belonged to automobile industry. Results from general analysis (2007) revealed that among the 98 selected companies, Sinadaroo Company had the highest efficiency and Ghazvine Shisheh Company had

the lowest. Regression analysis of the relation between efficiency and stock return also showed that there was a significant relation.

4 Research Hypothesis and Methodology

The subject of this research is this hypothesis that “based on data envelop analysis, there is a direct and significant correlation between the companies’ size and efficiency.”

In using DEA, efficiency of an operational unit is basically supposed as a decision-making unit. It is evaluated at low level when another decision-making unit with less resources comparing with under studied unit produces the minimum equivalent of that unit and vice versa. Thus, the main advantage of DEA in measuring efficiency over the traditional method is making decision regarding particular environmental and economic factors of these units. On one hand, DAE results in technically measuring the efficiency, and on the other hand, determines the required adjustments to turn an inefficient unit to an efficient one (Zarei, 2000). Regarding the available variables and the number of observations, this research was of cross sectional type. And as actual and historical information was used, the applied data can be classified as post-event. Since there is no exhaustive and prevalent theoretical model for the relation of size and efficiency, variables were defined based on an analog model. As there are two variables of independent (size) and dependent (efficiency), their correlation was studied by using a simple linear regression model. Presenting a DEA as a technique for efficiency-based rating of companies, this research is used to design the scoring systems of efficiency or determining different sections of a company.

5 Statistical Population and Sampling Method

The research statistical population includes all companies listed in Tehran Stock Exchange in time period of 2007 to 2010. To select the statistical society, the following conditions were considered:

1. Due to the necessity of information for the research time schedule, the selected companied had to be listed before 2007.
2. The selected companies are just those had been listed from the beginning of 2007 to the end of 2010.
3. The companies in statistical population should be the manufacturing ones.
4. To have similar financial period for sample companies, the end of financial year should be at the end of March.
5. To prevent from spam data, companies should not have loss and negative net cash flow.

6. Dividend has been considered for sample companies for under studied years.

Four hundred and thirty three companies have been listed in Tehran Stock Exchange since early 2007 that 358 companies are active in manufacturing. As efficiency is calculated based on annual performance, sample companies should be in similar financial periods. So, 327 companies had financial year ended in late March. In the next stage, three factors of loss, negative cash flow and dividend were applied for each year. The companies with dominant conditions of sample ones were then selected. Finally 75 companies were selected as ones having the required terms. The time schedule is five years from April 2007 to the end of March 2010.

6 Research Variables

Undoubtedly, size determines the volume and broadness of a company's activities. Due to access to product markets and saving production factors, larger companies face fewer commercial risks and show more resistance to commercial distresses. So, larger companies are expected to undergo fewer risks. To calculate the size of companies, criterion such as total assets, stock exchange value, total sale, number of staff and capital can be used. Due to time based actual price of assets and incongruity of acquiring time, sale volume (Rial) is employed to measure the size. Data includes net cash flow, operational costs, sale volume, net operational earnings, operational profit, and dividend gathered from information of financial statements obtained from Tadbir-Pardaz Information Bank. After gathering data about the sale volume of sample companies, data were collected to calculate the independent variable (company size) by specifying the level of sale and classifying it based on sale price. Data was also gathered for calculating dependent variable (company efficiency) by input data envelop analysis and variable return to scale.

6.1 Companies' Size

As said in theoretical principles, there are various approaches in determining the size of companies and many parameters are considered in this regard. The reason for such differences is approaches resulting from people's viewpoints about balance sheet. The main parameters of companies' size include: total sale per year, total assets, and stock market value. Regarding what explained in the section of theoretical principles, total sale per year was considered as dependent variable.

6.2 Companies' Efficiency

In this research, dependent variable is efficiency measured based on the efficiency score of DEA model. To calculate the efficiency score in similar researches, two methods of input oriented and output oriented of Benker, Charz, and Cooper were more attended. Due to emphasis on output, output oriented model of Benker, Charz, and Cooper was used.

