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Research Paper

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Multi-component Efficiency with share Resources in Insurance Companies

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ABSTRACT

In the most common utilization of Data Envelopment Analysis (DEA), the existing models used to in order to obtain efficiency score. However, trough real cases, efficiency are a factor of different share resources in Decision Making Units (DMUs). Indeed, in classical models, a DMU had its own inputs and outputs and could only be effective in its own efficiency, but in the model, which introduced here, some of the inputs are used for some of the components in common and the whole component makes outputs. In this article, the efficiency of four insurance companies in six periods is examined and indices in question include debt ratio, flow of capital resources ratio, profit margin, capital output of insurance companies, and the components of capital structure, profitability, and growth are known as those using the specific and common indices. In this article, in order to calculate efficiency of a decision making unit we have used four components and determined the specific efficiency of each single component individually. In this procedure, the efficiency of each component is calculated without the effect of those indices, which are not used. Moreover, the aggregate efficiency of all components will be recognizing. With this method, we will find inefficient components in an efficient DMU and we can determine exactly which of the inefficient components make the DMU inefficient. Finally, the relative efficiency of units will be calculating in financial component.

Keywords:
Data Envelopment Analysis; Share Resources; Multi-component Efficiency; Performance Evaluation; Insurances Companies

1. Introduction:

Data Envelopment Analysis technique was introduced in 1987 by Charnes [2]. This technique is one of the ways of scientific management for performance evaluation. The model CCR was innovated by Charnes [3] and some years later, Banker [1] developed the BCC model, both of these are the basic models of DEA. DEA is a mathematical programming used for deriving relative evaluation of decision making units. The phrase, relative, is for efficiency acquired by comparing units together.

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One of the advantages of this method is that DEA estimated the objective function (Objective function is a function that achieves maximum outputs from syntax inputs [7]).

The main model of DEA examines the relative efficiency of a DMU, which is the ratio of weighted outputs to weighted input. Indeed, relative influences, which are affected by each DMU, can show themselves in the efficiency frontier [5]. One general solution for controlling weight is the Cone-ratio, which means the values should limit for weights of inputs and outputs as closed cones [4]. Our first task in developing a model on basis of DEA is to choose a formula which suites nature of that organization and issue. This similar resource makes DMUs to compete to each other. The best model is variable return to scale that was developed by Banker [1] and was known as BCC.Constant and variable returns to scale are two of the main technologies which are widely used in DEA. Our main model in assessing performance evaluation is BCC model in this article.In classical models of DEA, a standard value of efficiency for decision making units was obtained, however, in most cases, the efficiency of a DMU with resources which classify some components, is essential.

In practice, decision making units have different scenario for achieving the optimal organization. Therefore, there are common and special outputs in components that can be received as common and specific inputs by using and processing this inputs.It is more reasonable to obtain the efficiency of a DMU in different components. Obtaining efficiency, which depends on components, is not a new idea. For example, Fare and Grosskopf [6] have provided a model in multi-stage models in which outputs of a process are both outputs and these are inputs for later processes .It should be noted that this application could not be used for multi-components efficiency with common sources. In addition, Cook et al. [5] have provided a model for computing the efficiency of a component, which has share resources. Productivity is a function of internal and external indices .The most important part in relative evaluation and productivity is to recognize the best of the community because others can be compared. From marketing point of view, insurers provide services, which reflect their commitments toward customer’s needs with high quality .Performance evaluation has extensive aspect in attracting customers, cost management, financial mediation and quality service. Shareholders want to maximize their own investment efficiency. Therefore, in financial review, we can assess insurance status in Liquidity, Capital Structure, Profitability and Growth.

2. Preliminaries

2.1. Data Envelopment Analysis

DEA is a mathematical programming technique which is widely used in measuring the relative efficiency of DMUs each if which consumes multiple inputs to produce multiple outputs. Consider a set n DMU_s . For $DMUj$, $X_j = (x_{1j}, \dots, x_{mj})^T$ and $Y_j = (y_{1j}, \dots, y_{sj})^T$ denote the semi positive vector-columns of its m inputs and s outputs, respectively .The mathematical form of the technical efficiency model used in this research is expressed in its simplest form as follows, which is the CCR model, provided by Charnes [2]:

$$
\begin{aligned}
&\boldsymbol{Min} \quad \boldsymbol{\theta_p - \varepsilon[\textstyle\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+]} \\
&\boldsymbol{S.t.} \\
&\quad -\textstyle\sum_{i=1}^{n} \boldsymbol{\lambda_j x_{ij} - s_i^- + \theta x_{ip} = 0} \ , \ \boldsymbol{i = 1, \dots, m} \quad \mathbf{(1)} \\
&\quad \textstyle\sum_{i=1}^{n} \boldsymbol{\lambda_j y_{rj} + s_r^+ = y_{rj}} \quad , \quad \boldsymbol{r = 1, \dots, s} \\
&\quad \boldsymbol{\lambda_j, s_r^+, s_i^- \geq 0} \quad , \quad \boldsymbol{for\ all\ i, j, r}
\end{aligned}
$$

