Performance measurement of companies of Pharmaceutical substances industry in Tehran Stock Exchange with the approach of COLS and DEA

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Abstract: One of the challenges facing investors is to identify companies that have better performance and less investment risk. One of Requirements of this decision is to measure the performance of companies correctly or in other words, evaluating the performance of units. This research is trying to introduce a comprehensive method for performance measuring of membered companies of Tehran stock exchange by using parametric and non-parametric methods and identifying appropriate benchmarks simultaneously. For this purpose, by using of financial ratios and also two approaches of DEA and COLS, the performance level of membered companies of Pharmaceutical Industry in Tehran stock exchange has been determined. For this purpose, at first the topic of 39 useful financial ratios in performance measure of business units has been identified by a literature review, then by using of Factor Analysis technique among these variables, nine main factors have been identified. Secondly, with regard to components of factor analysis, the efficiency of 24 pharmaceutical companies in stock exchange have been evaluated by techniques of DEA and corrected ordinary least squares, for the period 2003 to 2009.the findings of this efficiency measure indicates that Iran Drug Company and parenteral products in 2003 and 2004, Iran Drug Company in 2005, Osveh pharmaceutical company and new 2006, Abu reihan and Osveh pharmaceutical companies in 2007, common drug company and Osveh pharmaceutical in 2008 and finally ,Tehran-chemistry and common drug company in 2009 ,have accounted the highest efficiency ratio in input and output modes of axis of mentioned models.

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1. Introduction

Determining the performance and identifying the efficiency degree of companies and organizations with growing the range of competition and demand in different economical branches, becomes more important every day. Organizations and companies in all economical parts are trying to identify their strengths and weaknesses, and take action to appropriate reaction facing them and development of their performance by identifying the efficiency and productivity rate. Creation of a criteria and indicator that measure the realization of this important and is a feedback to identify the deviation and guidance for rectification of the affairs has been the cause of the emergence and expansion of the concepts of efficiency and productivity. In recent decades, following the development of science such as economics, methods and techniques of performance measure has been much broader and more complex, and are constantly being reviewed and improved with the purpose of more realistic estimating of efficiency. The importance of increasing the efficiency of developing country's industry, especially industries such as the pharmaceutical industry, which is a part of strategic industry, is essential. Because in these countries the available sources are usually limited, there are not needed technologies or if there are old or often outdated and in overall the rate of efficiency and productivity is extremely low. In such circumstances, identifying the organizations and companies compared to competitors, have better and more favorable performance is important for several reasons. One of the most important reasons can be much investment in useful parts of each country that minimizes the wastes and by creating the competition provides the growth and excellence of other industry activists. Also, with this way, the reasons of increasing or decreasing the efficiency can be investigated and necessary equipment and sub-structure are identified for improving more performance in related firms. About industries like pharmaceutical industries that in addition to economic aspect, have a direct impact on individuals' living conditions of community and it is an important criterion to measure the development of communities, it will have twice importance (Kebriayi Zadeh, 2003). Measuring the financial efficiency of a company is essential and vital in decision-making process, because the operations of an enterprise are largely dependent on the financial position of the firm. For this reason, corporate executives and investors have always paid attention to the information obtained from the analysis of financial statements. They are trying to evaluate the company situation and based on it make the most appropriate decisions by considering information such as financial ratios. Many studies have been done about the measurement of financial efficiency of companies by use of financial ratios. These researches generally identified the needed variables for efficiency measurement or merely paid attention to different methods of performance measurement. On this basis, study is ready to introduce a comprehensive approach that by it according to the field of research provided the possibility of identifying needed indicators of efficiency measurement and based on identified indicators, it investigated the performance of studies units by the most appropriate techniques of efficiency measurement. For this purpose in current research, technical efficiency of membered companies of materials and products industry of Tehran stock exchange has were investigated by use of Multi-Output Distance Functions and technique of Corrected Ordinary Least squares and also nonparametric of DEA technique. According to Peter Drucker, one of the greatest thinkers of the twentieth century, the main task of an organization is to create value. In modern uncertain economic environment, most of business ventures should have been accepted by the financial sector and normally shows a high return on capital. Therefore, it is important for business specialists to have the ability of creating real value creation from a financial background (Rahnamaye Rodpooshti, Nico Maram and Shahvardiany, 2012). Financial ratios analysis is one of tools and techniques that contributes to decision makers in a clearer understanding of health of a business unit and provides profitable information about the strengths and weaknesses of the company's financial condition and enables the analysts to explore the past and current financial statements to facilitate the reviewing, interpretation and reporting of their broad data. The use of these ratios to assess institutions performance has a long precedent and in recent years has also seen significant growth in their use. Nevertheless, use of these ratios, has problems that among them, we can point to large number of calculable ratios , different results obtained from each of these ratios and efficiency measurement of different departments of economic firm by each of them. These cases cause that analysts face to complexity and difficulty for concluding and largely make impossible the possibility to determine the rate of total efficiency of mentioned units. In this research, we aretrying to overcome these problems with the help of parametric and non-parametric methods mentioned above, and simultaneously with considering results of all these ratios , comparing the efficiency of mentioned units.

2. Literature review

In order to estimate the distance functions and measuring the efficiency, different methods are used. These methods are classified into two categories of Parametric and nonparametric methods. One of non-parametric methods that are typically used to estimate distance functions, Can point to the DEA that uses the linear programming to estimate distance functions and measure efficiency. Studies of (Farrell, 1957; Charnes et al., 1978; Cloutier and Rowley, 1993; Fandel, 1998; Fare et al., 1985; Fried et al., 2002; Lovell and Zieschang, 1990) are some studies that are adopted to apply this method.

Also recently, some researches in the field of efficiency measurement have estimated the parametric distance functions and determined efficiency of units by using econometric techniques and methods which among them we can point to these researches: (Brummer et al., 2002; Coelli, 2000; Coelli and Perelman, 1998; Hattori et al., 2002; Murty and Kumar, 2002; Herrero, 2005; Kumbhakar et al., 2007; Omrani et al, 2010). By comparing studies done for using parametric and nonparametric methods of estimating the distance functions, it is characterized that none of the others had a clear superiority from each other and And performance of estimators depends on some factors such as: the number of investigated units and noise in data which will continue to try to provide a brief description of each methods (Mortimer, 2002; Resti, 2000).

Technical efficiency

Koopmans provided a structure definition of Technical efficiency in 1951. According to this definition , when the manufacturer is efficient from technical perspective, that the increase in each output , at least leads to decrease one of other one of other outputs or increase one of inputs. And so, decreasing in each input needs to increase the consumption of at least one other input or decrease in one output of outputs. Therefore, an ineffective manufacturer can produce the same outputs with lower value of at least one of inputs, or increase the production of at least one of outputs (Fried et al., 2008).

Definition of Koopmans about the concept of technical efficiency shows that whether the firm (investigated unit) uses the best available technology in its product process or not.

Debreu (1951) and Farrell (1957) proposed a method to measure technical efficiency. Their method of measuring, with a focus on reducing inputs, is defined as (a minus) maximum reduction in all inputs such a way that it is possible for technology and the current output production. Also in this method efficiency with a focus on increasing outputs, is defined as the highest increasing the radius on all outputs such a way that technology and available inputs are possible. In both cases, value of one indicates that the studied unit from technical aspect is efficient, because no radial expansion is possible. A value except one indicates Intensity of technical inefficiency (Fried et al., 2008). In order to link Debreu-

Farrell's measurement methods with Koopmans' definition, also the linking of these two with technology structure will be useful to introduce some terminology and notations.

Production technology

If $x=(x_1,\ldots,x_N)\in R_+^N$ is a non-negative vector of inputs used for producing a non-negative vector of outputs $y=(y_1,\ldots,y_M)\in R_+^M$, production technology can be shown by equation 1:

$$T=\{(x,y)\in R_+^{N+M}:\ \text{X can product Y}\} \quad (1)$$

Also, for all $(x,y)\in T$, this technology for collecting outputs, by keeping inputs can be shown as equation 2:

$$P(x)=\{y:(x,y)\in T\}\quad ,x\in R_+^N \quad (2)$$

By keeping outputs, technology for det of required inputs, can be also shown in equation 3:

$$L(y)=\{x:(x,y)\in T\}\quad ,y\in R_+^M \quad (3)$$

It should be mentioned that above definitions are developed for negative values of inputs and outputs, but with respect to logarithmic form of most production functions, using the non-negative values seems more appropriate.