6.2.1 Calculation of Efficiency Score

To calculate the efficiency score, all sample companies should be considered as an independent decision-making unit (in case of using similar sample, using companies being active in a particular industry would bring about better results. This would come along with less generalized results). After determining the unit of decision-making, the main point is defining inputs and outputs of model to be able to judge them and select the best DEA model. Selecting data and outputs should be based on a conceptual insight. With an operational approach, inputs and outputs can be defined as follow: "factors that companies try to minimize them based on this fact that outputs are fixed are inputs; and factors that companies try to maximize them are outputs." Despite of various financial and non-financial factors can be considered as data and outputs of a manufacturing company, selection of data and outputs are limited to financial information offered by companies according to their financial statement and non-financial information does not matter. Factors such as total assets, fixed assets, total liabilities, working capital, operational cash flow, number of staff, and operational costs are considered as input, and factors such as sale volume and earning resulting from services, gross value added, profit margin, net and operational profits, dividend, export earning. In this research, by considering research background and asking experts and specialists, several input and output variables were selected as follow:

1. Operational net cash flow as resources of decision-making unit during financial period (as second input)
2. Operational costs as applied resources during financial period (as the second input)
3. Total sale and total net revenues indicating the process of earning money (as first output).
4. Operational costs to show the results of casual and continuous operation during the financial period (as the second output).
5. Dividend showing shareholders' earnings from acquired resources during the operational process of company (as the third output).

To increase the rate of productivity and efficiency, companies should manage their data and outputs. However, due to some limitations such as consistency of input resources of companies and as reduction of a part of input without changing other inputs or rules is impossible, maintaining the minimum resources including assets, number of staff and etc. and achieving more efficiency is not simple. Also, regarding the correlation between inputs and outputs, the ratio of change in inputs does not make similar changes in outputs. Return to scale model, one of which is BCC, seems a suitable model. Thus, in this research, efficiency of companies was calculated by output oriented variable return to scale.

6.2.2 Efficiency concept and its place in data envelopment analysis (DEA)

DEA in terms of economic theory, efficiency is the result of optimizing of production and allocation of resources. In other words, in a manufacturing unit, managers and laborers, according to the firm's objectives and the technological capability, attempt to determine the amount of output in such a way that while using up resources and optimum allocation of expenses, use factors of production (capital and labor) optimally (Oryani quoted Vahedian, 1388: p 9). In this method, after determining the efficient frontier it is indicated that where the decision-making units in this boundary are and what combination of inputs and outputs should be selected to achieve the efficient frontier, this is not possible without specifying the input and output values for each unit. Indeed a masterpiece and a milestone in the above method, has been the fact that it was able to calculate the linear programming methods of the above coefficients (Emami Meibodi, 1379: p 113). Efficiency of a unit means comparing its inputs and outputs but in most cases the decision-making use multiple inputs to produce multiple outputs this makes it difficult to calculate the measurement of efficiency and effectiveness, in this case, efficiency is defined as follows.

(Sum of weighted input) / (sum of weighted outputs) = efficiency

But in most cases, coefficients (price or value) of data and output are unclear or outputs have different scales, in these cases data envelopment analysis can be used. Data envelopment analysis is one of nonparametric approaches based on mathematical programming that makes it possible to assess the efficiency of similar decision making units which have multiple data and outputs. In this method at first the efficient frontier is created using some linear programming based on optimization. It is then determined whether or not the evaluated units are on the efficient frontier and thereby efficient and inefficient units are separated, this will be possible by determining the values of inputs and outputs for each decision making unit (Emami Meibodi, 1379: p 118).

In this method, input and output coefficient for each operating unit that is called a "decision unit" is determined in such a way that its efficiency will be maximized. In such circumstances, an operating unit is considered low efficient if another decision making unit with fewer resources produces at least equal to that unit's output, compared to the under study unit. And conversely, the efficiency of a decision making unit will be evaluated high if the above condition does not established (input centered vision). Also, it could be argued that the efficiency of a decision making unit will be evaluated low if another decision making unit with the same resources, compared to the under study unit produces at least equal to that unit's output and vice versa, the efficiency of a decision making unit will be evaluated high if the above condition does not established (output centered vision) (Moosavizade, 1389: p51). For each of these two perspectives, a different model based on data envelopment analysis is used.