Where $\varepsilon > 0$ is a non-Archimedean constant. The dual problem corresponds to (1) is as follows:

$$
\begin{aligned}
&\boldsymbol{Max} \quad \textstyle\sum_{r=1}^{s} \boldsymbol{u_r\, y_{rp}} - \sum_{r=1}^{m} \boldsymbol{vixip} \\
&\boldsymbol{S.t.} \\
&\quad \textstyle\sum_{i=1} \boldsymbol{v_i x_{ip} = 1,} \qquad\qquad\qquad\qquad \mathbf{(2)} \\
&\quad \textstyle\sum_{r=1}^{s} \boldsymbol{u_r y_{rj}} - \sum_{i=1} \boldsymbol{v_i x_{ij} \leq 0,\ j = 1, \dots, n} \\
&\quad \boldsymbol{u_r \geq \varepsilon, \quad r = 1, \dots, s} \\
&\quad \boldsymbol{v_i \geq \varepsilon, \quad i = 1, \dots, m.}
\end{aligned}
$$

Where u_r, $(r = 1, \dots, s)$ and v_i, $(i = 1, \dots, m)$ are multipliers for outputs and inputs, respectively .

2.2. Multi-component efficiency measurement

In real world application, the units under assessment may perform several different functions or may be separated into different components [8]. Hence, there is a need for providing an efficiency measurement with component-based information as part of the aggregate efficiency measure . Consider a set of n DMUs and assume that each unit is separated into b components . Let $(Y_k^{(1)}, Y_k^{(2)}, \dots, Y_k^{(b)})$ and $(X_k^{(1)}, X_k^{(2)}, \dots, X_k^{(b)})$ be the output and input vectors in which $Y_{k1}^{(i)} = \left(y_{k2}^{(i)}, y_k^{(i)}, \dots, y_{kj_i}^{(i)}\right) and\ X_{k1}^{(i)} = \left(x_{k2}^{(i)}, x_k^{(i)}, \dots, x_{kj_i}^{(i)}\right); i = 1, \dots, b,$ for DMUk .

A measure of aggregate performance $E_k^{(a)}$ can be represented as:

$$E_k^{(a)} = \frac{\sum_{i=1}^{b} \mu^{(i)^T} Y_k^{(i)} + \sum_{i=1}^{b} \mu^{(s_i)^T} (\beta Y_k)}{\sum_{i=1}^{b} V^{(i)^T} X_k^{(i)} + \sum_{i=1}^{b} V^{(s_i)^T} (\alpha X_k)} \qquad (3)$$

In the developed model, α_i, β_i and γ_i are decision variables that must be determined. The performance measure for component i, is defined as:

$$E_k^{(i)} = \frac{\mu^{(i)^T} Y_k^{(i)} + \mu^{(s_i)^T} (\beta_i Y_k)}{V^{(i)^T} X_k^{(i)} + V^{(s_i)} (\alpha_i X_k)}, \quad i = 1, \dots, b. \qquad (4)$$

As Jahanshahloo [8] have been provided the aggregate performance measure $E_k^{(i)}$ is a convex combination of the $E_k^{(a)} s$.

As regards of this assumption about the DMU and it component a DMU will be aggregated efficient if and only if it is efficient in all components.

Consider the following mathematical program:

$$\begin{aligned}
& Max \quad E_k^{(a)} \\
& \text{S.t.} \\
& E_j^{(a)} \le 1, \quad j = 1, \dots, n, \\
& E_j^{(i)} \le 1, \quad j = 1, \dots, n, \quad i = 1, \dots, b, \\
& \textstyle\sum_{i=1}^{b} \alpha_i = 1 \\
& \textstyle\sum_{i=1}^{b} \beta_i = 1 \\
& \left(\mu^{(i)}, \mu^{(s_i)}\right) \in \Omega_1, \quad i = 1, \dots, b, \qquad (5) \\
& \left(V^{(i)}, V^{(s_i)}\right) \in \Omega_2, \quad i = 1, \dots, b, \\
& \alpha_i, \beta_i, \ge 0, \qquad i = 1, \dots, b,
\end{aligned}$$

Where the sets Ω_1 and Ω_2 are assurance regions defined by any restrictions imposed on multipliers (See Thompson [9]). In the above model α and β are the portions of input and output shares. This model can be easily, as stated in Jahanshahloo et al. [8] can be converted into a linear form.