According to proposed equation, the diagram of production technology can be defined as $GR=\{(x,y):$ X can product Y} that describes a set of input and output vectors. This diagram is identified as a product set.

According to these two current properties , Koompans' definition of technical efficiency can be shown as a structure; $(y,x)\in T$,that is efficient from technical aspect if and only the relation $(y',-x')\ge(y,-x)$ is true for $(y',x')\notin T$; that guarantees any increasing in set of possible inputs and any reduction in set of possible outputs . These increase and decrease are applied radially but are not limited to it. It should also be noted, however, generally the production technology does not need to be a convex set, and nevertheless in most cases it is assumed that this set has the convexity property (Fried et al., 2008).

Production Frontier

Frontier of production output is the outside range of P(x) that shows the maximum possible value of output combinations for fixed level of X input. On this basis, the compositions of the frontier are more efficient than those that have been in frontier (Bellenger, 2010).

Also, according equation (3), it can be shown that production frontier indicates the maximum product that is obtained from different amount of source and in other words, expresses the technology level in industry (Mehregan.2008).

In other words, about production frontier, it can be indicated that set of required inputs are limited from below by isoquant inputs that includes the required compositions of inputs ,for production of fixed amount of outputs in Y level $(x,y)\in T \Leftrightarrow y\in P(x)\Leftrightarrow x\in L(y)$ (Bellenger, 2010).

Distance Functions

The approach of distance functions is a Multi-output Stochastic Methodology that is applied for estimating the efficiency. The structure of this method is similar to the production function approach, with the difference that it can also be used in several multi-output modes. (Herrero, 2005).

Distance Functions that first time have introduced by Shepard (1970), achieved a comprehensive method for calculating the efficiency. Distance functions can be input or output of axis. In input form of axis, it is assumed that manufacturers have the ability of allocating resources when the outputs are exogenous, while the external form of axis in inputs' exogenous mode is focus on output combination (Cuesta & Zofio, 2003). According to the definitions provided in section and by using equations (2) and (3) we can show output and input distance Functions of axis respectively by the relationships of (4) and (5).

$$D_o=\inf\left\{\theta:(x,\frac{y}{\theta})\in P(x)\right\} \quad (4)$$

$$D_I=\sup\left\{\lambda:(\frac{x}{\lambda},y)\in L(y)\right\} \quad (5)$$

An input oriented distance function shows the maximum value that the input vector x can be reduced, but still is doable to produce outputs; And the output function of axis, shows the maximum value that Y output axis can be increased, but also is producible by the inputs current inputs (Alvarez, 2004, p72). Also according to the relations (4) and (5) it can be shown that Equation (6) is true.

$$D_O \le 1 \Leftrightarrow y \in P(x) \Leftrightarrow x \in L(y) \Leftrightarrow D_I \ge 1 \qquad (6)$$

These functions are Additive and show the exact value that should be achieved to reach the border of production. On the output mode of axis, the observations under frontier, have a distance exactly less than one and in input mode of axis, the observations over the frontier have a distance exactly more than one. It should be noted that any observations on production frontier the border has a distance value of one whether in input mode or output mode of axis. It should be noted that according to Constant Return to Scale, the output distance function is equal to the inverse of input distance function. $D_O(x,y)=\left[D_I(y,x)\right]^{-1}$ But this situation is not necessarily true in the mode of Variable Return to Scale (Bellenger, 2010).

The technical efficiency of input oriented model

As mentioned previously, the technology can be calculated by relationship. This set constitutes a set of isoquant inputs of I(y) so that $I(y)=\{x : x \in L(y), \lambda x \notin L(y), \lambda < 1\}$ and also the efficient subsets of inputs can be defined on it as a form of $E(y)=\{x : x \in L(y), x' \notin L(y), x' \le x\}$.

For these three sets the relation of $E(y) \subseteq I(y) \subseteq L(y)$ is true.

Now, Debreu-Farrell's measuring method in mode of axis output defined the technical efficiency more precisely as the form of (7) equation.

$$TE_O(x,y)=\max\{\varphi : \varphi y \in P(x)\} = \left[\max\{\varphi : D_O(x,\varphi y) \le 1\}\right]^{-1} \qquad (7)$$

Also according to the equations (7) and (4), the relation (8) can be concluded.

$$TE_O(x, y) = [1/D_O(x, y)]^{-1} \qquad (8)$$

Thus, the value of technical efficiency in mode of axis output for $y \in P(x)$ will be $TE_O(x, y) \ge 1$ and for $y \in I(x)$ will be $TE_O(x, y) = 1$ (Fried et al., 2008).

Parametric methods

Parametric methods by using econometric techniques and based on appropriate data, estimate cost or production frontier, In this methods at first, a particular form is considered for the production or cost function, Then one of the methods of estimation of functions that is common in statistics and econometrics, the unknown coefficients (parameters) of the function is estimated. Since in these methods, function parameter or parameters are estimated, they are called parametric methods. Parametric methods are divided into two general distinct and defined methods .COLS technique is one of defined econometric methods and SFA is one of indefinite econometric methods. In COLS methods, all deviations from the frontier are considered inefficiency, but in SFA methods deviates from the frontier two inefficiency and random error components is broken to. Therefore, these levels of efficiency obtained from COLS are greater than degrees of efficiency obtained from SFA. In Figure 1 the mentioned methods have been shown (Development, 2006).

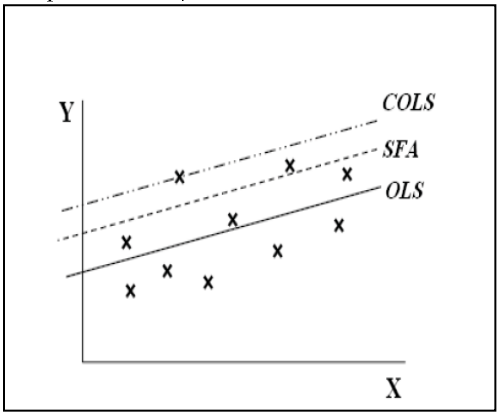

Fig 1, Comparison of COLS and SFA methods Form of production function

As noted above, in parametric methods in order to estimate the cost and production functions at first it must be determined the desired function. On the same basis in estimating a multi-output distance functions it is necessary to identify the first form of function. Various forms can be used for production functions. That among them, we can note to linear, Cobb - Douglas, quadratic, Translog forms and... . Then, respectively Cobb-Douglas and Translog functions are shown as the two most used types of these functions.

$$y = \beta_0 \prod_{n=1}^{N} x_n^{\beta_n} \qquad (9)$$

$$y = \exp(\beta_0 + \sum_{n=1}^{N} \beta_0 Ln(x_n) + \frac{1}{2}\sum_{n=1}^{N}\sum_{m=1}^{N} \beta_{nm} Ln(x_n) Ln(x_m)) \qquad (10)$$

Equation (9) Cobb-Douglas function and equation (10) show Translog function. According to one of the conditions of estimating these functions, is linearity of parameters, about these two functions, logarithmic form is used, which makes the possibility of linearity combination of parameters.

$$Ln(y) = Ln(\beta_0) + \sum_{i=1}^{N} \beta_n Ln(x_n) \quad (11)$$

$$Ln(y) = \beta_0 + \sum_{n=1}^{N} \beta_0 Ln(x_n) + \frac{1}{2}\sum_{n=1}^{N}\sum_{m=1}^{N} \beta_{nm} Ln(x_n) Ln(x_m) \quad (12)$$

Equations (11) and (12) the logarithmic respectively show the form of Cobb – Douglas and Translog function. It is also necessary that these functions observe two homogeneous conditions of r degree and the symmetry in order to better estimation. For this purpose, these conditions can be established by applying simple restrictions about the parameters. For example, about Translog function, we can show that this function is homogeneous from r degree, if the constraints of equation (13) apply upon it. This function is also symmetric if the constraints of (14) are applied on it (Coelli, 2005).

$$\sum_{n=1}^{N} \beta_n = r \quad and \quad \sum_{n=1}^{N} \beta_{nm} = \sum_{m=1}^{N} \beta_{nm} = 0 \quad (13)$$

$$\beta_{nm} = \beta_{nm} \quad (14)$$

According to the recent done researches and studies, mainly the Translog form as a flexible form which include input and output vectors and also the interaction between these factors, has been used for estimation of input and output distance functions, (Coelli and Perelman, 1999; Lovell et al., 1994; Alvarez, 2004; Herreo, 2005). We explain this form to estimate the distance functions.

