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The Relationship between Returns to Scale and Size of Companies using Data Envelopment Analysis in Iranian Insurance Companies

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Abstract
As we know, the insurance industry due to its mission is considered one of the important and basic industries in the country, and it is very important to determine and recognize the current performance of companies in this industry in order to provide the basis for continuous improvement while evaluating their performance compared to other companies. One of the performance evaluation criteria is return to scale, so that by recognizing it, it is possible to create a basis for improving the performance of companies. Therefore, the present study is aimed to investigate whether there is a relationship between returns to scale and company size in Iranian insurance companies or not. For this purpose, first the technical efficiency condition is calculated using three CCR, BCC and NIRS models, and then, return to scale of insurance companies is extracted with the Fare and Grosskopf method in three periods of 2017, 2018 and 2019. The comparison of the returns to scale of companies with their size indicated that the majority of companies in the industry operate with increasing or decreasing returns to scale and in all three periods only 15% of companies have constant returns to scale. Also, the results of the calculations showed that the insurance companies with small and medium market value have increasing returns to scale; thus, there is a potential to grow and expand their activities. Also, the increasing returns to scale in such companies are incentives for small and medium-sized companies to merge and take benefit of better cost economies.

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1. Introduction

Based on the role they play in the society's economy, insurance institutions can enhance the growth and development of the entire country's economy by protecting the national wealth and compensating financial losses on the economy and retaining and guaranteeing large investments in the society as well as by their development. The main role and mission of the insurance industry is to mitigate uncertainty. This function of the insurance industry is manifested as a special form for each social group and even the national economy as: job security, future income continuity, increasing the standard of living, protection of national wealth, development of investments and credit creation. In the explanation of the second role, it is said that security and compensation in the first role led to an increase in economic growth, and the insurance institutions themselves invest from the net premiums of received insurance rights. Thus, from the very beginning, such an industry can make investments from the insurance premium received, and this leads to the increase and growth of capital, and national production. By absorbing the received insurance premiums and effectively investing the collected funds, the insurance industry can provide a suitable ground for economic growth and development (Ebadi and Bagherzadeh, 2008).

Indeed, a few funds that are entrusted to the insurance companies by the insurers, in addition to providing for the damage and reviving the activities and providing financial security in case of various incidents, also constitute huge funds that can promote economic growth (Hosseinizad Eskandar, 2005). Therefore, due to its importance and essential role in the society, the insurance industry in Iran needs to assess the correct performance and, if necessary, improve the efficiency in order to survive and compete in this dynamic environment (Momeni and Shahkhah, 2009). One of the components of performance evaluation in this industry is return to scale (Cummins, 1998). By using the advantages in production scale, insurance companies can offer many financial products on a large scale and reduce their costs compared to companies that provide financial services separately and on a small scale (Fenn et al (2008). Hence, this question is always raised about the performance of insurance companies, Whether the efficiency of insurance companies operate at an optimal scale and whether it is possible to increase the efficiency to scale by changing their size.

In the review of literature, technical efficiency and scale efficiency have been calculated in a single step and not considered as a network (Najafi et al. (2014) and Zakeri et al. (2015). Cummins and Xie (2008) stated that in past researches, the concept of return to scale is used, which is an economic and important concept in data envelopment analysis and indicates the maximum increase in output for the increase in inputs. According to Kaviani and et al (2015), Naderifar and Farifteh (2016) and Barros and et al, for competitiveness and reduction, economic costs have been neglected. Also, traditional approaches of DEA method have been used for efficiency calculations. However, in the upcoming research, efficiency calculation is done as a network process (two-stage) and due to the negativity of some variables, the newer MSBM approach, which was first used by Sharp et al., in presence of negative variables is used to calculate efficiency. In Iran's insurance industry, in some companies, net life and non-life insurance premiums (after deducting reserves and reinsurance share) as well as net profit of life and non-life insurance, which are variables for calculating efficiency, are negative, so using this model is very suitable for it. Also, in domestic research, the effect of efficiency to scale, which is one of the important components of

efficiency, and its relationship with the size of companies in this industry, has never been investigated. Measuring efficiency on a scale with the size of the companies gives the country the opportunity to operate within the optimal size range and avoid wasting resources. It also gives companies the opportunity to become more efficient through growth. And finally, reducing costs and increasing production and services in this industry can lead to the growth of GDP in the country. Accordingly, in this research, the technical efficiency of 20 Iranian insurance companies and the returns to scale of these companies will be calculated in a two-stage network, and then the relationship between the returns to scale and size of the companies will be investigated.

In order to provide a complete report, the remaining of the paper is organized as follows: Section 2 explains the theoretical basics of the research. Section 3 describes the model used in the paper and Section 4 deals with the results and analysis of the returns to scale and its relationship with the size of the companies. And finally, section 6 presents the conclusion.

