

A Model for Evaluating Financial Performance of Companies by Data Envelopment Analysis

A Case Study of 36 Corporations Affiliated with a Private Organization

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Received: May 15, 2012

Accepted: June 5, 2012

Online Published: July 1, 2012

doi:10.5539/ibr.v5n8p8

URL: <http://dx.doi.org/10.5539/ibr.v5n8p8>

Abstract

In the contemporary world, with the rapid growth of commercial activities there is no doubt on the inevitability of existence of a performance evaluation system in all organizations. This necessity is so evident that the lack of an evaluation system is regarded as a symptom of the organization unhealthiness. Financial evaluations encourage companies to attain a higher level of performance by showing current financial position of a company in relation to other companies and creating a competitive environment. Such evaluations are also useful in reforming and improving weaknesses which is done through recognition of the strengths of performed activities. To this end, the present study has developed a model to evaluate corporate performance through data envelopment analysis and has examined the model on a group of companies. To do so, the means of financial performance for a five year period including: liquidity, activities, leverage, and economic added value are employed as input indices of Data Envelopment Analysis (DEA) Model and profitability ratios as output indices of the model. BCC input oriented covering model was used to rank the companies under study. Besides, a group of 36 companies were employed as the sample in the present case study of which 9 companies were found as efficient and the remaining 27 companies were regarded as inefficient. Efficient corporate were further ranked by Anderson Peterson Model. Finally, the extent and causes of weaknesses of each company were expressed by the use of reference units and auxiliary variables.

Keywords: data envelopment analysis, performance evaluation, evaluation

1. Introduction

Performance evaluation is regarded as a useful step in attaining a self evaluation method and consequently the improvement of accountability power. Some scholars have considered performance evaluation as a part of the great and emerging movement of accountability. They believe that performance evaluation is one of the best methods employing an accountability approach. Performance evaluation is itself in the need of some indexes through which to evaluate corporate performance. Performance evaluation indices are in fact an action guide from *what it is* towards *what it should be*. Evaluating the performance of firms and factories can act as a guideline that paves the way for future decisions, concerning investment, development, and, most importantly, control and supervision. (Tehrani & Rahnama, 2006)

2. Statement of the Problem

The history of investment and investors' performance has indicated that investment outcomes must be evaluated at the end of investment period to determine to what extent the performance of an enterprise is acceptable with regard to selecting the object, how to invest, how to finance, capital management, exploitation of financial and human resources, and the quality of capital control. Prior to the 18th century, due to low volume and limited diversification of investments there was no need for performance evaluation and ranking of companies. However, with a rise in the diversification of investments and investment volumes, especially the emergence of new approaches for corporate partnership such as joint stock companies, the quality of capital turnover got more complicated and, thus, the necessity of developing new approaches for evaluating managers' performance and companies ranking was brought in forefront of consideration. As a result and due to the influence of other factors,

the multitude and complexity of formulae and approaches for performance evaluation of investments as a base for ranking companies in terms of investments' preferences, complexity, volume, size, the type of investments, and other influencing factors, the employment of simple ROI formulae to complicated mathematic techniques has been continued until now (IslamiBidgoli, 2003).

Financial evaluations have been among the oldest and the most important approaches used for evaluating the performance of companies which are mainly based on financial statements. Financial analyses provide valuable information regarding procedures, correlations, qualities, dividends, and finally corporate strengths and weaknesses and the quality of their financial positions. Four main instruments used for performing such analyses are horizontal, vertical, procedural, and ratio analyses. Corporate performance analysis can provide an insight to managers over time to know their future directions. Such type of analysis, especially if illustrates companies' strengths and weaknesses over different time periods, is useful in recognizing the past and present conditions and of vital value for future strategies. Performance should be evaluated in a way that to recognize useful managerial information and provide some guidelines to direct future operations. In order to carry out performance analysis, various utility analysis approaches were investigated in this study and finally an envelopment data analysis was chosen as analysis framework.

3. Major Objectives of the Study

The main objective of the study is to develop a model for the evaluation of companies' performance through financial information and envelopment data analysis technique. The model can be useful in comparing the output and efficiency of different companies to provide some suggestions for their future.