Translog form of input distance function in multi-output mode

Translog distance function in mode of M output and K input is shown as form of equation (15).

$$\ln D_i = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \delta_{km} \ln x_{ki} \ln y_{mi}$$

$$i = 1,2,3,...N$$

(15)

In equation (15) ($\ln D$) indicates the input distance function of axis and I indicated the ith firm in sample. Also, as mentioned above, the axis input distance function should have symmetry and Linear Homogeneity properties. Therefore, the constraints (16) should be imposed upon it to be homogeneous According to the inputs from degree +1.

$$\sum_{k=1}^{K} \beta_k = 1$$
$$\sum_{l=1}^{K} \alpha_{kl} = 0, \quad k = 1,2,3,...,K \quad (16)$$
$$\sum_{k=1}^{K} \delta_{km} = 0, \quad m = 1,2,3,...,M$$

And for symmetry should be applied conditions (17) on an input-oriented distance function.

$$\alpha_{mn} = \alpha_{nm}, \quad m,n = 1,2,...,M$$
$$\beta_{kl} = \beta_{lk}, \quad k,l = 1,2,...,K \quad (17)$$

Using the homogeneous property was suggested in order to make the above function estimable by Cooeli and Perlman (1999). Homogeneity from degree +1 about inputs leads to establish the third characteristic of following equation (18):

$$D_I(0,x) = +\infty \quad and \quad D_I(y,0) = 0$$

A semi-continuous function is bounded from above

$$D_I(y,x)$$
$$D_I(y,\lambda x) = \lambda D_I(y,x) \quad for \quad \lambda > 0 \quad (18)$$
$$D_I(y,\lambda x) \geq D_I(y,x) \quad for \quad \lambda \geq 1$$
$$D_I(y,\lambda x) \leq D_I(y,x) \quad for \quad \lambda \leq 1$$

$D_I(y,x)$ is a convex function with respect to the inputs.

Based on this property and with selecting an optional input such as x_{Ki}, if $\lambda = 1/x_{Ki}$, all entries can be normalized, and the condition of homogeneity from degree +1 according to x and the input distance function can be applied (Alvarez, 2004).

$$D_I(y, x/x_{Ki}) = D_I(y,x)/x_{Ki} \quad (19)$$

With applying condition (19) on equation (15), it can be written in the form of equation (20).

$$\ln(D_{Ii}/x_{Ki}) = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K-1} \beta_k \ln x^*_{ki} + \frac{1}{2}\sum_{k=1}^{K-1}\sum_{l=1}^{K-1} \beta_{kl} \ln x^*_{ki} \ln x^*_{li} + \sum_{k=1}^{K-1}\sum_{m=1}^{M} \delta_{km} \ln x^*_{ki} \ln y_{mi}$$

$$i = 1,2,3,...,N$$

(20)

In above equation $x^*_k = x_k / x_K$. Also this equation can be shown as a simple form of (21).

$$\ln(D_{Ii}/x_{Ki}) = TL(x_i/x_{Ki}, y_i, \alpha, \beta, \delta) \quad i = 1,...,N$$

(21)

The equation (22) can be concluded from equation (21).

$$\ln(D_{li}) - \ln(x_{Ki}) = TL(x_i / x_{Ki}, y_i, \alpha, \beta, \delta) \quad i = 1,...,N$$
(22)

And finally the estimable input distance function of axis in multi-input and multi-output mode can be summarized in equation (23). (Coelli and Perelman, 1999)

$$-\ln(x_{Ki}) = TL(x_i / x_{Ki}, y_i, \alpha, \beta, \delta) - \ln(D_{li}) \quad i = 1,...,N$$
(23)

Translog form of output distance function of axis in multi-mode output

Translog output distance function of axis including M output and K input can also be shown as the form of equation (24) that indicates the output distance function of axis for the i th unit .

$$\ln D_{oi} = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \delta_{km} \ln_{ki} \ln y_{mi}$$
$$i = 1,2,3,...,N$$

(24)

Output-oriented distance function according to outputs is homogeneous from degree +1. Therefore, constraints of (25) can be imposed upon it.

$$\sum_{m=1}^{M} \alpha_m = 1$$
$$\sum_{n=1}^{M} \alpha_{mn} = 0, \quad m = 1,2,3,...,M$$
$$\sum_{m=1}^{M} \delta_{km} = 0, \quad k = 1,2,3,...,k$$
(25)

And for symmetry, the conditions of (26) should be imposed on the output distance function. (Coelli and Perelman, 1999)

$$\alpha_{mn} = \alpha_{nm}, \quad m, n = 1,2,...,M$$
$$\beta_{kl} = \beta_{lk} \quad k, l = 1,2,...,K$$
(26)

As it is mentioned about the axis input distance function, with a choice of optional output, such as y_{Mi} , if $\lambda = 1 / y_{Mi}$,all inputs can be normalized and the condition of homogeneity from degree +1 according to Ys can be applied on the outputs distance function. (Alvarez, 2004, p77)

$$D_o(x, y / y_M) = D_o(x, y) / y_M$$
(27)

By applying the homogeneity condition of (27), the output distance function can be rewritten as a form of (28).

$$\ln D_{oi} / y_{Mi} = \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y^*_{mi} + \frac{1}{2}\sum_{m=1}^{M-1}\sum_{n=1}^{M-1} \alpha_{mn} \ln y^*_{mi} \ln y^*_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M-1} \delta_{km} \ln x_{ki} \ln y^*_{mi}$$
$$i = 1,2,3,...,N$$

(28)

That in above equation, $y^*_m = y_m / y_M$. Equation (28) can be rewritten as a simple equation of (29).

$$\ln(D_{oi} / y_{Mi}) = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \delta) \quad i = 1,...,N$$
(29)

The equation (30) can be concluded from equation (29).

$$\ln(D_{oi}) - \ln(y_{Mi}) = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \delta) \quad i = 1,...,N$$
(30)

And finally, we will have the input distance function of estimable function in multi-input and multi-output mode as a summarized equation (Coelli and Perelman, 1999).

$$-\ln(y_{Mi}) = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \delta) - \ln(D_{oi}) \quad i = 1,...,N$$
(31)

3. Methodology

In current research, a number of useful financial ratios are calculated by gathering information stipulated in financial statements of companies registered member of Stock Exchange pharmaceutical industry. And then by performing a factor analysis on these data, the most appropriate of them was chosen as an indicator of efficiency measurement. Then according to approach of corrected ordinary least squares (COLS), the research data has been estimated by estimator of ordinary least squares (OLS) with statistical software and the efficiency of mentioned companies were calculated. Also, parallel with using DEA model as one of the nonparametric methods, the efficiency of mentioned units has been solved and modeled by the software GAMS.

Research variables

After studying and investigating literature and history of research, some of most useful financial ratios were identified and selected as investigated variables. About selection of financial ratios, we should pay attention that there are many standard ratios used for evaluating the efficiency of companies and organizations. Selection of the best and most effective ratio to measure the efficiency of investigated company, especially since it is important that ratios are selected somehow involve all dimensions of financial activities of company and provide a more accurate image of company efficiency and performance.so in current study, the most useful ratios are selected as research variables by careful investigation of done studied on this field. Among these researches, we can note to Chen and Shimerda research titled an applied analysis of useful financial ratios, that authors have succeeded to classify and provide 41useful and important ratios in mentioned researches by studying and investigating 26 researches about useful financial ratios. They indicated that the found ratios, in more current researches are known efficient and as the criteria have been used for measuring organizational performance have been used(Chen & Shimerda, 1981).also, Rahman and Hossari in a similar research ,succeeded to identify 48 useful financial ratios by studying and investigating 53 scientific researchers conducted in 1966 to 2002 (Hossari & Rahman, 2005).

In addition to these researches, DE et al (2011) studies, Hsieh & Wang, 2001, Bhunia & Sarkar, 2011 were investigate particularly and other conducted researches and papers about financial ratios were investigated generally and with regard to the rate of importance and also abundance of errands, 43 cases were selected as the most important and useful ratios among multitudes studied ratios. In addition, it should be mentioned that selection of mentioned ratios has been done based on data existence in provided financial statements by stock exchange organization and also, the use of experts' idea and adapting the importance of these ratios with Tehran stock exchange. Of these ratios, four ratios (non-current debts of equity, total equity to total assets, operational costs (incomes) to sale and also, the ratio of cost of sold good to Inventories of good and material that made the correlation matrix of factor analysis negative and Endangered the credibility of factor analysis, were eliminated and finally, 39 remained ratios were identified as main variables of this research (table 1) and calculated for statistical population of research . i.e. 24 membered companies of Pharmaceutical Industry of Tehran Stock Exchange during the seven financial years.

