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Post-Crisis Performance of Turkish Insurance Companies Using Fuzzy Data Enveloping Analysis

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Abstract:
This study analyzes efficiency of the Turkish insurance companies in 2006. In this study fuzzy data enveloping analysis is used. Data Envelopment Analysis (DEA) is a linear programming based method, used in measuring the efficiencies of organizational units, when many inputs and outputs are involved. In this paper fuzzy DEA (data envelopment analysis) models are used for evaluating the efficiencies of objects with fuzzy input and output data. The approach transforms fuzzy DEA models into possibility DEA models by using possibility measures of fuzzy events or fuzzy constraints.
JEL Classifications: *G22, C14, C67, C81*
Key words: *Firm Performance, Insurance Companies, Fuzzy Data Enveloping Analysis*

1. INTRODUCTION

Economic crisis are been after 1980. These are European Money Crisis in 1992-1993, Latin America Crisis in 1994-1995, South East Asian Crisis in 1997-1998, Russian Crisis in 1998, Brazil Crisis in 1999 and Argentina Crisis in 2002. Global capital flows fluctuated between 2 and 6 percent of world GDP during 1980-95, but since then they have risen to 15 percent of GDP (http://www.imf.org/external/about/histglob.htm). These crisis effected Turkish economy. Over 2001 the GDP contracted by 7.4% in real terms, whole sale price inflation soared to 61.6%, and the currency lost 51% of its value against the major foreign monies. The rate of unemployment rose steadily by 2 percentage points in 2001 and then another 3 percentage points in 2002. Real wages fall abruptly by 20% upon impact in 2001 (Yeldan, 2006).

In 2006, global capital flows totaled $7.2 trillion—more than a tripling since 1995. The most rapid increase has been experienced by advanced economies, but emerging markets and developing countries have also become more financially integrated (http://www.imf.org/external/about/histglob.htm). In Turkey year 2007 had best economic conditions in the 1995-2006 period. IMF was applied an exchange-rate based disinflation program. IMF provided financial assistance of $20.4 billions, net, between 1999 and 2003. In the November 2002 elections important political revolution was been. *Justice and Development Party* (AKP) was came to absolute power in the parliament in these elections (Yeldan 2006). But this political revolution did not effect economical politics. AKP government was applied the same post-crisis economical politics. Consequently, AKP government reached consensus with the IMF in 2004 according to the new stand-by agreement.

The aim of this study is analyzing Turkish insurance companies' performances in 2006. Data of 2006 were used because this year is post-crisis and before end of crisis, after AKP government beginning year. In this study fuzzy data enveloping analysis is used.

In the literature, there are many studies which deal performance and efficiency of insurance companies. In these studies different methods have been used for measurement of performance and efficiency. DEA is a widespread method for performance measurement.

2. METHODOLOGY

Data Enveloping Analysis (DEA) is a new data oriented method to measure the performance and efficiency of firms. It evaluates the performance of a set of peer entities. These peer entities are called Decision Making Units (DMUs) and convert multiple inputs into multiple outputs (Cooper, Seiford and Zhu, 2004, 1). DEA is a non-parametric and linear programming method developed by Charnes, Cooper and Rhodes (1978). This model is called the CCR model. CCR ratio model yields an objective evaluation of overall efficiency and identifies the source and estimates the amounts of the thus identified inefficiencies. Other DEA models are the BCC model (1984), the multiplicative models (1982, 1983) and the additive model (1985, 1987). These models may focus on increasing, decreasing, or constant returns to scale as found in economies that are here generalized to the case of multiple outputs (Charnes, Cooper, Lewin and Seiford, 1994: 24).

In DEA, decision making units and input and output data must be measured rightly and precisely. Therefore, Fuzzy Data Envelopment Analysis is recommended by using Fuzzy Theory. Thus, better efficiency scores are obtained and imprecise cases can be analyzed. Guo and Tanaka (2001) suggested fuzzy CCR model for

measurement efficiency. The efficiencies of decision making units (DMUs) are measured with fuzzy observations.