2. Theoretical basics of research

2.1. Efficiency measurement using network data envelopment analysis model

Efficiency measurement in insurance is one of the most attractive topics in recent years. Efficiency evaluation is investigated with two parametric (econometric) and non-parametric (mathematical) approaches. In the parametric approach, first a specific form is considered for the production function and then the unknown coefficients in the production function are determined using the data. In the non-parametric approach, there is no need to estimate the production function in advance, and the production function is estimated based on the data. The most common mathematical programming approach is data envelopment analysis. Data envelopment analysis determines the efficiency score as an optimization result. Starting with Farrell in 1957, the non-parametric approach was developed. He measured the efficiency of a production unit by using a method similar to efficiency measuring in engineering debates. The case that Farrell considered to measure efficiency included an input and an output. In 1978, Charnes, Cooper and Rhodes (1978) presented a model to measure performance with multiple inputs and outputs. This model was called the Data Envelopment Analysis (DEA). Based on the names of its developers, this model was known as the CCR model, which consists of the first letters of the names of these three people, and was presented in a paper "Measure the efficiency of decision-making units" in 1978. This method is based on using the inputs and outputs of the units and weighting them to calculate the efficiency. When different models of data envelopment analysis are used to evaluate the efficiency of a set of units, some of these units are efficient and some are inefficient, and this inefficiency of the units indicate their performance defects in obtaining the maximum outputs according to the defined inputs, or in other words, it is the lack of correct use of the company's resources and inputs.

When it is determined that a unit is inefficient via the data envelopment analysis model, the first question that is: "how can the unit be efficient and how should it act to be efficient? In fact, mentioning their success factors is the key to the solution. Generally, in many cases, technical inefficiency can be due to lack of knowledge regarding the basic aspects of units' activities and inappropriate use of resources. In this case, insurance companies are able to acquire knowledge of the correct use of resources through learning from the determined patterns to make their products efficient. It can be stated that the important feature of the data envelopment analysis method is that for each inefficient unit, it

identifies sets of efficient units that can be used as models to enhance that inefficient unit, and the solution to increase the efficiency level is considered based on them (Ochola, 2017). This model is divided into two main sub-branches, i.e., CCR model assuming constant returns to scale and BCC model assuming variable returns to scale. The data envelopment analysis method converts the multi-product and multi-factor mode of production into a single-factor and single-product mode, and it is solved separately for each of the similar decision-making units, and efficiency values are obtained for each. Figure 1 demonstrates the input and output for each decision-making unit, where x denotes the inputs and y represents the outputs of the model firm (Yang, 2006).

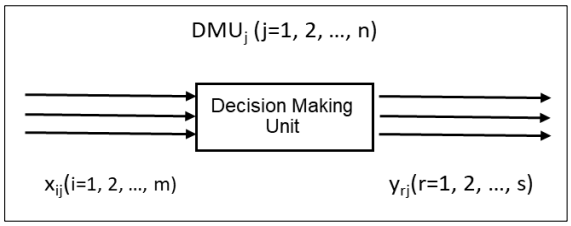

Figure 1: An overview of the inputs and outputs in the data envelopment analysis model

In a set consisting of n decision-making units, the j^{th} decision-making unit (DMUj (j=1, ..., n)) uses m inputs (x_{ij} (i=1, ..., m)) to produce the s outputs (y_{rj} (i=1, ..., s)). If DMUo is one of the decision-making units in the study, then x_{ij} and yrj are the i^{th} input and r^{th} output of DMUo, respectively. Model 1 shows the modified input-oriented CCR envelope model, which is one of the models of constant returns to scale, where ε is a very small positive non-Archimedean number, and s_i^- and s_r^+ are the shortage outputs r and the input surplus i (Zhou, 2003) and (Bazargan and Vasiq, 2003).

$$MinY_0 = \theta - \varepsilon\left(\sum_{r=1}^{s} S_r^+ + \sum_{i=1}^{m} S_i^-\right) \quad (1)$$

$$st:$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - S_r^+ = y_{ro} \qquad (r = 1, 2, \ldots, s)$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j + S_i^- = \theta x_{io} \qquad (i = 1, 2, \ldots, m)$$

$$\lambda_j, S_r^+, S_i^- \geq 0 \qquad (j = 1, 2, \ldots, n)$$

$$\theta \text{ free}$$

2.2. Scale efficiency

Scale efficiency is the development that an organization can obtain from the benefits of economies of scale by changing its size towards the optimal scale. The assumption of constant returns to scale in a model means that the size of the organization is not considered in determining relative efficiency. A small organization can create outputs with the same output-to-input ratio as a larger organization can; because economies of scale do not appear in these organizations, so doubling all inputs generally results in doubling outputs.

But in companies with economies of scale, the assumption of constant returns to scale is not considered. In these types of companies, doubling the inputs may result into more than doubling the output. Sometimes, as the organization gets bigger, doubling the inputs provides less than double the output, indicating decreasing returns to scale. This may be due to the inability to manage a large organization and the resulting inconsistencies. If the size of the organization has no impact on its efficiency, the returns to scale are constant (Koli, 1998).

In order to evaluate and measure the efficiency of the scale, see Figure 2.

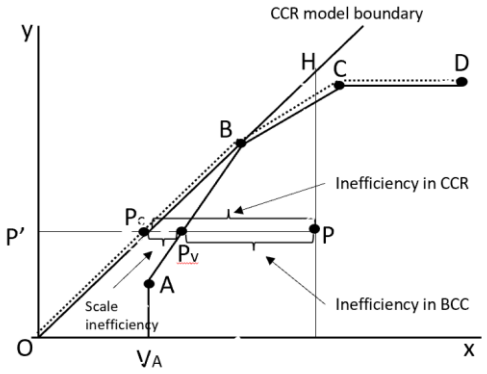

Figure 2: Calculation of scale efficiency (input-oriented)