Table 1, financial usable ratios as research variable

title	Way of calculation	explanation	Source
R1	operational sale/ profit (loss)	The ratio of operating profit margin	(De et al., 2011)
R2	Total assets / net profit (loss), after deducting tax	potential profitability / Return on total assets	(Chen & Shimerda,1981)
R3	Net profit(loss) after deducting tax /Sales	Net profit margin or return on sales	(Bhunia & Sarkar, 2011)
R4	Total of / net profit (loss), after deducting tax equity	Return of equity	(Hossari & Rahman, 2005)
R5	Total Current debts / Total Current Assets	Current ratio	(Karacaer&Kapusuzoglu,2008)
R6	financial Costs (benefits) Financial / Profit(loss) Operating	coverage ratio of Interest expense	(De et al., 2011)
R7	Total Current debts / (Inventories of good and (material - Total Current Assets	The instantaneous rate	(Hossari & Rahman, 2005)
R8	Total assets / sales	turnover ratio of total assets	(Chen & Shimerda,1981)
R9	Total assets / Total current and non-current debts	Debt ratio	(Bhunia & Sarkar, 2011)
R10	Total Assets / Total Current Assets	The ratio of current assets	(Chen & Shimerda,1981)
R11	Total assets / operational income (loss)	ratio of return on capital (ROI)	(Hossari & Rahman, 2005)

R12	Commercial accounts and notes receivable / sales	circulation ratio of Receivable accounts	(Bhunia & Sarkar, 2011)
R13	Total shareholders' equity / total current and non-current debts	Total debt Ratio	(Hossari & Rahman, 2005)
R14	Total Current debts / cash stock	cash Ratio	(De et al., 2011)
R15	Total Equity / Total Current debts		(Hossari & Rahman, 2005)
R16	Total shareholders' equity / fixed assets after deducting depreciation		(Karacaer&Kapusuzoglu,2008)
R17	(Sales / gross Profit(loss	Ratio gross profit margin	(Rudposhti et al, 2011, p478)
R18	Total Current debts - Total Current Assets) / Inventories of good and material	the ratio of Product to of the working capital	(Chen & Shimerda,1981)
R19	Inventories of good and material / Sales	circulation of good Inventory	(De et al., 2011)
R20	Total Current debts - Total Current Assets) / Sales)	circulation rate of Current capital	(De et al., 2011)
R21	Total assets / (Total Current debts - Total Current (Assets		(Chen & Shimerda,1981)
R22	Sales / cash stock		(Bhunia & Sarkar, 2011)
R23	Total Current debts / cash flow	Cash profit ratio	(Hossari & Rahman, 2005)
R24	Total shareholders' equity / operational income ((loss	ROE (return on (investment	(Bhunia & Sarkar, 2011)
R25	Total current debts and non-current debts / ((average annual stock price * number of shares) + (((capital - Total equity	Market value of equity to total debts	(Hossari & Rahman, 2005)
R26	Earnings per share after deducting tax / average annual stock price	Ratio of (P/E)	(Vakili fard Fred, 2001, p 99)
R27	Total assets / operational income (loss)		(Bhunia & Sarkar, 2011)
R28	Total Current Assets / Sales	The circulation ratio current assets	(Hossari & Rahman, 2005)
R29	After deducting depreciation of fixed assets / sales	The circulation ratio fixed asset	(De et al., 2011)
R30	Total shareholders' equity / sales		(Hossari & Rahman, 2005)
R31	Total Current debts - Total assets) / stock profit) adopted by council	Cash profit of on used capital	(De et al., 2011)
R32	Total assets / stock profit adopted by council		(De et al., 2011)
R33	Total shareholders' equity / stock profit adopted by council		(De et al., 2011)
R34	Total Current debts - Total assets) / operational) (income (loss		(De et al., 2011)
R35	Total Current Assets / cash stock		Nikoomaram and et al, 2011, p) (105
R36	Total assets / cash stock		(Hossari & Rahman, 2005)
R37	accounts average and Commercial payable documents at the beginning and end of the period / (cost of goods sold - inventory of good at begining (of period + inventory of good at the end of period	times of settling creditors	(Akbari, 2010, p 56)
R38	Average Inventories at the beginning and end of the period / Sale	circulation of good Inventory (other (method	(Hossari & Rahman, 2005)
R39	Sales / Average of accounts and receivable notes at the beginning and end of the period * 360	recovering demand period	((Akbari, 2010, p 77

Statistical population and sample

According to information published on the Tehran Stock Exchange about accepted companies, currently 27 companies have been members of Pharmaceutical Industry. Of these, three companies: Alborz Investment CO, Daroo pakhsh and Sobhan Pharmaceutical group, are engaging in production and distribution of Pharmaceutical, which due to observing the congruence origin, these companies been excluded from the research community and 24 other firms organize the statistical population of research. The names of these companies are visible in table 2.

Table 2, the statistical society studied by research study

Row	DMU	Symbol	Company
1	DMU1	D-Albor	Alborz daroo
2	DMU2	D-Iran	Iran daroo
3	DMU3	D-Pars	Pars daroo
4	DMU4	D-Tamad	raw materials production of Daroupakhsh
5	DMU5	Sh-Tehran	Tehran Chemistry
6	DMU6	D-Abur	Abu-Reyhan pharmacy
7	DMU7	D-Osveh	Osveh pharmacy
8	DMU8	D_ler	Exir pharmacy
9	DMU9	D_Amin	Amin pharmacy
10	DMU10	D-Tehran	Tehran pharmacy
11	DMU11	D-Jaber	Jaber -ebne-hayyan pharmacy
12	DMU12	D_rooz	Ruz-daroo pharmacy
13	DMU13	D-Sina	Sina Pharmacy
14	DMU14	D-Fara	Farabi Pharmacy
15	DMU15	D-Kosar	Kosar Pharmacy
16	DMU16	D-Zahravi	Zahravi pharmacy
17	DMU17	D-Razak	Razak medicinal
18	DMU18	D-Loghman	Loghman medicinal
19	DMU19	D-Dam	Damlran
20	DMU20	D-Shimi	Medicinal Chemistry of Daroupakhsh
21	DMU21	D-Fara	Injection products of Iran
22	DMU22	Daroo	Daroupakhsh Pharmacutical
23	DMU23	D-Kimi	Kimia drug
24	DMU24	D-Abid	Dr. Abidi ‘s lab of pharmacy

4. Research findings

Factor analysis on 39 identified financial ratios as the original variables of study was done by software version 17, SPSS, and principal component analysis method (PCA). According to that the value of adequacy test or sufficiency of Kayzer-Mayer-Olkin (KMO) sampling, is equal 0.710 and also the value of sig of Kervit Bartelt test is less than 5%, the sample size was shows appropriate for factor analysis. Also, in order to determine the number and identification of extracted components (factors), according to the Kaiser criterion, we identify components that have one or more of Eigen values. These components will include nine first components, which explain 86.9% of the variance of total variables. It should be noted that the first three components of this set, have the largest contribution in explanation of variation (54.4%).

After determining the number of components, factor loadings (factor scores) of each variable on the remaining elements can be observed in component matrix. Factor loadings of components Of these tables have generally small amounts which makes interpretation difficult, for example, in the eighth component, none of the variables does not have factor loadings greater than 0.5. Thus, since the interpretation of factor loadings without rotation is not an easy task, you must turn the factors to increase the ability of interpretation. As noted above after number of factors was identified, the next step is to try interpreting it. to help this process, the factors are rotated. This action does not only change the fundamental solutions, but also ,represents interpretation pattern in a way that is easier .with regarding that the purpose of applying factor analysis in this research is reduction of variables somehow these factors obtained from it , are not dependent together , the use of orthogonal rotation is more suitable. Therefore, in this study, varimax rotation is used. The results obtained from this rotation that are visible in table (3), help to easier identification of variables that have the most factor loading on nine mentioned components. According to this table, the most factors loading on the first component belongs to R15 and on second to ninth components, respectively belongs to R19, R10, R39, R36, R4, R18, R5 and R26. With regarding that these ratios have the most correlation value with related factors, they can be selected as a reagent of each factor. So, it is expected that by using these nine variables, the manner of other available ratios on the same level, can be explained logically. This approach has been used in previous research such as: Tuna and others (1997) ,Yarbod (2007) and (De et al., 2011; Tan et al., 1997). Accordingly, 39 selected ratios have been reduced to nine ratios obtained from Varimax rotation and furthermore, they are applied in order to evaluate the efficiency measurement of 24 studied companies.