7 Testing the hypothesis Steps

For the calculation of the research variables, using Excel software the necessary calculations have been performed on the raw data. To test the hypotheses (after calculating descriptive statistics of research variables), the Pearson correlation coefficient and determination coefficient were used to describe and evaluate correlations between research variables, then the significance of correlation coefficient was tested by t-test. The calculated P-Value using SPSS software was used to test the significance of the correlation coefficient, If P-Value is greater than the desired error level α, the resulting coefficient is not significant, and the hypothesis $H_0 : \rho = 0$ cannot be rejected. Similarly, if P-Value is smaller than the desired error level α, the resulting coefficient is significant, and the hypothesis $H_0 : \rho = 0$ is rejected. So, the resulting correlation coefficient is significant enough that the probability of raising it due to the random variations is small thus its result can be generalized to the population.

The regression line equation is used to determine the need for explanation and the possibility to extend the results to the community sample, the next step should be done more accurately to ensure the test. Regression model is assessing the effect of independent variables on the dependent variable. At this stage, using ANOVA and linear regression coefficients table, significance of model coefficients was calculated using P-Value it is investigated in the desired error level α.

7.1 Descriptive statistics

Before testing the hypotheses, the calculated descriptive statistics; including mean and standard deviation of variables are shown in the following table.

Table 1) Descriptive statistics

Variables	obs	min	max	mean	sd	var
Dependent Variable(Size)	365	4.43	7.72	5.5162	0.6161	0.38
Independent	365	0.07	1.00	0.3619	0.1453	0.02

7.2 Regression models and hypothesis testing

The following regression model is a linear equation the firms' sales is dependent variable and firms' efficiency (calculated by DEAP-Version 2.1) is the dependent variable, β_0 is the constant value, β_1 is independent coefficient and ε is the model error which is expressed as:

$$Y = \beta_0 + \beta_1(X) + u \qquad (2)$$

In the above equation, Y is the dependent variable (firm performance) and X is the independent variable (firm size).

For hypothesis testing, correlation between variables is tested, regression model and variance analysis test has also assessed. Finally, we will examine the presuppositions of the model. Therefore, to test the hypothesis, we state the hypothesis in statistical basis as follows.

There is no significant direct relationship between firm size and its performance based on DEA model, it means:

$$H_0 : \rho(X,Y) = 0 \qquad (3)$$

There is a significant direct relationship between firm size and its performance based on DEA model, it means:

$$H_1 : \rho(X,Y) \neq 0 \qquad (4)$$

In order to evaluate and comment on the above hypothesis, significance test of the regression and coefficient tests are computed and if the non-zero coefficients associated with the

independent variable will be proved the null hypothesis is rejected and the alternative hypothesis is accepted.

8 Hypothesis testing

As can be seen in the scatter plot, the overall shape of the observations is as a mass with a negative slope and some points with performance equal one are observed one at the top of the plot.

These points, called outliers, sometimes are created and deleted due to sampling or measurement error, and possibly sometimes actual observations are affective in the model analysis and we are not allowed to remove them. These points for some companies in some years have the efficiency of one and in some years they have efficiency less than one and for the two companies it was equal one for all years (which appears it is established due to measurement or accountability error). These points as outlier (waste) points were eliminated and firms that represent efficiency of one only in some years are considered as effective outliers in the sample analysis. Considering the above**,** the two companies' data with a value of 10 has been deleted as the outlier; while the mentioned data were used after a logarithmic transformation due to the large data size (sales) of the firm. The results of the 73 companies of the 365 are presented in the following table. To test this hypothesis, at first the Pearson correlation coefficient (r) between efficiency and firm size is estimated and then tested the hypothesis that the coefficient is zero has been examined.

Table 2) Correlation Coefficient

Observations	Corr. Coef.	P-Value	Test Result
365	-0.535	0	H_0 rejecte

The correlation coefficient obtained between the theory variables shows that in the years 2007 to 2011, these two variables are correlated with each other reasonably. In 5% error level, the P-Value is calculated to zero. This output shows that during the years 2007 to 2011 correlation coefficient is significant. So in this test the hypothesis.... is rejected. As it can be seen the correlation coefficient is negative that it shows inverse relationship between variables of size and performance. Assumption of this model is the normality of the obtained errors that its validity. This assumption is expressed as follows:

$$\varepsilon \overset{i.i.d}{\sim} N(0,\sigma^2) \qquad (5)$$

Summary of model statistics to estimate the Pearson correlation coefficient (value of r) and the standard deviation obtained are presented in the following table.