The constant returns to scale frontier that has one input and one output in the above Figure is a straight line that connects the origin to the point with the highest output-to-input ratio. The frontier of variable returns to scale at the right side of the CCR frontier is displayed as a broken curve denoted by VA ABCD. The scale efficiency of each unit is determined by comparing the technical efficiency score of that unit in the conditions of constant returns to scale and variable returns to scale. The distance between efficiency frontiers to constant (CCR frontier) and variable (BCC frontier) scale expresses the concept of scale inefficiency. Therefore, when efficiency is measured by assuming variable returns to scale, the efficiency score for each unit only shows technical inefficiency. Thus, the technical efficiency calculated assuming variable returns to scale is greater than or equal to the score obtained in constant scale. In Figure 1, unit B is the only unit with zero scale inefficiency. In other words, the unit operates at optimal scale. Units A, C and D have scale inefficiencies. Most of studies divide "technical efficiency of constant returns to scale" into two sections: "scale efficiency" and "pure technical efficiency". The pure technical efficiency is also called management efficiency. The examination of pure technical efficiency and scale efficiency is performed by solving CCR and BCC models for a given unit. If the technical efficiency calculated for both models is different, it indicates that the investigated unit has scale inefficiency, and the degree of scale inefficiency can be obtained by the difference in the technical efficiency score calculated by the two models. In Figure 2, in under the condition of constant return to scale, the technical inefficiency of the P unit is equal to the distance PP_C, while in the variable returns to scale, the inefficiency is equal to PP_v. The difference between the two, i.e. P_cP_v, denotes the scale inefficiency. The above concepts for the P unit can be expressed using the following ratios (Mehregan, 2012).

Technical Efficiency (constant returns to scale) $TE_{CRS} = P'P_C/P'P$

Technical Efficiency (increasing returns to scale) $TE_{VRS} = P'P_V/P'P$

Scale Efficiency= $SE = P'P_V/P'P$

All the above measures are ranging zero and one. Thus, it can be written:

Scale efficiency × technical efficiency (variable returns to scale) = technical efficiency (constant returns to scale)

$TE_{CRS} = TE_{VRS} \times SE$

$P'P_C/P'P = P'P_V/P'P \times P'P_V/P'P$

The weakness of scale efficiency measure is its inability to express increasing or decreasing returns to scale for the examined unit. To solve this problem, a new model for DEA has been used, which has non-increasing returns to scale. The non-increasing return to scale model is defined as follows (Mehregan, 2012):

$$MinYo = \theta$$

$$st:$$

$$\sum_{j=1}^{n} y_{rj}\,\lambda_j >= y_{ro} (r = 1,2,\dots,s)$$

$$\sum_{j=1}^{n} x_{ij}\,\lambda_j <= \theta x_{io} (i = 1,2,\dots,m)$$

$$\sum_{j=1}^{n} \lambda_j <= 1$$

$$\lambda_j, \geq 0 \quad (j = 1,2,\dots,n)$$

As shown, the difference between the above model and the BCC model is the

conversion of the limit of Lambda equal to 1 to Lambda smaller than 1. The Lambda constraint smaller than 1 indicates that the j^{th} unit is compared only with units that are equal or smaller than it from scale aspects.

The efficiency frontier of the NIRS model is illustrated in Figure 2 with section lines. The nature of the scale inefficiency of a unit (due to increasing or decreasing returns to scale) for a particular unit is obtained by solving the NIRS and BCC models. If the technical efficiency of the non-increasing returns to scale (TE_{NIRS}) model is equal to the technical efficiency of the variable returns to scale (TE_{VRS}) or (TE_{BCC}), there is decreasing returns to scale, and if they are unequal, we have increasing returns to scale. Do the following steps based on the Fare and Grosskopf (1985) method.

Step 1: Solve the following three models for the studied units.

NIRS Model

$$MinYo = \theta$$
$$st:$$
$$\sum_{j=1}^{n} y_{rj}\,\lambda_j >= y_{ro}(r = 1,2,\dots,s)$$
$$\sum_{j=1}^{n} x_{ij}\,\lambda_j <= \theta x_{io}(i = 1,2,\dots,m)$$
$$\sum_{j=1}^{n} \lambda_j <= 1$$
$$\lambda_j, \geq 0 \quad (j = 1,2,\dots,n)$$

BCC Model

$$MinYo = \theta$$
$$st:$$
$$\sum_{j=1}^{n} y_{rj}\,\lambda_j >= y_{ro}(r = 1,2,\dots,s)$$
$$\sum_{j=1}^{n} x_{ij}\,\lambda_j <= \theta x_{io}(i = 1,2,\dots,m)$$
$$\sum_{j=1}^{n} \lambda_j = 1$$
$$\lambda_j, \geq 0 \quad (j = 1,2,\dots,n)$$

CCR Model

$$MinYo = \theta$$
$$st:$$
$$\sum_{j=1}^{n} y_{rj}\,\lambda_j >= y_{ro}(r = 1,2,\dots,s)$$
$$\sum_{j=1}^{n} x_{ij}\,\lambda_j <= \theta x_{io}(i = 1,2,\dots,m)$$
$$\lambda_j, \geq 0 \quad (j = 1,2,\dots,n)$$

Step 2: Compare the efficiency score of CCR and BCC models. If these two scores are equal, the returns to scale are constant, otherwise variable.

Step 3: Compare the efficiency score of BCC and NIRS models. If these two scores are equal, the returns to scale are decreasing, otherwise, increasing.