Initially, “n” basic banking inputs and “m” basic banking outputs were considered for each bank and the Charnes, Cooper and Rhodes (1978) input-oriented model, CCR were applied. This model to the Fuzzy DEA model is transformed. Upper and lower bounds were added to the original CCR model. Values $x_{ij}^{L} \rangle 0$ and $y_{rj}^{L} \rangle 0$ and they were known to be between $\left[x_{ij}^{L}, x_{ij}^{U}\right]$ and $\left[y_{rj}^{L}, y_{rj}^{U}\right]$ bounds (upper and lower bounds). In this case, the mathematical formulation of this Fuzzy DEA model is (Apaydın and Güneş, 2008):

$$\theta_k^U, = \frac{\sum_{r=1}^{S} u_r y_{rk}^U}{\sum_{i=1}^{m} v_i x_{ik}^L}$$

max .....1)

$$\theta_j^U, = \frac{\sum_{r=1}^{S} u_r y_{rj}^U}{\sum_{i=1}^{m} v_i x_{ij}^L} \leq 1$$

, j = 1, …. , n ..... (2)

U_r , vi ≥ □ , ∀r, i

$$\theta_k^L, = \frac{\sum_{r=1}^{S} u_r y_{rk}^L}{\sum_{i=1}^{m} v_i x_{ik}^U}$$

max .....(3)

$$\theta_j^U, = \frac{\sum_{r=1}^{S} u_r y_{rj}^U}{\sum_{i=1}^{m} v_i x_{ij}^L} \leq 1$$

, j = 1, …. , n .....(4)

U_r , vi ≥ □ , ∀r, i

where y is the matrix of the output-vector; x is the matrix of the input-vector. Max θ_k^U yields best efficiency for the upper bound and max θ_k^L gives best efficiency for the lower bound.

3. DATA

The primary source of data for the empirical analysis are balance sheets, income statements and other data of each insurance company in the www.tsrsb.org.tr/ web page provided by The Association of the Insurance and Reinsurance Companies of Turkey. The sample of this study includes nineteen insurance companies operating in Turkey in the 2006 (Given in Table 1). 152 observations are used in the analysis for 2006.

TABLE 1. A SAMPLE OF TURKISH INSURANCE COMPANIES LISTED

INSURANCE COMPANIES		
AKSİGORTA	KOÇ ALLIANZ	KOÇ ALLIANZ H/E
AVIVA	RUMELİ	OYAK EMEKLİLİK
AXA OYAK	YAPI KREDİ	YAPIKREDİ EMEKLİLİK
BİRLİK	ACIBADEM S/H	DEMİR HAYAT
DEMİR	AMERICAN LIFE	GENEL YAŞAM
ERGOİSVİÇRE	BİRLİK HAYAT	
FİNANS	HÜR	

Total Equity / Total Liabilities and Equity, Total Equity / Technical Reserves, Total Equity / Technical Reserves, Liquid Assets / Total Assets ratios, Loss Ratio and Conservation Ratio (Net Insurance Premium Collections / Gross Insurance Premium Collections) are inputs and Technical Profit / Insurance Premium Collections, Gross Profit / Insurance Premium Collections and Balance Sheet Profit / Total Technical Profit ratios are outputs in the fuzzy CCR model. Inputs and outputs of the model are given as follows:

TABLE 2. INPUTS AND OUTPUTS OF THE MODEL

Inputs	***Outputs***
Total Equity / Total Liabilities and Equity	Technical Profit / Insurance Premium Collections
Total Equity / Technical Reserves	Gross Profit / Insurance Premium Collections
Liquid Assets / Total Assets	Balance Sheet Profit / Total Technical Profit
Loss Ratio	
Conservation Ratio (Net Insurance Premium Collections / Gross Insurance Premium Collections)	

DEA has two limitations for the study of the reliability. If the number of inputs is m and number of outputs p, the number of DMUs will be at least m+p+1. Number of DMUs is at least twice as high as the total numbers of variables (Boussofiance, 1991). This study has five inputs and three outputs. M+p+1 is equals 9. The number of DMUs is high than 9 (19>9). In addition the number of DMUs is higher than the double total variables (19>16).
Descriptive statistics of inputs and outputs of model are given in Table 3.