Table 3) Regression Result

Period	r	r^2	Adjusted r^2
2007-2011	-0.535	0.29	0.228

As previously mentioned, the regression model includes β_0 and β_1, indicating that the independent variable coefficient and the constant value. In this section, each of these coefficients' zero value is tested. The following table represents the coefficients of the regression model and the data required to test.

Table 4) Regression Coefficients

Period	Coefficients	Estimation	SE	t statistic	P-Value
2007-2011	Intercept	1.062	0.061	17.443	0
	(β_1)	-0.127	0.011	-11.572	0

The hypothesis of this study is that the coefficient of the independent variable (firm size) in the regression model, as the relationship (2), in the years 2007 to 2011 is zero. This hypothesis is stated as follows:

$$\begin{cases} H_0 : \beta_1 = 0 \\ H_1 : \beta_1 \neq 0 \end{cases} \qquad (6)$$

In regression model if the independent variable coefficient (β_1) is zero, then the assumption of H_0 will be accepted and this hypothesis means that the independent variable (the firm size) doesn't affect the dependent variable (the firm efficiency), this test is obtained by P-Value and it is shown in table 6; if P-Value is less than $\alpha = 0.05$, then β_1 isn't zero and the assumption H_0 will be rejected and if P-Value is more than $\alpha = 0.05$, β_1 will be zero so the assumption H_0 cannot be rejected. In linear regression model, the obtained p-Value for β_1 will be less than the desired error $\alpha = 0.05$. So, the test is significant and hypothesis H_0 can be rejected. In other words, β_1 or dependent variable coefficient in this model doesn't equal zero from 2007 to 2011. This coefficient shows that the independent variable has significant effect on efficiency from 2007 to 2011. In order to ensure the accuracy of the above results, the ANOVA table for each of the regression models during 2007 to 2011, with studying the null hypothesis of the slope of the regression, was studied.

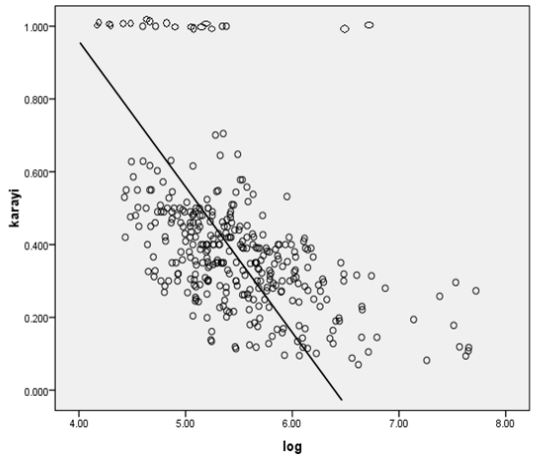
Table 5) Analysis of Variance

Period	F statistic	P-Value
2007-2011	133.909	0.0

As statistic of the variance analysis table shows, during 2007 to 2011, the test statistic F is a large number and certainly after comparing with number of Fischer table (1 and 338) degrees of freedom for the testing hypothesis that is zero slope of the regression line between 2007 to 2011, is rejected. In addition, the P-Value is zero that provides sufficient causes to reject the hypothesis. Therefore, the null hypothesis is rejected and ultimately the estimated model is as follows:

Y=1.062-0.127X (7)

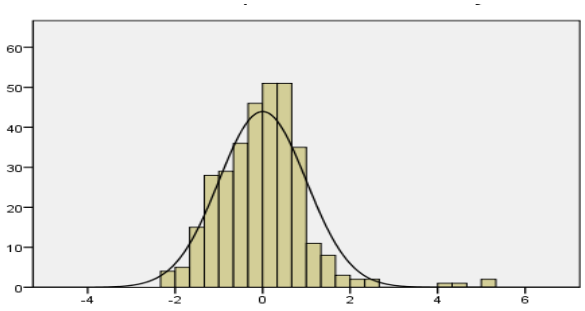
Figure1) Regression Line



8.1 Establishing prerequisites of regression model

Normally distributed errors can be shown by rectangular charts (histograms) which are plotted for errors. We can see the error rectangular chart corresponds roughly to normal charts; in fact errors are normally distributed random variables. Error terms have zero mean; mean of error terms in each year, estimated along with the chart clearly show that during 2007 to 2011 regression error is almost zero.