2.3. Review of literature

Most of the research done on insurance companies is to evaluate their performance through the traditional method of DEA, which has been done both inside and outside the country, some of them are mentioned below.

In a study, Ahmadi Qochan Atiq et al. (2022) examine the impacts of efficiency and financial risk on the performance of insurance companies listed on the Tehran Stock Exchange (TSE). The statistical sample data of their study included 13 insurance companies listed on the Tehran Stock Exchange. The results showed that there is a significant relationship between performance and financial risks. Also, it was found that there is a significant and direct relationship between efficiency and the type of suitable performance in the mentioned companies. Zhao et al. (2021) investigated the evolution and factors determining the profitability of 53 Chinese insurers during 2013-2017. They measured profitability with efficiency ratio by Data Envelopment Analysis (DEA) method. this research shows the importance of the arrangement of costs and revenues for an insurer and help to better understand the impact of company size and product specification on profitability. Elling and Jia (2019) examined the profitability and efficiency of more than 5,000 Insurance companies worldwide. They documented a significantly positive correlation between the efficiency measures and profitability measures. And they stated that the correlation of efficiency in the field of life Insurance is higher than non-life Insurance. Montazeri and et al. (2020) also evaluated the efficiency of companies in Iran's

insurance industry based on the CCR and BCC model and its relationship with important profitability ratios. In this study, 14 insurance companies were selected as a statistical sample and the data collected in a 7-year period between 2012 and 2017. The results of study indicated that the return on assets has a positive relationship with the efficiency calculated via the input-oriented approach and a negative relationship with the output-oriented approach. Taghavifard et al. (2017) examined the efficiency of 39 branches during 2011 and 2012 with an input-based approach and assuming variable returns to scale. According to the results, in many cases, the lack of effectiveness of managers is partly caused by the effect of environmental and uncontrollable factors on their performance.

Also, there have been limited researches regarding return to scale with the DEA method in the insurance industry, which are also mentioned below.

Klumpes in 2022 showed scale economies is often as operating synergy rationale for mergers and acquisitions. Under this motive, firms operating with non-decreasing (constant or increasing) returns to scale (NDRS) will be attractive acquisition targets because they are currently operating in the optimal size range or have the opportunity to become more efficient through growth. Firms operating with decreasing returns to scale are likely to be viewed as unattractive acquisition targets because they are already 'too large' in terms of scale economies. Cummins in 1998 estimated scale economies using the DEA approach. The scale economy results, revealed that the vast majority of firms in the industry are operating at either increasing or decreasing returns to scale. Only about 6 percent of the 445 firms in his sample are attaining the economic ideal of operating at constant returns to scale. About 63 percent of firms, most with assets of less than $300 million, are operating in the range of increasing returns to scale. Thus, in general, mergers of firms with less than $300 million of assets have the potential to reduce production costs in the industry. Grace and time (1992) in research using an industry sample of 423 U.S. life insurers showed that most firms had significant economies of scale while the largest agency companies exhibited approximately constant returns to scale. The existence of scale economies for large numbers of firms suggests that there may be market imperfections (due to, for example, information asymmetries or state regulation) which prevent firms from capturing the full benefits of increasing returns to scale. Public policy may require incentives for small to medium size companies to merge to better exploit cost economies and, therefore, compete more effectively against larger firms.

3. Research Methods

After reviewing the literature of the researches, the statistical samples are selected first. Among the existing insurance companies in the country, as Iran Insurance Company is considered a governmental company and is subject to its own laws, it is excluded from the study. Out of 24 non-governmental insurance companies, the Tosse Insurance Company was also excluded because its license was revoked in February 2014 in car insurance and all types of life insurance (third party, driver and automobile insurance), and Khavaremiane and Baran Insurance are specialized only in the field of life insurance, and on the other hand, like Hekmat Saba, and as startup companies have been also excluded. 6 other companies were also removed from the research due to the special working conditions in the free and specific economic zones, and 2 insurance companies of Amin and Iranian Reinsurance were also excluded due to the different nature of their activities. Thus, the statistical samples of this research include 20 non-governmental Asia, Alborz, Dana, Moallem, Parsian, Razi, Karafarin,

Sina, Mellat, Dey, Saman, Novin, Pasargad, Mihan, Kowsar, Ma, Arman, Ta'avon, Sarmad and Tejarat-e- No insurance companies.

After selecting the statistical samples, the efficiency of the companies and their returns to scale via Fare and Grosskopf method are calculated. Before calculating the efficiency, the variables should be determined first. In this research, in order to calculate the efficiency, a two-stage model is used. It is assumed that each DMU has m inputs as x_{ij} (i=1,..., m) and d outputs as z_{dj}(i=1,...,d) for the mentioned stage and then d outputs as input for the second stage and the outputs of the second stage (y_{rj} (i=1, ..., s)) are considered, which are referred to as intermediate measures. So, the inputs, intermediate and output variables based on the background of the research of Kao and Hwang's (2008) researches and numerous researches by Cummins are determined as follows:

First stage inputs:

X1: Commission costs and interest fees

X2: General and administrative expenses

X3: Market value

Outputs of the first stage and inputs of the second stage:

Z1: Life Insurance premium

Z2: Non-life Insurance premium

Outputs of the second stage:

Y1: Net profit of life insurance

Y2: Net profit of non-life Insurance benefit

Y3: Return on invested assets

(Kao and Hwang's (2008) and Cummins (2016))