Minor objectives of the study:

- Evaluating and monitoring current control and evaluation system used in corporate.
- Attaining a comprehensive financial system for evaluating companies' performance.
- Increasing reliability, accuracy, and the rate of evaluation system of companies' performance.
- Providing financial indices affecting the assessment of companies' performance.
- Finally, developing DEA practical models for evaluating companies' performance.

4. Review of Literature

Since the present study aims to develop a financial model to evaluate companies' performance, a summary of studies done in Iran and in other countries in various areas is presented here:

4.1 Studies Done in the Field of Investment Funds with the DEA Model

Zhao, Wang and Lai (2011) in a study titled "Mutual funds performance evaluation based on endogenous benchmarks" developed two second order DEA models to evaluate the performance of investment funds based on an internal measurement. The study makes a distinction between two vital factors associated with the performance of investment funds, i.e. risk and productivity. This method was tested in a sample of 25 investment funds active in china market. The results of the study indicate ranking of investment funds is more associated with the system risk control than other factors.

Zhao and Yue (2010) in a study "A multi-subsystem fuzzy DEA model with its application in mutual funds management companies' competence evaluation" proposed a (DEA) based on the fuzzy logic in the form of several subsystems in order to evaluate the main core of competitions for the management of investment funds. To analyze the completions for the management of investment funds in a financial market, Zi Joan considers the distance these organizations perceive for achieving their objectives and then analyzes the management of investment funds.

Edirisinghe and Zhang (2010) in their study "Input/output selection in DEA under expert information, with application to financial markets", embarked a study on fundamental analysis of business firms through the employment of quarterly financial data to determine an optimized fundamental empowerment index based on the DEA method. Over 800 business organizations including a large part of the US Stock Market were employed to assess the model.

Sebastian and Ester (2008) conducted a study on "Data envelopment analysis of mutual funds based on second-order stochastic dominance". In this study, they considered whether data envelopment analysis can be employed pervasively to evaluate the performance of investment funds. However, most methods employed based on the DEA overestimate the rate of the existing risks in portfolios' internal scales. This is due to the fact that in conventional DEA method, the risks associated with portfolios are the same as a linear blend of existing risks in

investment funds which may lead to overlook the significant effects of portfolios' irregularities. In the study, 6 DEA pseudo-linear modeling programs were assessed in estimating the partial efficiency of investment funds along with a second order stochastic control (SSD).

Zhao and Wang (2007) in their study under the title of "Empirical Study on Chinese Mutual Funds' Performanc" evaluated the performance of investment funds active in China via the DEA method. The sample under study included 24 institutions with open investment and 54 institutions with closed investment in 2004 and 2005. Results of the study suggest that the majority of investment funds working in Chinamarket are not efficient.

Gregoriou, Sedzro, Komlan and Zhu (2005) conducted a study titled "Hedge fund performance appraisal using data envelopment analysis" to evaluate the performance of risk coverage funds via (DEA). One of advantages of the employment of DEA approach is that it does not need a lucid criterion and as a result reduces the problems resulting from the use of scales and criteria to investigate abnormal distribution of return of the investment in these funds.

Panayiotis (2004) in a study entitled "Performance Evaluation of the Bond Mutual Funds Operating in Greece" evaluated the performance of 39 joint investment funds in financial markets in Greece within the time period of 15/03/1999 to 12/31/1999. The ranking of these investment funds was different in the average return of the investment and the overall risk of the investment.

Galagedera and Silvapulle (2002) studied "Australian Mutual Fund Performance Appraisal Using Data Envelopment Analysis" to measure the relative efficiency of 257 investment funds in Australia. They also investigated the reasonable return using (DEA) to determine how the efficiency of these funds is dependent on characteristics, management strategies and their operational environment. The efficiency was examined with different combinations of input-output variables.

Basso and Funari (2001) in a study entitled "Theory and methodology a Date Envelopment Analysis approach to measure the mutual fund performance" developed a model that can be used in the performance evaluation of investment funds. This model employs a kind of operational research methodology known as (DEA). In this method, several inputs and variables can be manipulated and, as a result, it is possible to examine various risk measures. The results of this study suggest that by using this process it is possible to determine a mixed portfolio for each specific fund to be used as a specific benchmark for the fund.

4.2 Studies Done in the Field of Banking with the DEA Model

Halkos and Salamouris (2004) evaluated the performance of Greek banking sector and determined their efficiency using data envelopment analysis and financial ratios. The results showed that DEA can be used as both a substitute for and a supplement to traditional methods of financial analysis to evaluate the performance of organizations.

