

Measuring the relative efficiency of insurance industry: Evidence from Tehran Stock Exchange

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ABSTRACT

Measuring the relative efficiency in insurance industry plays essential role for productivity improvement in insurance industry. In this paper, we present an empirical investigation to measure the relative efficiency of some insurance firms listed on Tehran Stock Exchange using data envelopment analysis (DEA) over the period 2011-2013. The proposed study of this paper uses four inputs namely; total assets, price to earnings ratio, beta and sigma and four outputs namely; net earnings, one-year, two-year and three-year returns. The study uses two methods of input and output oriented DEA to measure the relative efficiencies of 9 banks and the results indicate that most insurance firms perform well in terms of efficiency.

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1. Introduction

Measuring the relative efficiency in insurance industry plays essential role for productivity improvement in insurance industry (Brockett et al., 1998; Saad, 2006). Charnes et al. (1978) are believed to be the first who introduced the idea of data envelopment analysis (DEA) for measuring the relative efficiency of different firms and there have been tremendous efforts on contributing to the idea of DEA method. Cummins and Weiss (2013) presented a comprehensive analysis for firm performance in the insurance industry using frontier efficiency and productivity techniques. Brockett et al. (2005) compared financial intermediary against production approach to efficiency of marketing distribution systems and organizational structure of insurance companies. Cummins et al. (2003) investigated economies of scope in financial services by implementing DEA bootstrapping analysis of the US insurance industry. Barros et al. (2010), Cummins and Zi (1997), Hardwick et al. (2003), Klumpes (2004) and Kasman and Turgutlu (2007), Sinha et al. (2009), Md Saad et al. (2011) and measured cost efficiency in the Greece, United States, United Kingdom, Turkish, India and Malaysian life insurance industry by applying different kinds of DEA methods. Diboky and Ubl (2007) investigated ownership and efficiency in the German life insurance market using DEA bootstrap method. Shujie et al. (2007)

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performed an investigation on technical efficiency of China's insurance industry after the country joined to WTO. Retzlaff-Roberts and Puelz (1996) performed a survey on classification in automobile insurance using a DEA and discriminant analysis hybrid. Chen (1998) determined the comparative efficient firms of insurance industries through the implementation of DEA method. Wei (2009) investigated efficiency of insurance fund utilization in China's insurance companies using a resource-based two-stage DEA model. Brockett et al. (2004) performed an empirical investigation to evaluate solvency versus efficiency performance and various forms of organization and marketing in US property—liability insurance firms.

2. The proposed study

This paper presents an empirical investigation to measure the relative efficiency of some firms listed on Tehran Stock Exchange using data envelopment analysis (DEA) over the period 2011-2013. Charnes et al. (1978) are believed to be the first who introduced the idea of DEA for measuring the relative efficiency of different firms as follows,

$$\max \Theta_o = \sum u_r y_{ro} \quad (1)$$

subject to

$$\sum u_r y_{rj} - \sum v_i x_{ij} \leq 0 \quad j=1,2,\dots, n \quad (2)$$

$$\sum v_i x_{io} = 1 \quad i=1,2,\dots, m \quad (3)$$

$$u_r, v_i \geq 0 \quad r=1,2,\dots, s \quad (4)$$

Here, x_{ij} and y_{rj} represent inputs and outputs and u_r, v_i represent dual variables associated with input/output variables, respectively. The study assumes there are m criteria and n units. The input oriented DEA can be formulated as follows,

min Φ

subject to

$$\begin{aligned} \sum \lambda_j x_{ij} &\leq \Phi x_{io} & i=1,2,\dots, m \\ \sum \lambda_j y_{rj} &\geq y_{ro} & j=1,2,\dots, n \\ \lambda_j &\geq 0 & r=1,2,\dots, s \end{aligned} \quad (5)$$

Φ free in sign

The first DEA model is established based on a simple criteria, which is constant return to scale. However, Banker et al. (1984) and Banker and Thrall (1992) proposed variable return to scale DEA.

$$\max \Theta_o = \sum u_r y_{ro} + w$$

subject to

$$\begin{aligned} \sum v_i x_{io} &= 1 & i=1,2,\dots, m \\ \sum u_r y_{rj} - \sum v_i x_{ij} + w &\leq 0 & j=1,2,\dots, n \\ u_r, v_i &\geq 0 & r=1,2,\dots, s \end{aligned} \quad (6)$$

w free in sign

and dual of this problem is written as follows,

$$\begin{aligned}
 & \min \Phi \\
 & \text{subject to} \\
 & \sum \lambda_j x_{ij} \leq \Phi x_{io} \quad i = 1, 2, \dots, m \\
 & \sum \lambda_j y_{rj} \geq y_{ro} \quad j = 1, 2, \dots, n \\
 & \sum \lambda_j = 1 \quad r = 1, 2, \dots, s \\
 & \lambda_j \geq 0 \\
 & \Phi \text{ free in sign}
 \end{aligned} \tag{7}$$

where λ_j represents dual variable.