In the initial DEA models, the positive assumption of the input and output variables is considered as a default, while considering the mentioned variables in the insurance industry and extracting its data for the given period, it was observed that a number of the variables are negative (Life Insurance premium and Non-life Insurance premium (after deducting reserves and reinsurance share), net profit of life and non-life insurance; therefore and Commission costs and interest fees of some companies in some periods) , in the data envelopment analysis approach, by generalizing the above method based slacked measures, the Modified Slack-Based Measure (MSBM) is used to calculate the efficiency and return to scale in the presence of negative variables. The modified slack-based measure in 2006 was rewritten by sharp and et al using the Portella method as follows:

$$Min \quad \rho = \frac{1-\frac{1}{P}\sum_{t=1}^{p} L_t^- / R_{to}}{1+\frac{1}{S}\sum_{r=1}^{s} L_r^+ / R_{ro}} \times \frac{1-\frac{1}{m}\sum_{i=1}^{m} s_i^- / R_{io}}{1+\frac{1}{P}\sum_{t=1}^{p} s_t^+ / R'_{to}} \qquad (2)$$

st :

$$\sum_{j=1}^{n} z_{tj}\lambda_j - S_t^+ = z_{to} \qquad (t = 1, 2, \ldots, p)$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j + S_i^- = x_{io} \qquad (i = 1, 2, \ldots, m)$$

$$\sum_{j=1}^{n} y_{rj}\mu_j - L_r^+ = y_{ro} \qquad (r = 1, 2, \ldots, s)$$

$$\sum_{j=1}^{n} z_{tj}\mu_j + L_t^- = z_{to} \qquad (t = 1, 2, \ldots, p)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (j = 1, 2, \ldots, n)$$

$$\sum_{j=1}^{n} \mu_j = 1 \qquad (j = 1, 2, \ldots, n)$$

$$\lambda_j, \mu_j, S_t^+, S_i^-, L_r^+, L_t^- \geq 0$$

Where R_{io} ،R''_{to} ، R'_{to} and R'''_{ro} are as follows:

$$R_{io} = x_{io} - \min_j \{x_{ij}\} \qquad (i = 1, 2, \ldots, m)$$

$$R_{to} = z_{to} - \min_j \{x_{ij}\} \qquad (t = 1, 2, \ldots, p)$$

$$R'_{to} = \max_j \{z_{tj}\} - z_{to} \qquad (t = 1, 2, \ldots, p)$$

$$R_{ro} = \max_j \{y_{rj}\} - y_{ro} \qquad (r = 1, 2, \ldots, s)$$

In calculations to determine the returns to scale, Fare and Grosskopf method with MSBM approach is used perform the steps. Then the obtained results will be compared with the market value of the companies in three periods to see if the companies operate

within the optimal size range and whether there is a potential to reduce costs and increase production and services in this industry. The steps are given in the flowchart below:

4. Research findings

After determining the criteria to evaluate the efficiency of insurance companies and considering them as input, intermediate and output variables using the information collected from the investigated companies in three years of 2017, 2018 and 2019, first the efficiency of the companies in the studied period was calculated in three models CCR, BCC and NIRS and the results are shown in three Tables 1, 2 and 3.

Table 2 calculates the efficiency by assuming variable returns to scale. In other words, it is assumed that by increasing the input by A unit, the output does not increase based on the same amount and the output change is greater than or less than A. With these assumptions, it can be observed that Asia, Parsian, Dey, Pasargad, Kowsar and Ta'avon insurance companies operated efficiently in three consecutive years, and Dana, Mihan and Arman insurance companies have been active after 2017 in two years 2018 and 2019 efficiently. After being efficient in two consecutive years of 2017 and 2018, Tejarat-e- No Insurance Company witnessed a decrease in performance in 2019. This type of efficiency is a type of technical efficiency with variable returns to scale. In order to find how the returns to scale in the above companies is and whether there is a relationship between the returns to scale and the size of the companies, the returns to scale of the companies has also been calculated and presented in Table 4 according to Fare and Grosskopf method.

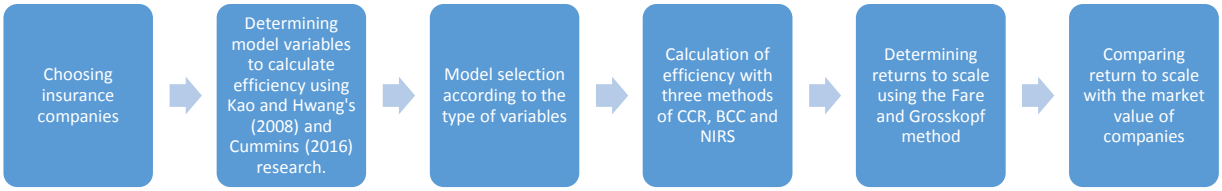

Figure 3: Flowchart to the Article Process

Table 1: Efficiency Results of Insurance Companies with CCR Model

No.	Company Name of	2017	2018	2019
1	Asia Insurance companies	1	1	0.67
2	Alborz Insurance companies	0.71	0.50	0.58
3	Dana Insurance companies	0.58	1	0.49
4	Moallem Insurance companies	0.57	0.42	0.60
5	Parsian Insurance companies	1	0	1
6	Karafarin Insurance companies	0	0.03	0.10
7	Razi Insurance companies	0.24	0.33	0.64
8	Sina Insurance companies	0.41	0.48	0.74
9	Mellat Insurance companies	0.26	0.05	0.77
10	Dey Insurance companies	1	1	1.00
11	Saman Insurance companies	1	1	0.57
12	Novin Insurance companies	0.21	0.11	0.21
13	Pasargad Insurance companies	1	1	0.57
14	Mihan Insurance companies	0	0	0.67
15	Kowsar Insurance companies	0	1	0.69
16	Ma Insurance companies	0	0	0.61
17	Arman Insurance companies	0.31	1	1.00
18	Ta'avon Insurance companies	1	1	0.40