3. The Performance of Insurance Company

The shareholders of an insurance company have certain concerns about financial performance of the company.For management, both aspects of short and long-term operations of the company are important .Stockholders are more concerned about profitability of the company in long term but coincidentally, the insurers are more concerned about the ability of the company in short and long-term payments according to the contracts.Moreover, insurance representations, agents and insurers have concerns about financial analysis of the company .Of course, their views are not separated from each other but their concentration is on different issues.Financial ratio analysis is a very simple tool for recognizing the financial situation of an agency .By this method, analysis can join two parts of financial data and as a result, it is a useful comparative tool.Components show the relationship among reasons for changing and altering patterns in the best way. The relationship indicates the risks and available chance for the company which is being examined. Of course, financial components are considered based on data and previous situations of the company that may cause some difficulties for future trends of the company .

3.1. Financial ratio in insurance companies

Financial ratios in insurance companies are often divided into four components :Liquidity, Capital Structure, Profitability, and Activity.

The unique feature of insurance operations has allowed attention to be paid in selecting these components and exploiting ratios which are used in each of these groups.

3.1.1. Liquidity

In the common financial analysis, liquidity means the ability of agency, to undertake commitments in their expected time.

$$Current\ Ratio = \frac{Current\ assets}{Current\ liabilities} \qquad (6)$$

This ratio shows the ability of a company to pay current debts in the short term .

$$Quick\ Ratio = \frac{bank\ demand\ deposit + cash\ accounts}{Current\ liabilities} \qquad (7)$$

According to the financial standard, ILO, the average and normal amount of this ratio for industry is one. If this ratio is more than one the company can compete with other challenger companies. In this condition, the company can sell its own securities and collect debtors' accounts and it will be able to pay current debts without selling assets.

3.1.2. Capital Structure

This ratio compares and measures the scale of the assets, provided by equity holders to debts which provided as loan for investing from creditors of company.

The level ratio consists of:

$$Debt\ Ratio = \frac{total\ liabilities}{total\ assets} \quad or \quad \frac{Profit}{total\ assets} \qquad (8)$$

These ratios measure the ratio of the total sum, which is provided by creditors. (If the equity is less than debt, the risk goes to the debt holders.) According to Waxier-Wilson measurements, the normal limit of this ratio is 33% in most industries. If this ratio shows 50%, the company has to raise its own capital by selling stocks and then think about borrowing.

$$average\ recieivable\ collection\ period = \frac{account\ receivable}{average\ premium\ received\ from\ policy\ selling} \qquad (9)$$

This ratio shows how many days it will take to collect the obtained receivable to cash.

$$capital\ turnover = \frac{premium\ earned}{total\ investment} \qquad (10)$$

If the amount of movement of investing resources is little, it means that the company used its own fixed assets with suitable capacity like other companies of this industry.

$$total\ assets\ turnover = \frac{premium\ earned}{total\ assets} \qquad (11)$$

If the amount of this ratio is less than the average for the industry, the company has not resorted to produce and effort according to its own invested assets .This index shows that however much output is insured right, what the managers of the company have delivered according to the received input, is considered as the sum of the company assets .For this reason, this index can be brought up as an efficiency standard for managers of a company in practice .Of course, we should notice that the number related to this index should not reduce less than the specific limit, for example, 50%.Technical resources at year-end plus technical resources of the beginning of year minus exported insurance premium equals received insurance premium.