Figure2) Test of Normality



To investigate the lack of correlation between the residues and constant variance and regarding regression model coefficients of the regression model, Durbin - Watson test is used. In this test we will investigate and test this hypothesis in which ρ_s Indicates the consecutive correlation between the error terms that is $\rho_s = \rho_{e_i,e_j}$.

$$H_0 : \rho_s = 0$$

The statistic of the test is as follows in which e shows the considered residuals. If the value obtained for this statistic is approximately 2, the hypothesis under study cannot be rejected. Therefore, the correlation between the error terms is rejected. In general, in regression model we have:

$$Var(\underline{\varepsilon}) = (I - H)E(\underline{\varepsilon}\underline{\varepsilon}')(I - H)'$$

In which $H = X(X'X)^{-1}X'$ is called Hat Matrix. I is the identity matrix and X' is the transpose of the matrix X. *Var(ε)* is a matrix the variance values of error terms that is $\sigma_{e_I}^2$ are on its main diagonal and its i and j are $Cov(e_i, e_j)$. but we know that we have $\rho_{i,j} = \frac{Cov(e_i, e_j)}{(Var(e_i)Var(e_j))^{1/2}}$, so by accepting the above hypothesis it can be assured that the resultants are not correlated that is *Var(ε)* is a diagonal matrix in which the values of $\sigma_{e_I}^2$ are zero and out of it the values are zero.

$$Var\ (\underline{\varepsilon}) = \begin{bmatrix} \sigma_{e_1}^2 & 0 & 0 \dots & 0 \\ 0 & \sigma_{e_2}^2 & 0 \dots & 0 \\ 0 & \dots & \dots & \sigma_{e_n}^2 \end{bmatrix}$$

Table 6) Analysis of Variance

Period	Durbin-Watson statistic
2007-2011	1.863

As the above table shows, the statistics are almost close to 2. Durbin-Watson statistic can help proving the constant variance of the model.

8.2 Results of hypothesis testing

As it has been shown in tables 3 to 5, the independent and dependent variables are correlated and $P-Value$ in error level 5% is zero. Also in linear regression model, the obtained $P-Value$ for β_1 is less than the level of the desired error $\alpha = 0.05$; while the test statistic F in variance analysis is a very large number. So, according to the above results the hypothesis of H_0 (Lack of a significant and direct relation between the firm size and its efficiency) is rejected in error level 5% and is accepted with 95% reliability by hypothesis a significant relation between the size and efficiency of the firm because the correlation coefficient is negative so the mentioned relation is reverse.

9 Research findings and their analysis

As it was investigated, by considering a regression model with one variable, testing existing data about the size and efficiency of the firm in the listed firms in Tehran Stock Exchange was carried out during 2007 to 2011. In the used model, the firm size is independent variable and firm efficiency is the dependent variable and their relationship to each other has been studied and tested. To calculate the firms' efficiency, data envelopment analysis, which is one of the most powerful techniques of ranking, has been used. According to calculations, the efficiency of the firms during the period studied for 375 years is described below.

Table 7) Efficiency Intervals(2007-2011)

Period	Coefficients	Estimation	SE	t statistic	P-Value
2007-2011	Intercept (β_0)	1.062	0.061	17.443	0
	(β_1)	-0.127	0.011	-11.572	0

Table 8) Efficiency Intervals(2007-2011)

	Efficiency Intervals											Sum
Number of Firms	0-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	0.5-0.6	0.6-0.7	0.7-0.8	0.8-0.9	0.9	1	1
	6	39	60	101	87	33	9	5	1	1	33	375

As shown in the table the gap of efficiency in 293 years, is below 0.5 and efficiency of 49 firms is between 0.5 to 1 and just 33 firms have been efficient in the studied period that shows lack of appropriate using of resources by firms to achieve the desired outputs. This could be due to a lack of competitive environment, the market dominated by government policies and lack of investment by the private sector and lack of accountability of managers towards them. To evaluate the efficiency of firms, the average efficiency of 75 samples were included in the study as described below.