No.	Company Name of	2017	2018	2019
19	Sarmad Insurance companies	1	0.94	0.76
20	Tejarat-e- No Insurance companies	1	0	0.62

Table 2: Efficiency Results of Insurance Companies with BCC Model

No.	Name of Companies	2017	2018	2019
1	Asia Insurance company	1	1	1
2	Alborz Insurance company	0.35	0.81	0.73
3	Dana Insurance company	0.25	1	1
4	Moallem Insurance company	0.36	0.78	0.87
5	Parsian Insurance company	1	1	1
6	Karafarin Insurance company	0.55	0.04	0.12
7	Razi Insurance company	0.27	0.3	0.7
8	Sina Insurance company	0.53	0.57	0.84
9	Mellat Insurance company	0.28	0.07	0.78
10	Dey Insurance company	1	1	1
11	Saman Insurance company	0.62	0.95	0.67
12	Novin Insurance company	0.28	0.35	0.39
13	Pasargad Insurance company	1	1	1
14	Mihan Insurance company	0.82	1	1
15	Kowsar Insurance company	1	1	1
16	Ma Insurance company	0.43	0.44	0.71
17	Arman Insurance company	0.39	1	1
18	Ta'avon Insurance company	1	1	1
19	Sarmad Insurance company	0.81	0.92	0.88
20	Tejarat-e- No Insurance company	1	1	0.75

Table 3: Efficiency Results of Insurance Companies with NIRS Model

No.	Company Name of	2017	2018	2019
1	Asia Insurance companies	1	1	1
2	Alborz Insurance companies	0.35	0.81	0.73
3	Dana Insurance companies	0.25	1	1
4	Moallem Insurance companies	0.36	0.78	0.87
5	Parsian Insurance companies	1	1	1
6	Karafarin Insurance companies	0.36	0.03	0.10
7	Razi Insurance companies	0.31	0.37	0.64
8	Sina Insurance companies	0.51	0.57	0.85
9	Mellat Insurance companies	0.26	0.03	0.90
10	Dey Insurance companies	1	1	1
11	Saman Insurance companies	1	0.94	0.67
12	Novin Insurance companies	0.24	0.19	0.21
13	Pasargad Insurance companies	1	1	1
14	Mihan Insurance companies	0.07	0.32	0.67
15	Kowsar Insurance companies	1	1	1
16	Ma Insurance companies	0.32	0.23	0.32
17	Arman Insurance companies	0.39	0.77	1
18	Ta'avon Insurance companies	0.61	0.63	0.40
19	Sarmad Insurance companies	0.74	0.94	0.76
20	Tejarat-e- No Insurance companies	0.63	0.32	0.62

Table 4: Results of returns to scale of companies

No.	Name of Company	2017	2018	2019
1	Asia Insurance company	DRS	DRS	DRS
2	Alborz Insurance company	DRS	IRS	DRS

3	Dana Insurance company	DRS	CRS	DRS
4	Moallem Insurance company	DRS	DRS	DRS
5	Parsian Insurance company	CRS	DRS	CRS
6	Karafarin Insurance company	IRS	IRS	IRS
7	Razi Insurance company	IRS	IRS	IRS
8	Sina Insurance company	IRS	DRS	IRS
9	Mellat Insurance company	IRS	IRS	IRS
10	Dey Insurance company	CRS	CRS	CRS
11	Saman Insurance company	IRS	IRS	DRS
12	Novin Insurance company	IRS	IRS	IRS
13	Pasargad Insurance company	CRS	CRS	DRS
14	Mihan Insurance company	IRS	IRS	IRS
15	Kowsar Insurance company	DRS	DRS	DRS
16	Ma Insurance company	IRS	IRS	IRS
17	Arman Insurance company	IRS	IRS	CRS
18	Ta'avon Insurance company	IRS	IRS	IRS
19	Sarmad Insurance company	IRS	IRS	IRS
20	Tejarat-e- No Insurance company	IRS	IRS	IRS

As shown in the above Table, Day Insurance Company during three periods and Parsian Insurance Company in 2017 and 2019, Pasargad Insurance Company in 2017 and 2018, and Arman and Dana Insurance Company had constant returns to scale only in 2018 and 2019, respectively. Karafarin, Razi, Mellat, Novin, Mihan, Ma, Ta'avon, Sarmad and Tejarat-e- No insurance companies have experienced increasing returns during all three periods, and Asia, Kowsar and Moallem insurance companies have also experienced decreasing returns during all three periods.

As shown in Table 5, 15% of the companies have constant returns to scale and 85% of them have variable returns to scale in each of the three years under study. In 2017 and 2018, 25% of the companies were encountered with decreasing returns to scale, and in 2019, 35% of companies encountered decreasing returns to scale. In other words, the economies of scale for a large number of firms show that there may be market imperfections (for example, due to information asymmetry or governmental regulation) that prevent firms from taking full benefits of increasing returns to scale.