IslamiBidgoli and Kashani Poor (2004) in a study under the title of "Comparing and evaluating methods performance evaluation of bank branches and suggesting a suitable model" measured the efficiency of 142 branches of Tejart Bank, using triple data envelopment analysis, stochastic frontier methods, and financial ratios. They ranked 142 branches based on their efficiency for each of these three methods. The results of the study demonstrated that of these three new models, data envelopment analysis is more appropriate for measuring the efficiency of the bank branches.

Haghighat and Nassiri (2003) in an article entitled "An investigation of banking system performance using data envelopment analysis (a case study of Agricultural Bank)" evaluated the performance of 172 branches of Agricultural Bank with fixed and variable returns assumptions at a scale in a region of the country. Technical efficiency of the branches was estimated and finally some branches were selected as inefficient units for the reference model.

4.3 Other Studies Done in the Field of DEA and Performance Evaluation

Wen-Cheng LIN, Chin-Feng LIU and Ching-Wu CHU (2005) in a study titled "Performance Efficiency Evaluation of The Taiwan's Shipping Industry: An Application of Data Envelopment Analysis" tried to develop a suitable method to evaluate the performance of shipping industries with regard to financial indexes since financial indexes are not easily quantifiable at times and the measured financial indices seem suspicious and unreliable. As a result, financial indices are regarded as important measures of performance evaluation.

Feroz, Kim, and Raab (2003) examined financial statements of a sample of corporations active in oil and gas industry by data envelopment analysis. They suggested that DEA can be a suitable complement for traditional

analysis of financial ratios in business corporations. In addition, DEA serves as a reliable and stable basis to evaluate managerial and operational performance of companies.

Sueyosh (2000) in a study: "A process for evaluating retail store efficiency: a restricted DEA approach" has pointed out that one of the disadvantages of previous BEA-based analyses is that such analyses are often applied for evaluating companies' past performance. Emphasizing that making plans for the future is more important than past performance, this study has developed a random DEA model and then as it is the case for random models, future information is incorporated in the model under study as well. The proposed model in the study has been called "DEA future analysis".

Keung (2000) examined whether data envelopment analysis based on risk-return considerations can determine stocks priced relative to bad stocks. In this study, four industry including telecommunications, telecommunication equipment, hardware and software, and computer services were tested at the end of 1997 and 1998. The result of examination of data envelopment analysis indicated that software industry had the lowest pricing efficiency while the telecommunications industry enjoyed the highest pricing efficiency.

Worthington (1998) compared the performance of 30 gold generating companies through data envelopment analysis. The results of the study indicated that simple ratios are not useful in comparing and ranking the performance of the companies and, therefore, multiple input and output methods should be applied to do so.

Khajavi, GhayuriMoghadam and Ghaffari (2010) conducted a study titled "Data envelopment analysis as a complement for traditional analyses of financial ratios" to perform a comprehensive analysis of financial statements that takes into account and accumulate all financial ratios. To do so, the study has proposed Data envelopment analysis and financial statements of 267 corporations have been analyzed for the time period of 2005 to 2007. In addition, financial ratios of 4 inputs and 7 outputs have been analyzed in the input based BCC envelopment model, showing that 32 corporations enjoyed a relative efficiency.

Mohammadi (2007) in his study under the title of "Application of mathematical planning technique (hierarchical analysis and data envelopment analysis) to analyze financial statements of medicine companies" has suggested that of the liquidity ratios, growth, increase in proportion of owners' equity and of operational ratios, the inventory turnover ratios are of highest significance in the medicine industry. Then the scores for inefficiency of medicine companies were determined using the data envelopment analysis model.

Kimiagari and Farhad (2006) in a study titled "Development of a model to measure, evaluate, and rank the financial performance of urban water and drainage companies" have introduced and examined a number of method used in financial evaluation including activity-based cost estimation, Malcolm Baldrige's rewarding model, balance score card, European quality award, economic value added etc. Finally, they have developed a model with flexibility and comparability features through Eviews Software for each year based on evaluation models.

Khajavi, SalimiFard, and Rabiyyeh (2005) conducted a study on "The employment of the data envelopment analysis for determining portfolios of highly efficient companies accepted in Tehran's Stock Market". In this study, input based CCR model with envelopment form was employed. The results of the study indicated that of 90 companies under investigation, comprising 32% of the total numbers of companies were determined as efficient companies while the remaining 61 companies were inefficient.