Finally, there is another type of DEA model, which is output oriented and it is expressed as follows,

$$\begin{aligned}
 & \max \Theta_o = \sum v_i x_{io} \\
 & \text{subject to} \\
 & \sum u_r y_{ro} + w = 1 \quad i = 1, 2, \dots, m \\
 & \sum u_r y_{rj} - \sum v_i x_{ij} + w \leq 0 \quad j = 1, 2, \dots, n \\
 & u_r, v_i \geq 0 \quad r = 1, 2, \dots, s \\
 & w \text{ free in sign}
 \end{aligned} \tag{8}$$

There is also another method, which reduces inputs and increases outputs, simultaneously as follows,

$$\begin{aligned}
 & \min z = -\sum s_i^- - \sum s_r^+ \\
 & \text{subject to:} \\
 & \sum -\lambda_j x_{ij} + s_i^- = x_{io} \\
 & \sum -\lambda_j y_{rj} + s_r^+ = y_{ro} \\
 & \sum \lambda_j = 1, \lambda_j \geq 0
 \end{aligned} \tag{9}$$

The proposed study of this paper uses four inputs namely; total assets, price to earnings ratio, beta and sigma and four outputs namely; net earnings, one-year, two-year and three-year returns. Table 1 demonstrates the implementation of Kolmogorov-Smirnov test to learn whether the data were normally distributed or not. As we can observe from the results of Table 1, all data are normally distributed.

Table 1
The summary of Kolmogorov-Smirnov test

Var.		2011		2012		2013	
		Z	Sig.	Z	Sig.	Z	Sig.
X ₁	Total assets	0.236	0.200	0.231	0.200	0.205	0.200
X ₂	Price/Earnings	0.027	0.200	0.205	0.200	0.165	0.200
X ₃	Beta	0.251	0.078	0.213	0.200	0.222	0.200
X ₄	Sigma	0.278	0.200	0.217	0.200	0.201	0.188
Y ₁	Net earnings	0.234	0.127	0.198	0.200	0.202	0.200
Y ₂	One-year return	0.202	0.200	0.205	0.200	0.212	0.200
Y ₃	Two-year return	0.264	0.083	0.263	0.200	0.220	0.200
Y ₄	Three-year return	0.235	0.178	0.231	0.182	0.226	0.200

3. The results

The proposed model of this paper uses two DEA models of input oriented and output oriented to measure the relative efficiencies of nine insurance firms, proposed by Banker et al. (1984), and Table 2 summarizes the results.

Table 2

The summary of the implementation of DEA method

Bank	Output oriented			Bank	Input oriented		
	2011	2012	2013		2011	2012	2013
1	00.1	00.1	00.1	1	1.00	1.00	1.00
2	00.1	00.1	00.1	2	1.00	1.00	0.94
3	00.1	0.95	00.1	3	1.00	1.00	1.00
4	00.1	00.1	00.1	4	1.00	1.00	1.00
5	00.1	00.1	00.1	5	0.98	1.00	1.00
6	00.1	00.1	00.1	6	1.00	0.95	1.00
7	96.0	00.1	00.1	7	1.00	1.00	1.00
8	0.93	0.97	0.91	8	0.97	1.00	1.00
9	00.1	00.1	00.1	9	1.00	1.00	1.00

As we can observe from the results of Table 2, most insurance firms remained efficient and therefore, we need to perform super efficiency method (Andersen & Petersen, 1993). Table 3 demonstrates the summary of our results.

Table 3

The summary of supper efficiency

Bank	Efficiency	Anderson & Peterson
1	1	1.8073
2	1	1.8036
3	1	1.7425
4	1	1.6359
5	1	1.6331
6	0.993	
7	0.983	
8	0.98	
9	0.97	

4. Discussion and conclusion

Measuring the relative efficiency of insurance firms has become a necessity since there is a tight competition among insurance service providers across the world. There is no doubt that DEA method has proven to be one of the most important techniques to learn about the status of an insurance firm. In this paper, we have performed DEA technique to measure the relative efficiencies of some major banks listed on Tehran Stock Exchange. The results of this study has indicated that all firms were relatively efficient compared with each other. We have also measured super efficiency for some insurance firms, which were detected efficient according to BBC technique to have better insight about efficiency of the industry.

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