Table 9- Firms Average Efficiency (2007-2011)

Efficie	Firms	Ef	Efficien	Firms	Ef	Efficien	Firms	
0.34	Afset	5	0.53	Damloran	2	0.26	Sina Chemical	1
0.36	Alborz Medicine	5	0.28	Dr. Abidi	2	0.61	Iran Fiber	2
0.15	Iran Khodro	5	0.30	Zahravi	2	0.63	Iran Auto Parts	3
0.31	Iran Medicine	5	0.88	Sobhan	2	0.22	Iran Carburetor	4
0.23	Iran Merinous	5	0.23	Farabi	3	0.26	Isfahan Tile	5
0.87	Alumtak	5	0.44	Kowsar	3	0.25	Pars Tile	6
0.80	Iran Tractor	5	0.22	Loghman	3	0.32	Alvand Tiles and	7
0.26	Iran Behnoush	5	0.23	Iran Tractor	3	0.49	Kaveh Paper	8
0.16	Pars Khazar	5	0.16	Zamiyad	3	0.34	Kalsimin	9
0.31	Pars Medicine	6	0.19	Saipa	3	0.22	Iran Carbon	10
0.19	Arak Petrochemical	6	0.15	Azin Saipa	3	0.26	Bahman Group	11
0.25	Isfahan	6	0.23	Sarma Afarin	3	0.16	Barez Industrial	12
0.23	Abadan	6	0.61	Oroumiyeh	3	0.17	Sepahan Industrial	13
0.41	Khark Petrochemical	6	0.26	Tehran	3	0.51	Razak Laboratory	14
1.00	Farabi Petrochemical	6	0.38	Sepahan	4	0.30	Sahand Rubber	15
0.73	Casting Sand	6	0.31	East Cement	4	0.14	Pak Pasteurized	16
0.30	Iran Zink Mine	6	0.66	North	4	0.44	Iran Brake Lining	17
0.44	Jam Medicine	6	0.45	Soufiyan	4	0.19	Iran Machine and	18
0.24	Iran Oxygen and	6	0.86	Qaen Cement	4	0.47	Nirou Moharekeh	19

Table 9- Firms Average Efficiency (2007-2011)								
Efficie	**Firms**	**Ef**	**Efficien**	**Firms**	**Ef**	**Efficien**	**Firms**	
0.21	Iran porcelain Soil	7	0.40	Kerman	4	0.29	Shahid Bahonar	20
1.00	Daroupakhsh	7	0.44	Mazandaran	4	0.95	Damavand Mineral	21
0.44	Aboureyhan	7	0.50	Sina Medicine	4	0.22	Behran Oil	22
0.44	Osvah Pharmacy	7	0.15	Qazvin Glass	4	0.22	Pars Oil	23
0.21	Oksir Pharmacy	7	0.21	Glass and	4	0.21	Mazandaran Noush	24
0.27	Jaber-e- Ebne Hayan Pharmacy	75	0.34	Daroupakhsh Medicinal	50	0.16	Nirou Moharekeh	25

As it can be seen in the table, the average efficiency of Farabi Petrochemical Companies is 1 and the average efficiency of 12 companies is between 0.5 and 1. The average efficiency of 11 companies has been less than 0.2, and the average efficiency of the 50 companies is between 0.2 and 0.5.

10 Conclusion and policy recommendations

The results of this research in the studied period, and with 95% confidence level show that there is significant and inverse relationship between firm size and its efficiency based on DEA model: in fact the larger the company its efficiency decreases**.** Thus, according to confirming the inverse relationship between firm size and firm efficiency, it is recommended to investors and managers to consider the efficiency index and the desired output with respect to investments made according to the DEA models to achieve efficiency.

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