Measurement efficiency

After identifying the main research variables through factor analysis, in this part, efficiency of the pharmaceutical companies on the stock exchange will be measured by data envelopment analysis. According to sensitivity of DEA model to variables' selection, the most important issue in this part is the Grouping of identified ratios into two groups of input and output variables in the previous section. Unfortunately, the majority of accomplished researches in this field, no consistent approach and methodology have been introduced to identify the inputs and outputs and researchers mainly have applied this classification by their own opinions, far as some of ratios have been classified in a research titled as an output variable and in other research titled as an input variable. Malhtra approach has been used in this study.according to Malhatra (2008) and Vertingten (1998), ratios that their increasing means the efficiency of company as an output and ratios that their reduction means better performance as input of DEA and COLS models were used. (Malhotra D.K. & Malhotra R., 2008; Worthington, 1998). Also, this approach, consistent with the definitions of Koompanz ,Debro and Farrel about technical efficiency .so, the literature of topic has been investigated and according the desirability of being increased or decreased of nine ratios obtained factor analysis ,these ratios are divided to two groups of input and output. Then this classification is titles in detail and with reference to the nature of mentioned ratios.

Input ratios

1) Ratio of current assets to total assets (R10), Any increase in this ratio is lead to reduce the profitability of the enterprise, because it is assumed that the ratio of current assets to fixed assets will lead to less profitability (Khan, 2004).
2) The ratio of total current debts to total equity (R15), this ratio indicated the relation of debt and Eigen values (total equity).when this ratio is high, the diagnosis is undesirable and its continuous increase will require revising in manner of combining investors (Akbari, 2010)
3) Ratios of good to working capital (R18), this ratio indicates that some percentage of working capital is changed to goods inventory. High percentage is considered as an indication of existence of problem in circulating current operation (Akbari, 2010).
4) The period of demands recovery (R39), this ratio is calculated based on day and indicates that on average it will take a few days to recovery the demands from credit sales. If this ratio is smaller, it is better, because by faster recovering the demands, speed of short-term obligations is increased (conditioned beliefs, 2010).

Output ratios

1) The ratio of cash to total assets (R36), as one of liquidity ratios, shows the company's ability to provide needed cash to pay its debts to creditors. Hence, if this ratio allocates greater amount, the probability of

financial distress is reduced. It should also be paid attention that current assets (like cash), have less ability to profitability. Therefore, companies should try balancing among these assets, create an optimum combination to earn maximum profits and reducing risk, (wahlen, Baginski, Bradshaw, 2008). Is necessary to explain that existence of ratio of current assets to total assets (R10) as one of the inputs of model will help to establish this balance. Because In case of the excessive increase of cash balance, And consequently increasing rate of R36, R10 rate has also increased that with regard to its nature as an input variable, increasing R10 provides efficiency reductions.

2) R26 ratio, which shows the relationship between annual stock price and earnings per share after deducting tax. This ratio is one of most important scales of stock evaluation that can be used by investors in the market. This low ratio indicates that the share of this article, is not very appropriate and the high ratio can indicate its favorable position in the market share. (vakili fard, 2001). It is Necessary to explain that this ratio like other financial ratios cannot be the ultimate criterion alone for evaluation and should be investigated in the presence of other factors.
3) Current ratio of R5 that is obtained from division of current assets to current company debts indicated the ability of company to pay its debts to creditors. Increase in this ratio indicates that creditors will have more confidence about receiving their own demand to get (Nikoo maram, 2010).
4) Inventory rotation ratio of good R19, which can be used to calculate two commonly methods. Both methods were used in this study that results of the first method i.e. division of Sales to good Inventories is reflected in ratio R19, And the results of the second method; division of sold goods on good inventory, is visible by R38 ratio.it is nesseccary to mentioned that R19 and R38 factor loading to sixth factor, are very close together and In simple terms, the ratio of these two can be used interchangeably. It should also be noted that, typically, a high inventory rotation ratio is an indication of a company's management efficiency. If all other factors are constant, the much rotation flow is more desirable than low-rotation ratio (Novo, 2001).
5) Net profit to equity ratio (R4), that if this ratio is higher, the profitable unit has a better performance and therefore has greater efficiency, and consequently, productivity of business unit is higher than financial perspective (Nikoomaram, 2010).

DEA results

After determining input and output variables in this section, by using data envelopment analysis models that were discussed above, we calculate efficiency of 24 companies of statistical population of research. For this purpose, BCC and CCR methods by GAMS software have been modeled and solved in two input and output modes during financial years of 2003 to 2009, and their results are visible in following tables.

Input and output oriented CCR models

According to the same obtained results of input and output oriented CCR model, it is showed only input oriented model (see table 3).

Table 3, CCR DEA model results (2003-2006)

	2003	2004	2005	2006
DMU 1	65.55%	70.15%	70.06%	65.02%
DMU 2	100.00%	100.00%	100.00%	100.00%
DMU 3	93.04%	100.00%	100.00%	100.00%
DMU 4	100.00%	100.00%	100.00%	100.00%
DMU 5	68.36%	62.43%	49.67%	64.90%
DMU 6	100.00%	94.97%	100.00%	100.00%
DMU 7	77.43%	73.81%	100.00%	100.00%

DMU 8	100.00%	84.23%	69.68%	66.23%
DMU 9	61.14%	58.92%	93.75%	100.00%
DMU 10	70.19%	84.23%	96.31%	89.37%
DMU 11	80.82%	100.00%	100.00%	100.00%
DMU 12	100.00%	100.00%	93.38%	100.00%
DMU 13	100.00%	100.00%	100.00%	100.00%
DMU 14	86.22%	73.47%	70.95%	80.27%
DMU 15	75.51%	66.90%	67.33%	78.55%
DMU 16	73.97%	81.78%	100.00%	100.00%
DMU 17	94.28%	71.74%	72.74%	68.62%
DMU 18	100.00%	89.05%	63.12%	57.43%
DMU 19	61.29%	63.20%	69.41%	53.89%
DMU 20	100.00%	100.00%	70.44%	61.09%
DMU 21	100.00%	100.00%	100.00%	99.86%
DMU 22	63.52%	52.69%	66.34%	67.09%
DMU 23	64.67%	63.56%	82.73%	99.33%
DMU 24	100.00%	100.00%	100.00%	100.00%

Continue Table 3, CCR DEA model results (2007-2009)

	2007	2008	2009
DMU 1	100.00%	100.00%	100.00%
DMU 2	80.96%	100.00%	81.73%
DMU 3	100.00%	100.00%	100.00%
DMU 4	91.67%	88.10%	89.00%
DMU 5	86.73%	59.72%	99.49%
DMU 6	100.00%	77.63%	74.79%
DMU 7	100.00%	100.00%	100.00%
DMU 8	77.69%	86.14%	82.66%
DMU 9	59.76%	67.66%	91.49%
DMU 10	78.03%	95.07%	69.00%
DMU 11	100.00%	100.00%	100.00%
DMU 12	100.00%	100.00%	100.00%
DMU 13	100.00%	100.00%	100.00%
DMU 14	71.47%	77.99%	80.55%
DMU 15	78.31%	91.01%	90.23%
DMU 16	100.00%	100.00%	100.00%
DMU 17	86.88%	100.00%	95.97%
DMU 18	94.79%	76.35%	100.00%
DMU 19	63.84%	67.59%	67.82%
DMU 20	66.17%	77.58%	100.00%
DMU 21	100.00%	100.00%	100.00%

DMU 22	73.80%	77.64%	95.11%
DMU 23	90.87%	80.65%	74.77%
DMU 24	86.37%	100.00%	100.00%

As shown in Table (3) in 2003, among 24 investigated companies, 10 companies have efficiency equal one. Similarly, in 2004 to 2008, respectively, 9, 10, 11, 9, 11 and 11 units have been identified as efficient units. The lowest level of efficiency in 2003 belongs to DMU9 and is equal 61.14%.

Similarly, for 2004 to 2009 respectively, the DMUs of 22 with 52.69%, 5 with 49.67%, 19 with 53.89%, and9 with 59.76%, 19 with 67.82% and 5 with 59.72%, have the lowest efficiency range among the companies under investigation. It is noteworthy that DMUs of both 5 and 9 for 2 years were the most inefficient companies and the lowest efficiency range obtained from CCR model in 7 years, belongs to DMU of 5 in 2005. The only company that during period of 7 years has 100% efficiency, is DMU of 13 and then it can pointed to DMU of 21 that only in 2006 has 99.86 % efficiency and in other financial years has 100% efficiency.