Then, in order to compare the inefficiency of the scale with the size of the companies, the market value data of the insurance companies is presented in Table 5.

Now, the comparison of market value and returns to scale of companies is performed separately in each year. By comparing the returns to scale of each company with its market value, it can be observed that small-sized insurance companies have increasing returns to scale. In 2017, companies with a market value smaller than 2,050 billion rials had increasing returns to scale.

In 2018, companies with a market value smaller than 2,900 billion rials had increasing returns to scale, and companies with decreasing or constant returns to scale had a large market value.

Table 5: Market Capitals of Companies (Million Rial)

No.	Name of Company	2017	2018	2019
1	Asia Insurance company	3,452,300	3,910,000	18,774,900
2	Alborz Insurance company	4,012,000	4,824,000	21,524,000
3	Dana Insurance company	3,130,500	3,247,500	19,244,000
4	Moallem Insurance company	2,058,220	4,684,500	9,004,500

5	Parsian Insurance company	4,095,000	4,497,000	28,888,000
6	Karafarin Insurance company	1,561,000	1,435,000	9,380,000
7	Razi Insurance company	2,804,000	3,574,000	9,000,000
8	Sina Insurance company	1,566,000	2,005,500	9,552,000
9	Mellat Insurance company	5,420,700	7,401,450	21,982,050
10	Dey Insurance company	2,525,000	3,237,500	19,885,000
11	Saman Insurance company	5,181,000	4,902,000	12,321,770
12	Novin Insurance company	1,509,000	1,818,000	5,319,000
13	Pasargad Insurance company	6,238,418	18,088,434	67,339,188
14	Mihan Insurance company	1,125,000	1,302,000	4,684,500
15	Kowsar Insurance company	3,630,000	7,480,000	60,476,681
16	Ma Insurance company	1,729,500	2,863,500	9,537,000
17	Arman Insurance company	1,158,000	1,116,000	3,475,500
18	Ta'avon Insurance company	392,000	1,285,500	6,607,500
19	Sarmad Insurance company	1,675,500	2,277,000	17,432,100
20	Tejarat-e- No Insurance company	2,047,500	2,237,500	7,173,330

Table 6 :Economy of Scale Vs. Market Cap of Insurance Company in 2017

No.	Name of Company	Economy of Scale	Market Cap
1	Ta'avon Insurance company	IRS	392,000
2	Mihan Insurance company	IRS	1,125,000
3	Arman Insurance company	IRS	1,158,000
4	Novin Insurance company	IRS	1,509,000
5	Karafarin Insurance company	IRS	1,561,000
6	Sina Insurance company	IRS	1,566,000
7	Sarmad Insurance company	IRS	1,675,500
8	Ma Insurance company	IRS	1,729,500
9	Tejarat-e- No Insurance company	IRS	2,047,500
10	Moallem Insurance company	DRS	2,058,220
11	Dey Insurance company	CRS	2,525,000
12	Razi Insurance company	IRS	2,804,000
13	Dana Insurance company	DRS	3,130,500
14	Asia Insurance company	DRS	3,452,300
15	Kowsar Insurance company	DRS	3,630,000
16	Alborz Insurance company	DRS	4,012,000
17	Parsian Insurance company	CRS	4,095,000
18	Saman Insurance company	IRS	5,181,000
19	Mellat Insurance company	IRS	5,420,700
20	Pasargad Insurance company	CRS	6,238,418

Table7: Economy of Scale Vs. Market Cap of Insurance Company in 2018

No.	Name of Company	Economy of Scale	Market Cap
1	Arman Insurance company	IRS	1,116,000
2	Ta'avon Insurance company	IRS	1,285,500

3	Mihan Insurance company	IRS	1,302,000
4	Karafarin Insurance company	IRS	1,435,000
5	Novin Insurance company	IRS	1,818,000
6	Sina Insurance company	DRS	2,005,500
7	Tejarat-e- No Insurance company	IRS	2,237,500
8	Sarmad Insurance company	IRS	2,277,000
9	Ma Insurance company	IRS	2,863,500
10	Dey Insurance company	CRS	3,237,500
11	Dana Insurance company	CRS	3,247,500
12	Razi Insurance company	IRS	3,574,000
13	Asia Insurance company	DRS	3,910,000
14	Parsian Insurance company	DRS	4,497,000
15	Moallem Insurance company	DRS	4,684,500
16	Alborz Insurance company	IRS	4,824,000
17	Saman Insurance company	IRS	4,902,000
18	Mellat Insurance company	IRS	7,401,450
19	Kowsar Insurance company	DRS	7,480,000
20	Pasargad Insurance company	CRS	18,088,434

In 2019, companies with a market value smaller than 1,700 billion rials had increasing returns to scale, and companies with decreasing or constant returns to scale had a large market value. In this period, two insurance companies, Moallem and Saman, although they have a market value of less than 1,700 billion Rials, they have decreasing returns to scale. By reviewing the market value of the companies in 2020, it can be said that the market value of these two companies has also increased, so they are out of the category of small companies. Thus, the output of the tables indicates that small and almost medium companies have the potential to grow in their field of work.