3.1.3. Profitability

There are two sources of income for an insurance company resulting from insurance and revenues from investing. Income investment of insurance company has been formed by bank deposit, interest income and stock profits .The income from received insurance premium should be equal to the expected expenses of compensation payments, insurance expenses and income tax .In the absence of insurance profit, income investment should mostly cover all operation expenses, providing enough efficiency for stockholders and finally, supply required surplus funds for stability and growth of the company.

$$marginal\ profit = \frac{earning\ before\ tax}{income\ from\ policy\ sold} \tag{12}$$

If the amount of this ratio is less than the industry average, it means the scale price of the company is either low, scale expenses have increased, or both .The more companies move toward profitability, the more the above ratio is increasing, while they are moving toward services, the ratio is getting lower but it should be noticed that the number related to this component should not be less than the specific limit.

$$(ROA)\ return\ on\ assets = \frac{earning\ before\ tax}{total\ assets}\ \ or\ \ \frac{Profit}{total\ assets} \tag{13}$$

This ratio shows that efficiency is a set of company assets in comparison with industry and the larger these asset are, more desirable it will be which shows managers capability of using assets. This key performance index shows the ability to use all the capacity.

$$(ROE)\ return\ on\ equity = \frac{profit}{total\ equity\ owners} \tag{14}$$

This ratio shows the return on equity, so a higher amount of this ratio is desirable.

$$(ROI)\ return\ on\ Investment = \frac{profit}{average\ investment} \tag{15}$$

Regarding regulations investment instruction, for obtaining profit directly, insurance companies invest only in stock, bank deposits and other operations.

$$the\ cost\ of\ policy\ issue = \frac{general\ expenses + tax + premium\ payed + other\ expenses}{net\ received\ policy\ preimium} \tag{16}$$

This ratio includes some proportion, which are used by financial observers for supervising company performance.

Insurance cost ratio indicates expenses that a company undertakes for insurance .So the smaller this ratio is, the lower the expenses in insurance operations will be. In addition, it thus indicates insurance company efficiency.

Insurance is a mechanism for transferring fixed risks of financial compensation toward paying agreed fixed amounts to a person who is called the insurer .Paying insurance should be done before the insurer covers possible damage. Insurer can decrease risks which may be caused by providing insurance services and making equal coverage of a large number of units at a risk.

$$Damage\ coefficient = \frac{damage\ events}{premium\ earned} \tag{17}$$

Insurance companies can be successful by variegating courses of activity in the various operations and services they supply. They do not put all the eggs in one basket.

Undoubtedly, damage coefficient is one of the most important proposed indices in the insurance industry. Although a lower damage coefficient is desirable for company operation, it cannot be always a desirable matter. Insurance companies' duty is services and compensating damage caused by events and decreasing payable damage.

3.1.4. Growth

Growth is obtained by examining trends, comparing the numbers of several financial periods of an organization, and thereby, we can compare important items on the balance sheet and profit and loss with similar items of other periods .Sometimes, changes of these similar items in the financial cases of insurance institutions may display the situation to be proper and promising. Some growth that can be examined in insurance institutions is as follows:

- ✓ Growth of received premiums,
- ✓ Growth of earning before tax,
- ✓ Growth of investment,
- ✓ Growth of policies sold,
- ✓ Growth of third party insurance to total policies.

$$Growth = \frac{Sales\ (Income)}{total\ assests} \tag{18}$$

3.2. Effective indices on insurance companies performance

In this section, effective indices on insurance companies' performance can be analyzed in components such as capital structure, profitability, liquidity, growth and finally, financially.

In the offering analysis, four Iranian insurance companies have been compared from 2000 to 2005 . Considered indices for insurance companies evaluation is shown below in Table 1.

Table 1: Input and Output indices for all components

Components	***Input***	***Out put***
Capital Structure		
	debt ratio	Return of Equity
	Average Capital Turnover	Return on Investment
	Capital in Use	Return on Policies Sold
	Personal Expenses	
	Total Fixed Assets	
Profitability		
	Expenses per Policies	Income from Policy sold
	Capital in Use	Compensation Payment
	Personal Expenses	Accumulated Profit (loss)
	Total Fixed Assets	Current Ratio
		Quick Ratio
		Growth of policies sold
		Investment Growth
Liquidity		
	Average collection Period	Profit Growth
	Capital in Use	Proportion of Premium Earned
	Personal Expenses	
	Total Fixed Assets	
Growth		
	Capital in Use	Assets Quality
	Personal Expenses	Proportion of Third Party
	Total Fixed Assets	Equity Ratio
		Return of Total Assets
		Risk Ratio

Components and share resources in this project are as follows in Figure 1.