Input oriented BCC model

In this section like the previous section, by using four inputs and five outputs, efficiency of membered companies of Pharmaceutical Industry is gauged. For this purpose, BCC model of the input of axis is used. The obtained results of solving this model can be observed by GAMS software in Table (4).

Table 4, results of BCC model of input and output oriented (2003-2006)

	2003		2004		2005		2006	
	Out	In	Out	In	Out	In	Out	In
DMU 1	76	70	96	80	96	89	87	68
DMU 2	100	100	100	100	100	100	100	100
DMU 3	95	98	100	100	100	100	100	100
DMU 4	100	100	100	100	100	100	100	100
DMU 5	100	100	82	96	53	83	100	100
DMU 6	100	100	100	100	100	100	100	100
DMU 7	81	90	75	85	100	100	100	100
DMU 8	100	100	87	86	97	73	92	69
DMU 9	73	80	92	60	100	100	100	100
DMU 10	71	78	85	88	100	100	96	90
DMU 11	86	85	100	100	100	100	100	100
DMU 12	100	100	100	100	95	94	100	100
DMU 13	100	100	100	100	100	100	100	100
DMU 14	88	95	74	83	75	79	82	88
DMU 15	77	84	67	81	75	76	83	85
DMU 16	77	79	84	92	100	100	100	100
DMU 17	100	100	84	76	91	75	84	74
DMU 18	100	100	100	100	81	64	61	74
DMU 19	71	74	64	74	75	74	72	64

DMU 20	100	100	100	100	81	78	72	70
DMU 21	100	100	100	100	100	100	100	100
DMU 22	65	72	64	66	77	71	78	74
DMU 23	73	78	65	78	87	85	100	100
DMU 24	100	100	100	100	100	100	100	100

Continue Table 4, results of BCC model of input and output oriented (2007-2009)

	2007		2008		2009	
	Out	In	Out	In	Out	In
DMU 1	100	100	100	100	100	100
DMU 2	92	81	100	100	86	85
DMU 3	100	100	100	100	100	100
DMU 4	93	92	90	88	90	92
DMU 5	100	100	67	93	100	100
DMU 6	100	100	78	86	77	81
DMU 7	100	100	100	100	100	100
DMU 8	94	80	99	87	92	83
DMU 9	70	71	74	76	93	95
DMU 10	91	97	100	100	70	90
DMU 11	100	100	100	100	100	100
DMU 12	100	100	100	100	100	100
DMU 13	100	100	100	100	100	100
DMU 14	81	77	83	83	85	86
DMU 15	81	82	91	97	95	91
DMU 16	100	100	100	100	100	100
DMU 17	95	87	100	100	97	96
DMU 18	97	95	81	93	100	100
DMU 19	84	65	87	72	79	73
DMU 20	73	72	90	79	100	100
DMU 21	100	100	100	100	100	100
DMU 22	84	74	83	79	95	95
DMU 23	97	92	86	88	82	81
DMU 24	92	92	100	100	100	100

As shown in Table (4) in 2003, among the surveyed companies, 12 companies have an efficiency equal one. Similarly, in 2004 to 2009, respectively, 11, 12, 14, 10, 12 and 12 units have been identified as efficient units. The lowest level of efficiency in 2003 belongs to DMU of 1 and is equal 69.73%. Similarly, for 2004 to 2009, respectively, the DMUs of 9 with 60.03%, 18 with 64.32 % , 19 with 64.22 % , 19 with 65.15 %,19 with 71.63% and 19 with 72.89% , have the lowest efficiency among the investigated companies . It is noteworthy that DMUs of 19 has been the most inefficient company for four consecutive years and the lowest efficiency obtained from BCC model of input of axis during seven years belongs to DMU9 in 2001.DMUs of 13 and 21 seven years period, had 100% efficiency based on this model and after them, DMUs of 3, 12 and 24 After the DMU 3, 12 and 24 have shown the best performance in this period. DMU of 3 only had 98.05% efficiency in 2003 and has 100% efficiency in other financial year. DMU of 12 except in 2005 that had 93.51% efficiency also has been completely efficient in other years. DMU of 24 had 91.67% efficiency in 2007 and in the rest years of the reviewing period was 100% percent efficient. By comparing BCC method of axis input and CCR method, it can be seen that more units have been identified efficient by BCC method and also in this method, there is a less distance between inefficient and efficient companies in comparison to CCR model that this is due to returns to variable scale of model BCC. As shown in Table (4), the number of units in each financial year has been identified effective, exactly like the mode of axis input of BCC model. Also the lowest level of efficiency in 2003 belongs to DMU of 22 and is equal 65.24%. Also for 2004 to 2009, respectively, the DMU 19 with 63.56%, 5 with 53.14%, 18 with 60.80%, 9 with 69.94%, 5 with 66.61% and 10 with 69.94% had the lowest efficiency among the investigated companies. It is noteworthy that DMU5 has been the most inefficient company in two years and for a seven years period, the lowest level of efficiency obtained from BCC model of output of axis belongs to this unit in 2005.

In a state of output of axis like the input mode of axis, DMUs of 13 and 21 during the period of 7 years had 100% efficiency and after them, DMUs of 3, 12 and 24 have shown their own best performance. DMU of 3 only had 95.50% efficiency in 2003 and on other fiscal years had100% efficiency. DMU of 12, except in 2005 that had 94.71% efficiency, also was quite efficient in other years. DMU of 24 had 92.24% efficiency in 2007 and in the rest years of the period of reviewing, was 100 % efficient. By comprising BCC method of axis input with axis output of this model and also results of CCR model , it can be seen that there is a less distance between efficient and in efficient companies. It indicates that if desired companies decrease their input ratios, they can improve the efficiency more than the time of their increasing output ratios.

Results of model-based on techniques COLS

As discussed in detail in Chapter Two, estimation of distance function by COLS techniques, in two modes of input axis and output axis is possible. It is expected that efficiency results obtained from these two modes, assuming returns to variable scale, differ from each other. On this basis, in this part in order to measure the efficiency of surveyed units, estimating the distance function has been done in both modes.

Solving input oriented COLS

In the present study, according to previous studies, Translog distance function order to estimate the efficiency of surveyed units has been selected. Also input and output vectors, like last part, are extracted and used from obtained results of factor analysis. So by considering vector of input variables, including four financial ratios R10, R15, R18 and R39 and vector of output variables consisting of five financial ratios R4, R5, R19, R26 and R36, Translog estimable distance function in mode of axis input, can be shown as equation (32)

.

$$\ln(D_{Ii}/x_{1i}) = \alpha_0 + \sum_{m=1}^{5}\alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{5}\sum_{n=1}^{5}\alpha_{mn}\ln y_{mi}\ln y_{ni} + \sum_{k=2}^{4}\beta_k \ln(x_{ki}/x_{1i}) + \frac{1}{2}\sum_{k=2}^{4}\sum_{l=2}^{4}\beta_{kl}\ln(x_{ki}/x_{1i})\ln(x_{li}/x_{1i}) + \sum_{k=2}^{4}\sum_{m=1}^{5}\delta_{km}\ln(x_{ki}/x_{1i})\ln y_{mi}$$

$$i = 1,2,3,...,24 \qquad (32)$$

By estimating equation (32) by constrained OLS and consideration of assumptions (1) and (2) , the initial parameters of function of axis input can be estimated. For this purpose, SAS (statistical analysis software) was used that is one of the powerful statistical software in field of estimating regression functions. With the help of this software, data from 2003 to 2009 of all companies is used as a panel data set. Thus, 168 calculated data for each research variable has entered in equation (32) and we estimate the parameters of this model. The results obtained from estimating mentioned function, have been shown briefly at table (5).

$$\sum_{k=2}^{4}\beta_k = 1$$

$$\sum_{l=1}^{5}\alpha_{kl} = 0, \qquad k = 1,2,3,...,5 \quad (1)$$

$$\sum_{k=2}^{K}\delta_{km} = 0, \qquad m = 1,2,3,...,5$$

$$\alpha_{mn} = \alpha_{nm}, \quad m,n = 1,2,...,5$$

$$\beta_{kl} = \beta_{lk}, \quad k,l = 2,...,4 \quad (2)$$

As at the end of table (5) can be seen, the results of statistical tests ordinary least squares estimator of constrained statistical tests, respectively for test the goodness of fit index, or the equivalent of 92.89%, which shows that in about 93% of variability by Translog the other explanatory variables, is explained. As at the end of table (5) can be seen, the results of statistical tests of estimator of constrained ordinary least squares, respectively for test of coefficient of goodness or determining of fit is equal 92.89%, which shows that in about 93% of changes of dependent variable is explained by other explanatory variables of Translog function. To express better, we can show that based on Entry form of distance function, about 93% observations in estimation are true. Also according to the descriptions presented in the second season, due to the increasing number of model parameters, the adjusted coefficient $\bar{R}^2$ should be calculated for this estimation. The result of calculation of this coefficient shows that the goodness of done estimation fit is more than 90% by constrained OLS. Results of test of meaningfulness of overall multiple regression (F test), shows that at meaningfulness level of 99%, the assumption of $H_0 : \beta_1 = \beta_2 = ... = \beta_k = 0$, which is based on no relation between independent and dependent variables, has been refused and the opposite assumption, H_1, has been accepted. Also a large number of parameters estimated in this model, based on the t-test at 95% level are recognized meaningful. Finally, it can be concluded that based on these tests, the estimated line is fitting well by OLS.