QodratianKashan and AnvariRostami (2004) in a study named "Development of a comprehensive model for performance evaluation and ranking of companies" have proposed a model to be used for ranking companies. To do so, after reviewing a comprehensive literature, the authors have examined four components of 6 components of finance, internal processes, customers, development and innovation, human resources, and management in the BCC model. Based on the examination of these components, 422 performance indexes were derived to evaluate and rank companies. In addition, decision making model for several indexes was employed for making it possible to make a final and collective judgment on final ranking of each company. In this study, the authors have pointed out that the ranking methods lack the desired totality and therefore they are not efficient in determining weaknesses, strengths, opportunities, and threats. The reason is that such methods are often dependent on a single index. However, this study has employed 6 indices of finance, customers, human resources, development and innovation, and management internal processes along with 422 secondary indices. After the determination of the components under study and the significance of each components by Shannon's Entropy Technique, the weight of each index used in the model was measured and finally the sample of automobile companies were ranked practically through Tapsis technique.

5. Research Question

The present study aims to answer the following question:

Which model can be used with companies' financial information and data envelopment analysis to rank companies and evaluate their performance?

6. Research Methodology

Research methods in behavioral sciences are in general divided according the following two criteria:

- a) Research objectives
- b) The method of data collection

Since the present study deals with a real, objective, and dynamic subject, it follows an applied objective and is a descriptive research with regard to the method of data collection and, as a result, it employs a cross sectional survey method (Sarmad, Bazargan & Hejazi, 2010).

In comparison with parametric methods such as regression, the DEA model has some advantages (Charnes et al., 1987):

1. Concentration on each observation instead of the average of population.
2. Providing an individual measurement approach for each unit that uses independent variables (inputs) to make dependent variables (desired outputs).
3. Using multiple inputs and outputs at the same time.
4. Adaptable to exogenous variables.
5. Be able to include replica variables.
6. There is no need to know previous weights of inputs and outputs.
7. The functional form of the production relationship does not limit it.
8. Providing an estimate for changes in inputs and outputs to make the units efficient.
9. Optimum response of Pareto.
10. Equity standards in the relative evaluation of each unit are met.

Main instruments used in the present study are as follows:

To determine variables under study and their weights in the DEA model, field research and questionnaires were employed. Besides, library research, documents, books, articles, theses, and internet references were employed to review the literature on the subject matter. And finally to collected financial data organizational documents (financial statements) were used in the present study.

7. Data Collection

A questionnaire was used in the present study to determine input and output variables in the DEA model. The questionnaire contained two types of questions. The first part of questions dealt with the determination of input variables affecting the performance evaluation and the second set of questions was associated with the determination of output variables affecting the performance measurement. The number of questions dealing with input variables was 11 and those related to output variables were 6 designed based on the Likert scale. The questionnaire employed in the study served as an instrument to obtain input and output variables affecting the research problem to carry out the DEA model and was administered to accounting and financial professors (from British, Iranian, and Australian universities).

In addition, to determine the weight of input and output variables, a questionnaire was administered to the experts in the field to weigh input and output ratios. Furthermore, in order to calculate the specified ratios according to the financial statements, the mean of these ratios for a period of five year for each company of the corporations was found and applied to the model.

8. Research Variables

Independent Variables under study are:

Input and output variables including financial ratios (current ratio, quick ratio, working capital ratio, accounts receivable turnover ratio, inventory turnover ratio, Asset turnover ratio, collection period ratio, debt ratio,

interest coverage ratio, equity ratio, economic value added (EVA), ROA ratio, ROE ratio, return on current assets ratio, return on equity ratio, operational profit to sale).

The dependent variable was determined as companies' performance and efficiency.

9. Research Population and Sampling Procedure

The population under study consisted of 36 corporate in a holding involving in different activities. Since the research population was limited the sample of the study was selected as the whole companies in the population under study.

10. Data Analysis

A questionnaire was employed to measure variables under investigation. To do so, performance evaluation indexes were derived from financial statements and ratios existing in different books and articles and since there were a large number of variables, a questionnaire was developed and distributed among professors and experts to select those indices were more significant and influential.