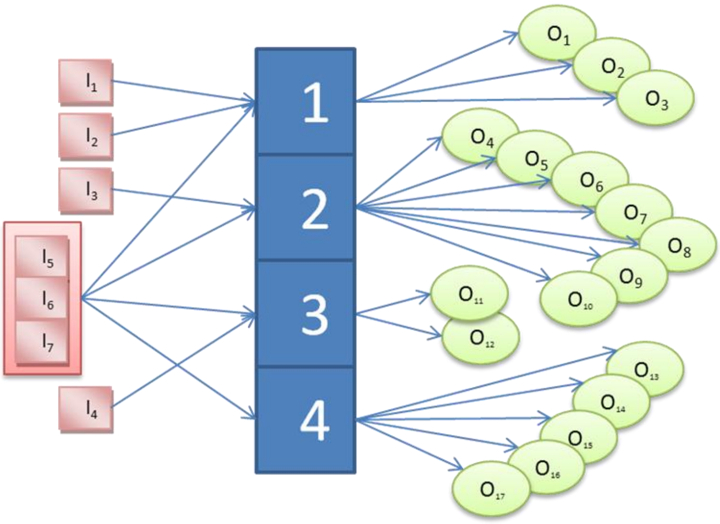

Figure1: Multi Component Diagram

4. Result analysis

In this part, insurance companies' performance is analyzed in components such as capital structure, profitability, liquidity, growth and finally, financially.As mentioned above, the help of a multi-component efficiency model, which has been discussed above, solves calculations of this part .Tables and charts of insurance companies' efficiency are presented and analyzed in this part.

Table 2 :Multi-component measurement

	Capital Structure	Profitability	Liquidity	Growth	Financial
2000					
DMU1	0.22	0.43	0.52	0.26	0.36
DMU 2	0.25	0.17	0.22	0.89	0.32
DMU 3	0.16	1.00	0.89	1.00	0.76
DMU 4	0.39	0.36	0.41	0.50	0.41
2001					
DMU1	0.35	1.00	0.90	1.00	0.20
DMU 2	0.42	0.60	0.37	0.20	0.56
DMU 3	0.29	1.00	1.00	1.00	0.20
DMU 4	0.78	0.53	0.52	0.32	0.55
2002					
DMU1	0.31	1.00	0.34	0.87	0.63
DMU 2	0.22	1.00	0.43	0.89	0.63
DMU 3	0.52	1.00	1.00	1.00	0.20
DMU 4	0.66	0.65	0.70	0.76	0.69
2003					
DMU1	0.35	1.00	0.26	1.00	0.65
DMU 2	0.23	0.70	0.60	0.76	0.57
DMU 3	0.54	1.00	1.00	1.00	0.89
DMU 4	0.50	0.74	0.52	1.00	0.71
2004					
DMU1	1.00	1.00	1.00	1.00	1.00
DMU 2	0.74	0.50	0.73	0.18	0.54
DMU 3	0.20	1.00	1.00	0.71	0.82
DMU 4	1.00	1.00	0.20	1.00	0.95
2005					
DMU1	1.00	1.00	1.00	1.00	1.00
DMU 2	0.52	0.32	0.44	1.00	0.57
DMU 3	0.20	1.00	1.00	1.00	0.96
DMU 4	1.00	1.00	0.56	0.95	0.88

Table 2 shows the relative efficiency of insurance companies from 2000 to 2005. Insurance companies' efficiency has been calculated in areas such as capital structure, profitability, liquidity, growth and financially and has been indicated in the above table .According to this table, it is observed that over the studied years, DMU3 and DMU1 efficiency has the first rank.DMU1 is the only company among four insurance companies that is efficient in all parts in the two most recent years so it has the highest efficiency among all insurance companies in both years.

5. Conclusion

In this article, multi component efficiency of insurance companies' of Iran was examined in four companies in six periods with Data Envelopment Analysis (DEA) technique.Risk and revenue evaluation of insurance companies are two of the major the performance indices of these institutions. Insurance companies supply policy to the customer such that their risk is compensation payment and the output is return on policies sold. Financial evaluation of these companies with financial ratios from the four components of liquidity, profitability, capital structure, and activity (efficiency) are available. Multi-component efficiency method can find efficiency of one component in a decision making unit and calculate aggregate efficiency while considering all of the components. This leads to find the cause of inefficient DMU by finding the efficient component and avoiding efficient component cover inefficient component. The performance models can be used for these organizations which are being examined like this sample. In this kind of performance evaluation, the obtained information is very effective in setting strategy of organizations and decision based on previous performance and movement process for the future of the organization. The most important factor in this kind of performance evaluation is organization efficiency with share inputs and outputs that can have very interesting sensitivity analysis in mode of organization evaluation.Iran insurance have shown unstable situation in this kind of attitude in examined years and specifically, decision making has been changeable in relation to the annual situation. According to multi-component efficiency, insurance organization performance has not been a growing movement toward pre-planned goals.

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