Table 5, estimated parameters obtained from OLS method for in and output oriented of distance function

Parameter	Cols coefficient rate		Parameter	Parameter	
	Output Oriented	Input Oriented		Output Oriented	Input Oriented
α_0	-2.95	-2.97	α_{44}	0.004	0.07
α_1	-	0.42	α_{45}	-0.03	-0.005
α_2	0.24	0.35	α_{51}	-	0.04
α_3	0.45	0.54	α_{52}	0.04	0.01
α_4	0.48	-0.30	α_{53}	0.01	0.01
α_5	-0.17	-0.12	α_{54}	-0.03	-0.005
α_{11}	-	1.73	α_{55}	0.01	-0.02
α_{12}	-	-0.06	β_2	0.04	-0.11
α_{13}	-	0.05	β_3	0.42	0.24
α_{14}	-	0.15	β_4	0.50	0.86
α_{15}	-	0.04	β_{11}	1.85	-
α_{21}	-	-0.06	β_{12}	-0.54	-
α_{22}	-0.05	-0.01	β_{13}	0.13	-
α_{23}	0.06	-0.02	β_{14}	0.12	-
α_{24}	-0.04	0.04	β_{21}	-0.54	-
α_{25}	0.04	0.01	β_{22}	0.08	0.48
α_{31}	-	0.05	β_{23}	-0.01	-0.04

α_{32}	0.06	-0.02	β_{24}	-0.001	-0.13
α_{33}	-0.05	-0.02	β_{31}	0.13	-
α_{34}	0.008	0.002	β_{32}	-0.01	-0.04
α_{35}	0.01	0.01	β_{33}	-0.02	-0.008
α_{41}	-	0.15	β_{34}	-0.03	-0.01
α_{42}	-0.04	0.04	β_{41}	0.12	-
α_{43}	0.008	0.002	β_{42}	-0.001	-0.13
R^2 (%)	98.15	92.89			F Value
$\bar{R}^2$ (%)	97.55	90.58			Pr > F

Continue Table 5, estimated parameters obtained from OLS method for in and output oriented of distance function

Parameter	Cols coefficient rate	
	Output Oriented	**Input Oriented**
β_{43}	-0.01	-0.03
β_{44}	-0.09	-0.04
δ_{12}	-	0.18
δ_{13}	-	0.11
δ_{14}	-	0.07
δ_{15}	-	-0.01
δ_{21}	0.64	-
δ_{22}	-0.06	-0.05
δ_{23}	0.02	0.001
δ_{24}	0.03	0.005
δ_{25}	0.01	0.01
δ_{31}	-0.12	-
δ_{32}	-0.05	-0.10
δ_{33}	-0.01	-0.04
δ_{34}	-0.01	-0.06
δ_{35}	-0.004	-0.01
δ_{41}	-0.38	-
δ_{42}	-0.008	0.01
δ_{43}	-0.08	-0.05
δ_{44}	0.04	-0.09
δ_{45}	-0.004	0.03
	40.18	163.30
	<.0001	<.0001

After determining the goodness of done fit by OLS, in second stage of solving COLS model, the intercept of (α_0) obtained from OLS method should be modified by adding the largest positive value of its disruption in each financial year, and thereby, the estimated efficient frontier for each year, is determined (Coelli and Perelman, 1999).

The biggest disturbing sentences for COLS Model are respectively: the value of 0.2006 in 2003, the value of 0.0885 in 2004, 0.1021 in 2005, 0.1576 in 2006, 0.0415 in 2007, the value of 0.0566 in 2008, 0.1242 in 2009. Accordingly, the estimated line by OLS model is modified as much as these values and the efficiency frontier are estimated for these years. Then, by using the other estimated parameters of table (5) and putting them in equation (32), the distance function of axis input is calculated for each company in each financial year. Then with measuring the distance among identified points given by distance function, compared to estimated efficiency frontier by COLS model, the efficiency of each investigated unit is identified in that year. The results obtained from this process are reflected in table (6). Based on the information of this table and what was said, a unit that devoted itself the most value of disruption sentence of OLS model , allocated itself the efficiency equal 100% because of forming frontier .The units are : DMU21 in 2003, DMU16 in 2004, DMU2 in 2005, DMU7 in 2006, DMU5 in 2007, DMU5 in 2008 and DMU12 in 2009 .

Also the most inefficient units estimated by COLS model in mode of input axis are respectively: DMU18 with 73.87% efficiency in 2003, DMU20 with 85.84% efficiency in 2004, DMU15 with 83.10% efficiency in 2005, DMU8 with 81.39% efficiency in 2006, DMU4 with 90.77% efficiency in 2007, DMU18 with88.53% in 2008 and DMU1 with 82.32% efficiency in 2009. In this method, unlike the DEA model, many companies did not have 100% efficiency and ranking of investigated companies is possible.

Table 6, results of measuring the efficiency of COLS technique in input and output modes of axis

	2003		2004		2005		2006	
	Out	In	Out	In	Out	In	Out	In
DMU 1	98	89	85	95	86	93	94	84
DMU 2	100	88	100	87	100	100	100	93
DMU 3	88	82	89	91	88	90	96	91
DMU 4	96	82	82	92	87	90	99	84
DMU 5	88	83	83	89	86	87	90	83
DMU 6	89	90	85	90	74	90	92	86
DMU 7	87	86	81	98	86	96	95	100
DMU 8	96	77	89	89	89	86	92	81
DMU 9	88	79	87	96	92	89	95	87
DMU 10	93	79	86	87	87	84	93	85
DMU 11	97	81	87	90	89	94	97	92
DMU 12	97	84	90	93	89	90	100	85
DMU 13	91	75	82	93	86	94	88	88
DMU 14	92	80	86	88	88	86	94	82
DMU 15	87	86	89	87	94	83	92	88
DMU 16	93	78	93	100	90	96	88	91
DMU 17	96	80	80	92	80	90	92	87
DMU 18	92	74	79	86	86	88	99	90
DMU 19	89	81	86	89	90	88	89	83
DMU 20	92	82	91	86	88	90	90	84
DMU 21	98	100	84	96	93	85	85	88
DMU 22	96	84	80	97	85	94	94	88
DMU 23	92	82	85	93	87	92	90	83
DMU 24	99	77	83	88	86	85	92	84

Continue Table 6, results of measuring the efficiency of COLS technique in input and output modes of axis

	2007		2008		2009	
	Out	In	Out	In	Out	In

DMU 1	97	95	88	94	94	82
DMU 2	92	94	88	93	93	88
DMU 3	90	95	93	96	93	87
DMU 4	95	91	91	92	93	89
DMU 5	100	100	90	100	100	89
DMU 6	87	98	87	93	95	87
DMU 7	99	97	100	96	97	85
DMU 8	95	91	95	99	94	89
DMU 9	89	95	91	96	93	91
DMU 10	93	94	95	94	94	88
DMU 11	95	95	91	91	96	89
DMU 12	92	92	86	100	92	100
DMU 13	93	95	88	98	99	89
DMU 14	91	95	90	94	93	85
DMU 15	89	96	95	93	94	86
DMU 16	93	96	97	98	93	89
DMU 17	91	95	95	94	98	88
DMU 18	95	93	88	89	91	89
DMU 19	90	94	88	91	93	86
DMU 20	97	94	93	93	97	90
DMU 21	85	94	89	94	96	86
DMU 22	96	100	95	98	96	90
DMU 23	93	93	88	94	93	88
DMU 24	91	92	91	94	94	87