5. Conclusion and Suggestion

The present study attempts to investigate whether there is a relationship between returns to scale and company size in Iranian insurance companies or not. In order to achieve this goal, in the first step of the research, we calculated the technical efficiency of 20 insurance companies (Asia, Alborz, Dana, Moallem, Parsian, Razi, Karafarin, Sina, Mellat, Dey, Saman, Novin, Pasargad, Mihan, Kowsar, Ma, Arman, Ta'avon, Sarmad and Tejarat-e-No). To calculate the technical efficiency, the data envelopment analysis approach with three models CCR, BCC and NIRS based on the researches of Ahmadi Qochan Atiq et al (2022), Zhao et al. (2021), Elling and Jia (2019), Kaviani and et al (2020) and Taghavifard et al (2017) was applied. To solve the model, the data related to the insurance industry was extracted for statistical samples. After extracting the data, it was found that some of the data are negative, therefore, to calculate the efficiency, the MSBM model Based on Sharp's suggestion was used instead of the modified input-oriented envelopment model, and then the efficiency of 20 companies was calculated.

Table 8: Economy of Scale Vs. Market Cap of Insurance Company in 2019

No.	Name of Company	Economy of Scale	Market Cap
1	Arman Insurance company	CRS	3,475,500
2	Mihan Insurance company	IRS	4,684,500

3	Novin Insurance company	IRS	5,319,000
4	Ta'avon Insurance company	IRS	6,607,500
5	Tejarat-e- No Insurance company	IRS	7,173,330
6	Razi Insurance company	IRS	9,000,000
7	Moallem Insurance company	DRS	9,004,500
8	Karafarin Insurance company	IRS	9,380,000
9	Ma Insurance company	IRS	9,537,000
10	Sina Insurance company	IRS	9,552,000
11	Saman Insurance company	DRS	12,321,770
12	Sarmad Insurance company	IRS	17,432,100
13	Asia Insurance company	DRS	18,774,900
14	Dana Insurance company	DRS	19,244,000
15	Dey Insurance company	CRS	19,885,000
16	Alborz Insurance company	DRS	21,524,000
17	Mellat Insurance company	IRS	21,982,050
18	Parsian Insurance company	CRS	28,888,000
19	Kowsar Insurance company	DRS	60,476,681
20	Pasargad Insurance company	DRS	67,339,188

The calculations of technical efficiency with the assumption of variable returns to scale showed that Asia, Parsian, Dey, Pasargad, Kowsar and Ta'avon insurance companies operated efficiently in the period under study, and three insurance companies, Dana, Mihan and Arman could operate efficiently in the two years of 2018 and 2019. After being efficient in two consecutive years of 2017 and 2018, Tejarat-e- No Insurance Company experienced a decrease in performance in 2019. Then, the returns to scale of 20 insurance companies were calculated. The results showed that Dey Insurance Company during three periods, Parsian Insurance Company in 2017 and 2019, Pasargad Insurance in 2017 and 2018, and Arman Insurance only in 2019 had constant returns to scale. Karafarin, Razi, Mellat, Novin, Mihan, Ma, Ta'avon, Sarmad and Tejarat-e- No insurance companies experienced increasing returns during all three periods, and Asia, Kowsar and Moallem insurance companies have also experienced decreasing returns during all three periods. In other words, in all three periods, we observed that only 15% of companies have constant returns to scale, which is consistent with the studies of Cummins and Xie (1998), who showed in their study that the vast majority of companies in the industry operate with the increasing or decreasing returns to scale. Only about 6 % of the 445 firms in his sample achieved the economic ideal of operating with constant returns to scale. Also, the results of the calculations showed that insurance companies with small and almost medium market value of the industry have increasing returns to scale and there is a potential to become larger and develop their activities, which is consistent with the studies conducted in other countries. Cummins and Xie (1998) stated that about 63% of companies, most of which have assets less than 300 million dollars, operate within increasing returns to scale. Thus, in general, merging companies with less than $300 million in assets have the potential to reduce production costs in the industry which the findings of our research showed during three years that nine small companies equivalent to at least 45% of

companies had increasing return to scale. Also, like findings of Grace and time (1992) that indicated most firm of 423 U.S industry sample of life had significant economies of scale. But Contrary to those findings of Grace and time (1992) which exhibited the largest agency companies had constant returns to scale, our result showed our largest agency companies had constant returns to scale or decreasing returns to scale.

according to Grace and Tim (1992), increasing returns to scale are incentives for small to medium-sized firms to merge and better use cost economies and, thus compete more effectively with larger firms. Also, as recommended by Clumps (2022), based on this motivation, the firms that operate with non-decreasing (constant or increasing) returns to scale (NDRS) will be attractive acquisition targets because they are now operating in the optimal size domain or use this opportunity to become more efficient via growth. Firms operating with decreasing returns to scale are likely to be considered as unattractive acquisition targets as they are "too large" in terms of economies of scale. Based on these researches in order to further improve findings in this field, the following suggestions are provided:

- Combine small and medium-sized companies and recalculate technical efficiency and scale efficiency and examine the results
- All sizes of the companies were combined and the technical efficiency and scale efficiency were calculated and the results were examined
- Small and medium companies should be combined with other companies and the technical efficiency and scale efficiency were calculated and the results were examined

It is necessary to explain that there was **a limitation** in the calculations .In order to calculate efficiency in the study, one of the input variables used is the market value. According to review of literature, this variable was extracted according to Cummins' various researches in this field. In his research, Cummins used the asset value as the input of the first stage, and due to the lack of asset revaluation of most of the insurance companies in Iran, their market value was used in this research.

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