TABLE 3. DESCRIPTIVE STATISTICS OF INPUTS AND OUTPUTS (2006)

Inputs	***Mean***	***Standard Deviation***	***Min***	***Max***
Total Equity / Total Liabilities and Equity	0,55774	0,251235	0,284	1,179
Total Equity / Technical Reserves	0,866249	0,125601	0,527	1,104
Liquid Assets / Total Assets	0,047179	0,056763	0,003	0,258
Loss Ratio	0,061642	0,056919	0,002	0,18
Conservation Ratio (Net Insurance Premium Collections / Gross Insurance Premium Collections)	2,779114	2,120596	0,528	7,265
Outputs				
Technical Profit / Insurance Premium Collections	0,294684	0,190354	0,08	0,845
Gross Profit / Insurance Premium Collections	1,522421	2,105924	0,219	9,289
Balance Sheet Profit / Total Technical Profit	0,822421	0,23778	0,228	0,995

Different normality tests were used in the literature. But most normality test is Shapiro-Wilk test for small to medium sized samples (sample < 3000) according to Shapiro (1968, 1343-1372) and most authors (TBB, 127; Tabachnick and Fidel, 2000; Coakes and Steed, 1997). Because of this advantage of Shapiro-Wilk test, it was used in this study. The test statistic was clearly significant at P = 0.05 which rejects the null hypothesis that these data are from a normal distribution. Normality test results are given in Table 4 for %5 significant degree.

TABLE 4. SHAPIRO-WILK NORMALITY TEST RESULTS

Inputs	***Shapiro-Wilk***	***p***
Total Equity / Total Liabilities and Equity	0,88	0,020
Total Equity / Technical Reserves	0,60	0,0001
Liquid Assets / Total Assets	0,73	0,0001
Loss Ratio	0,80	0,001
Conservation Ratio (Net Insurance Premium Collections / Gross Insurance Premium Collections)	0,86	0,011
Outputs		
Technical Profit / Insurance Premium Collections	0,65	0,0001
Gross Profit / Insurance Premium Collections	0,87	0,0125
Balance Sheet Profit / Total Technical Profit	0,84	0,005

4. RESULTS

The technical efficiency scores for the upper and lower bounds are given in Table 5. In the upper and lower bounds AKSİGORTA, ERGOİSVİÇRE, FİNANS, HÜR, AMERİCAN LİFE, BİRLİK HAYAT, DEMİR HAYAT, GENEL YAŞAM and YAPIKREDİ EMEKLİLİK are fully (relative) efficient because both the upper and lower bound scores are 1.

TABLE 5. TECHNICAL EFFICIENCY SCORES (UPPER AND LOWER BOUNDS) (CCR-I)

Insurance Companies	Lower Bound (CCR-I)	Upper Bound (CCR-I)
AKSİGORTA	1,000	1,000
AVIVA	0,9147	0,9809
AXA OYAK	0,9652	0,9419
BİRLİK	0,6939	1,000
DEMİR	0,7306	1,000
ERGOİSVİÇRE	1,000	1,000
FİNANS	1,000	1,000
HÜR	1,000	1,000
KOÇ ALLIANZ	0,4721	0,9408
RUMELİ	0,8194	0,9570
YAPI KREDİ	0,5029	1,000
ACIBADEM S/H	0,7618	0,9962
AMERICAN LIFE	1,000	1,0000
BİRLİK HAYAT	1,000	1,0000
DEMİR HAYAT	1,000	1,0000
GENEL YAŞAM	1,000	1,0000
KOÇ ALLIANZ H/E	0,3817	0,9000
OYAK EMEKLİLİK	1,000	0,8697
YAPIKREDİ EMEKLİLİK	1,000	1,000

Models for each inefficient DMUs are made using the data in Table 5. Below, inefficient banks for the year 2006 are classified. As can be seen in 2006, DMUs of nine insurance companies are fully efficient. The remaining ten insurance companies are not efficient. These insurance companies efficiency scores are measured fuzzy in bound values. EMS software was used for these measurements.