To analyze the collected data, data envelopment analysis was used in the present study. The employed model was BCC coverage model and Anderson & Peterson model. In addition, for the confidentiality matters a set of specific codes were used instead of companies' name.

10.1 Software Used in the Study

To analyzed information obtained from companies and estimate financial ratios, Excel software was used. Besides, Lingo 13, and Winqs software packages were run to perform the DEA model. Finally, SPSS Software was used to analyze the questionnaires.

10.2 Weighing of Ratios

Input variables were divided into three groups of liquidity, activity, and leverage ratios while output variables were put in a single group i.e. profitability ratio. Table1 shows the result of weighing and the final model is shown in figure 1.

Table 1. Results Weighting Variables

		Weight	
Liquidity Ratio	Current Ratio	0.50	INP1
	Quick Ratio	0.30	
	Working Capital Ratio	0.20	
	Total	1.00	
Activity Ratio	Accounts Receivable Turnover Ratio	0.20	INP2
	Inventory Turnover Ratio	0.25	
	Asset Turnover Ratio	0.35	
	Collection Period Ratio	0.20	
	Total	1.00	
Leverage Ratio	Debt Ratio	0.50	INP3
	Interest coverage Ratio	0.30	
	Equity Ratio	0.20	
	Total	1.00	
Economic Indicator	Economic Value Added	1.00	INP4
Profitability Ratio	Return On Assets (ROA)	0.35	OUT
	Return On Equity (ROE)	0.22	
	Return On Current Assets	0.10	
	Return On Equity	0.18	
	Operating Profit to Sales	0.15	
	Total	1.00	

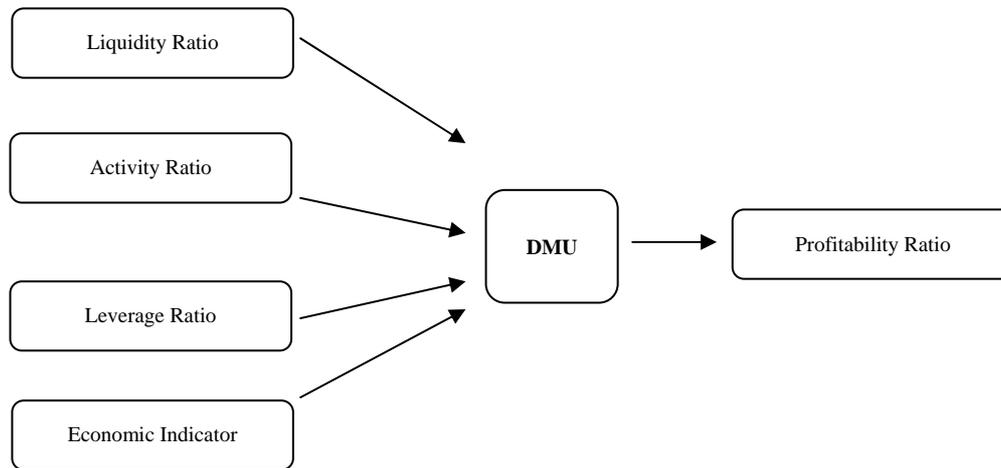


Figure 1. Final Model

11. Conclusion from the Research Question

Because of applying the financial ratios as the input and output indices of the DEA model, the obtained model can evaluate the financial performance of companies, which is the most important aspect of evaluation in each company.

Since the author was committed to keep the data obtained from the companies as secret and confidential, companies were codified to keep the information related to each company as secret.

1. Can the developed model capably evaluate and estimate the companies' performance?

The result obtained from the DEA model indicate that of 36 companies examined through the study, 9 companies were regarded as efficient while the remaining 27 companies were determined as inefficient implying that the model can accurately measure companies' performance. The selected indexes and the derived model can efficiently investigate and compare the companies' financial positions as well.

2. How was the companies' efficiency evaluated within the time period of 2005 to 2009?

Efficiency measure obtained through the DEA model in the area under study ranked 36 companies (of which 9 were efficient and 27 ones as inefficient).

12. Suggestions for Future Researchers

Future researchers can focus more on the following topics:

- a) Future researchers can rank and evaluate a set of companies active in stock market by the model proposed in this study using the DEA method.
- b) In addition to indexes investigated here through the present study, future researchers can examine other qualitative indexes to further develop the proposed model.

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