Solving the output oriented model of COLS

After estimating the mode of axis input technique of COLS, in this stage by considering vector of input and output variables used in previous sections, Translog distance function in mode of axis output can be shown as an estimable form in equation (33).

$$\ln(D_{oi}/y_{1i}) = \alpha_0 + \sum_{m=2}^{5}\alpha_m \ln(y_{mi}/y_{1i}) + \frac{1}{2}\sum_{m=2}^{5}\sum_{n=2}^{5}\alpha_{mn}\ln(y_{mi}/y_{1i})\ln(y_{ni}/y_{1i}) + \sum_{k=1}^{4}\beta_k \ln x_{ki}$$
$$+\frac{1}{2}\sum_{k=1}^{4}\sum_{l=1}^{4}\beta_{kl}\ln x_{ki}\ln x_{li} + \sum_{k=1}^{4}\sum_{m=2}^{5}\delta_{km}\ln x_{ki}\ln(y_{mi}/y_{1i})$$
$$i = 1,2,3,...,24$$

(33)

Like the mode of input axis, according to assumptions (3) and (4), with the help of constrained OLS, the equation (33) can be estimated.

$$\sum_{m=2}^{5}\alpha_m = 1$$
$$\sum_{n=2}^{5}\alpha_{mn} = 0, \qquad m = 2,3,...,5 \quad (3)$$
$$\sum_{m=2}^{5}\delta_{km} = 0, \qquad k = 1,2,3,4$$

$$\alpha_{mn} = \alpha_{nm}, \quad m,n = 2,...,5$$
$$\beta_{kl} = \beta_{lk}, \quad k,l = 1,2,...,4 \quad (4)$$

Conclusion

The results obtained from the estimation of mentioned function, are shown briefly in Table (7). At the end of this table, also results of statistical estimator tests of distance function of output axis are visible. These results is equal 98.15% for test of fit identification or goodness of R^2 ,that indicates more than 98% of dependent variable changes ,are estimated by other explanatory variables of Translog function. In addition, the result of adjusted coefficient of Determining $\bar{R}^2$ for done estimation is equal to 97.55%, indicating a good done fit. According to results of being meaningfulness test of total combination regression (F test), the assumption $H_0 : \beta_1 = \beta_2 = ... = \beta_k = 0$, that is based on no relation between dependent and independent variables is refused in 99% of meaningfulness level and the opposite assumption,H_1 is accepted. In this model, many estimated parameters in 95% level, are recognized meaningful based on T test. According these tests, it is observed that the estimated line from distance function of axis output is fitted well by estimator of OLS. In axis output mode, after determining the fit goodness of estimation done by OLS method, the intercept (α_0) obtained from this method should be corrected. For this purpose, in second stage of solving COLS model, the biggest negative disruption sentence of each financial year is added to (α_0) and by it, we determine the frontier of estimated efficiency for each year, (Coelli and Perelman, 1999).the biggest disruption sentences for COLS model, are respectively: -0.0799 in 2003, -0.1636 in 2004,-0.1400 in 2005,-0.0744 in 2006, -0.0678 in 2007, -0.0942 in 2008 and -0.0341 in 2009. So, the estimated line by OLS model is corrected as much as these values and the efficiency frontier are estimated for these years.

Table 7, the results of OLS for output oriented distance function

Parameter	COLS coefficient	Parameter	COLS coefficient	Parameter	COLS coefficient
α_0	-2.95592	α_{54}	-0.03642	β_{42}	-0.0011
α_2	0.24008	α_{55}	0.01686	β_{43}	-0.03641
α_3	0.45683	β_1	-0.65311	β_{44}	-0.04309
α_4	0.48089	β_2	0.04279	δ_{12}	0.18966
α_5	-0.1778	β_3	0.4298	δ_{13}	0.11476
α_{22}	-0.05627	β_4	0.50485	δ_{14}	0.0721
α_{23}	0.06474	β_{11}	1.8529	δ_{15}	-0.01558
α_{24}	-0.04731	β_{12}	-0.5442	δ_{22}	-0.05828
α_{25}	0.04179	β_{13}	0.13764	δ_{23}	0.00171
α_{32}	0.06474	β_{14}	0.12886	δ_{24}	0.0053
α_{33}	-0.05322	β_{21}	-0.5442	δ_{25}	0.01166
α_{34}	0.00862	β_{22}	0.08082	δ_{32}	-0.10217
α_{35}	0.01251	β_{23}	-0.01904	δ_{33}	-0.04243
α_{42}	-0.04731	β_{24}	-0.0011	δ_{34}	-0.06066
α_{43}	0.00862	β_{31}	0.13764	δ_{35}	-0.01569
α_{44}	0.00478	β_{32}	-0.01904	δ_{42}	0.01972
α_{45}	-0.03642	β_{33}	-0.02303	δ_{43}	-0.05736
α_{52}	0.04179	β_{34}	-0.03641	δ_{44}	-0.09472
α_{53}	0.01251	β_{41}	0.12886	δ_{45}	0.03197
R^2 (%)	98.15		F Value	163.30	
$\bar{R}^2$ (%)	97.55		Pr > F	<.0001	

Then, like mode of axis input, here the distance function of axis output for each company in each year is calculated by using the other estimating parameters of table (7) and putting them in equation (33).and by measuring the distance between determined points by distance function compared with frontier of estimation efficiency by COLS model, the efficiency of each investigated unit is determined in that year. Results of efficiency measurement by COLS model in axis output are reflected in Table (8), based on data of mentioned table, the units with 100% efficiency, include : the DMU2in 2003, DMU2 in 2004, DMU2 in 2005, DMU12 in 2006, DMU5 in 2007, DMU7 in 2008 and DMU5 in 2009.also, the most inefficient estimated units by COLS model in mode of axis output are: DMU15 with 86.91% efficiency in 2003, DMU18 with 79.44% efficiency in 2004, DMU6 with 74.14% efficiency in 2005, DMU21 with of 85.24% efficiency in 2006, DMU21 with 84.96% in 2007, DMU12 with 86.17% efficiency in 2008 and DMU18 with 90.81 efficiency in 2009.

Table 7, the result of COLS in output oriented model

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
DMU 1	97.93%	84.64%	86.44%	93.58%	96.94%	87.68%	94.32%
DMU 2	100.00%	100.00%	100.00%	99.71%	91.52%	87.77%	93.05%
DMU 3	87.75%	89.30%	87.66%	95.76%	89.86%	92.97%	93.14%
DMU 4	96.37%	81.96%	87.09%	98.81%	95.45%	91.22%	92.81%
DMU 5	87.78%	82.66%	86.43%	90.38%	100.00%	89.57%	100.00%
DMU 6	88.54%	84.60%	74.14%	91.74%	87.28%	87.02%	95.01%
DMU 7	87.00%	80.59%	85.70%	95.07%	99.13%	100.00%	96.51%
DMU 8	95.51%	88.65%	89.23%	92.10%	95.00%	95.33%	93.92%
DMU 9	87.64%	87.40%	91.98%	94.72%	88.53%	90.70%	92.85%
DMU 10	93.16%	85.51%	87.30%	92.99%	93.16%	94.96%	93.56%
DMU 11	97.27%	86.64%	88.55%	96.97%	95.09%	90.74%	95.66%
DMU 12	96.95%	90.10%	89.04%	100.00%	92.46%	86.17%	92.03%
DMU 13	90.69%	82.28%	85.74%	87.98%	92.68%	88.00%	98.99%
DMU 14	92.47%	85.73%	87.74%	93.90%	91.40%	89.83%	92.87%
DMU 15	86.91%	88.72%	93.95%	92.15%	89.48%	94.85%	93.52%
DMU 16	93.05%	93.07%	90.32%	87.77%	92.77%	97.33%	93.04%
DMU 17	95.60%	80.16%	79.98%	92.29%	91.28%	94.84%	97.81%
DMU 18	92.13%	79.44%	85.72%	98.58%	95.26%	88.28%	90.81%
DMU 19	89.35%	86.05%	89.52%	89.45%	90.40%	88.38%	92.56%
DMU 20	91.87%	90.51%	88.09%	89.56%	97.49%	93.42%	96.67%
DMU 21	97.75%	84.11%	92.89%	85.24%	84.96%	89.27%	96.41%
DMU 22	95.79%	79.68%	84.80%	93.92%	95.61%	94.70%	96.39%
DMU 23	92.36%	84.99%	87.15%	89.80%	92.99%	87.98%	92.97%
DMU 24	98.95%	83.45%	85.84%	91.56%	90.52%	90.61%	94.39%

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