AVİVA : [0.9147 , 0.9809]
AXA OYAK : [0.9652 , 0.9419]
BİRLİK : [0.6939 , 1.000]
DEMİR : [0.7306 , 1.000]
KOÇ ALLIANZ : [0.4721 , 0.9408]
RUMELİ : [0.8194 , 0.9570]
YAPI KREDİ : [0.5029 , 1.000]
ACI BADEM S/H : [0.7618 , 0.9962]
KOÇ ALLIANZ H/E : [0.3817 , 0,9000]
OYAK EMEKLİLİK : [0.8697, 1.000]

We can classify these insurance companies according to regret approach. Below is the application of the model on one insurance companies using bound values for the year 2006.

R(AVİVA) = max [max (0.9419, 1.000, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 0.9000, 1.000) – 0.9147, 0] = 0.0853
R(AXA OYAK) = max [max (0.9809, 1.000, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 0.9000, 1.000) – 0.9652, 0] = 0.0348
R(BİRLİK) = max [max (0.9809, 0.9419, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 0.9000, 1.000) – 0.6939, 0] = 0.3061
R(DEMİR) = max [max (0.9809, 0.9419, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 0.9000, 1.000) – 0.7306, 0] = 0.2694
R(KOC ALLİANZ) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9570, 1.000, 0.9962, 0.9000, 1.000) – 0.7306, 0] = 0.4721
R(RUMELİ) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9408, 1.000, 0.9962, 0.9000, 1.000) – 0.8194, 0] = 0.1806
R(YAPI KREDİ) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9408, 0.9570, 0.9962, 0.9000, 1.000) – 0.5029, 0] = 0.4971
R(ACI BADEM S/H) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9408, 0.9570, 1.000, 0.9000, 1.000) – 0.7618, 0] = 0.2382
R(KOC ALLİANZ H/E) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 1.000) – 0.3817, 0] = 0.6183
R(OYAK EMEKLİLİK) = max [max (0.9809, 0.9419, 1.000, 1.000, 0.9408, 0.9570, 1.000, 0.9962, 0.9000) – 0.8697, 0] = 0.1303

AXA OYAK has the lowest score and thus is accepted as having the high efficiency in the group (ten insurance companies). Because of this AXA OYAK is excluded from the list. The same method is applied for the remaining 9 insurance companies, excluding the insurance company with the lowest score each time until two insurance companies remain. The insurance companies are classified through CCR-I in 2006 and the following efficiency classification is obtained:

AXA OYAK > AVİVA > OYAK EMEKLİLİK > RUMELİ > ACIBADEM S/H > DEMİR > BİRLİK > YAPI KREDİ > KOC ALLİANZ > KOÇ ALLİANZ H/E

5. CONCLUSION

This study measured the efficiency of insurance companies with using Fuzzy DEA in post-crisis year, 2006. In the result ten insurance companies (Ergoİsvçre, Finans, Hür, American Life, Birlik Hayat, Demir Hayat, Genel Yaşam, Oyak Emeklilik ve Yapı Kredi Emeklilik) are fully efficient. Koç Allianz H/E is the lowest efficient insurance company in 2006. In this paper fuzzy DEA method and CCR model was used for measurement of insurance company efficiency. Fuzzy DEA models can play an important role for perceptual evaluation problems comprehensively existing in the real world, finance sectors, for example insurance sector. Other DEA models will be applied in other studies. Comparison of national insurance companies to foreign insurance companies may be studied in other papers. In this study one important and normal year data used, but this is very short period. Other studies can be used long period data.

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