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Analysing The Efficiency Of The Greek Life Insurance Industry

By

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Abstract:

This paper uses the DEA-CCR and the DEA-BCC models to evaluate the performance of Greek life insurance companies in the period 1994 to 2003, combining operational and financial variables. These models identify adequately the inefficient companies, but are weak in discriminating among those found to be efficient. To improve the results, we employ the Cross-Efficiency and the Super-Efficiency models. We estimate an inefficiency gap of about 27%. Furthermore, by using the Mann-Whitney Z-Test, we find that large and quoted life insurance companies, as well as those involved in mergers and acquisitions, exhibit higher efficiency. A major finding is that the local market is in great need of further consolidation.

Keywords: Greek life insurance companies, Data Envelopment Analysis, Efficiency.

1. Introduction

European insurance industry has traditionally been extremely regulated and protected. As a result of the implementation of the Third European Union Directive on insurance in 1994, this situation changed, that is, competition increased across national frontiers and a restructuration of the insurance industry took place via the consolidation of the intra market, mergers, acquisitions and alliances. In what concerns to the Greek market, the number of insurance companies declined by 38% between 1994 and 2003, while the average company size increased by almost 500% (CEA, 2005). Moreover, the regulated premium tariff system (for Motor TPL and Fire branches), which had formerly prevailed, was abolished in 1994**.** The beneficial effects of deregulation would have been further reinforced if an adequately empowered supervisory authority had been in place to oversee the Greek insurance market. We believe that the absence of any

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substantial supervision of insurance operations has delayed the consolidation of the Greek insurance market. A continuous process of consolidation would have served to improve competition in the medium to long term, by removing the weaker players from the market. Nevertheless, in the decade following the above-mentioned deregulation, Greek life insurance companies have attempted to increase their efficiency.

This paper analyses the technical efficiency of Greek life insurance companies from 1994 to 2003 with the aid of four well-known DEA (Data Envelopment Analysis) models: (i) the DEA-CCR model (Charnes, Cooper and Rhodes, 1978); (ii) the DEA-BCC model (Banker, Charnes and Cooper, 1984); (iii) the Cross-Efficiency DEA model (Sexton, Silkman and Hogan, 1986 and Doyle and Green, 1994); and (iv) the Super-Efficiency DEA model (Andersen and Petersen, 1993). DEA is a linear programming technique that enables management to benchmark the best-practice decision-making units (DMUs), by calculating scores denoting their efficiency. Furthermore, DEA provides estimates of the potential improvement that can be made by inefficient companies. In the first stage of our study, the four DEA models are used to calculate both technical and scale efficiency. In the second stage, the Mann-Whitney U-Test is used to test some hypotheses (Brockett and Golany,1996).

As far as we know, this is the first article to examine the relative efficiency of the Greek life insurance sector, although there is a previous study on the Greek non-life insurance sector (Noulas et al., 2001). From an academic perspective, the particular contribution of this paper lies in the use of four alternative DEA models, whereas previously published papers have mainly restricted the analysis to one model. On the other hand, information about efficiency is helpful to regulators that analyse the market structures, to companies that want to consolidate through mergers and acquisitions or make alliances, and also for capital markets.

The paper is organized as follows. In section 2, we survey the literature on the topic. In section 3, we describe the Greek institutional setting and recent evolution. In section 4, we present the theoretical framework. In section 5, the data and results are presented and discussed. In section 6, we draw our conclusions.

2. Literature Review

In the United States as well as in European countries, studies about efficiency in the insurance industry have emerged, using both parametric and non parametric approaches, during the eighties and nineties.

Research about efficiency in insurance employs frontier models. Two contemporary scientific methods to analyze efficiency quantitatively are the econometric frontier and data envelopment analysis (DEA). Both have advantages and drawbacks. Under the econometric approach, a functional form for the cost, profit or production frontier is specified. Firms that are found to be below the efficient frontier, may be due to inefficiency, but also it may result of random shocks or measurement errors, due to the stochastic nature of the approach. Thus, the function error term is hypothesized to consist of an inefficiency component and a purely random component. Unlike the econometric stochastic frontier approach, the DEA (a non-parametric method) allows the use of multiple inputs and outputs and does not impose any functional form on the data, neither does it make distributional assumptions for the inefficiency term[iv]. Both methods assume that the production function of the fully-efficient decision unit is known. In practice, this is not the case, and the efficient isoquant must be estimated from the sample data. Under these conditions, the frontier is defined relative to the sample considered in the analysis.

Cummins and Zi (1998) apply these two methodologies and also some variants of each, to explore the efficiency of US life insurance companies and conclude that the choice of the efficiency estimation method can make a significant difference. They find that average efficiency is higher for econometric models than for DEA models. Although, efficiency rankings for the DMUs included in the sample are well preserved in the econometric methods and less well preserved between econometric methods and programming methods. Other studies on the US insurance markets include Cummins and Weiss (1993), Gardner and Grace (1993), Cummins, Weiss and Zi (1999) and Cummins and Weiss (2000).

In Europe, there was a growth in research about efficiency in the insurance sector during the nineties, stimulated by a radical change in the sector, after the implementation of the single market in European financial services in 1993, which increased competition in state members and put additional pressure on less efficient insurers. The studies by Fecher et al. (1993) and Cummins, Turchetti and Weiss (1996), reflect this environment.

Fecher et al. (1993) use both a parametric approach (a stochastic Cobb-Douglas frontier) and a non-parametric approach (DEA) to construct the efficient frontier. The sample consists on 84 life and 243 non-life French insurance companies. The authors observe that the results are not very sensitive to the approach used, and that there is a great dispersion of efficiency levels between companies. In life insurance, average efficiency is only 30% and for non-life it is 50%. Another important conclusion is a positive correlation between the size of the company an efficiency.

Cummins, Turchetti and Weiss (1996) study the Italian market, considering a sample of 94 companies (life, non-life and mix) between 1985 and 1993. They use a DEA distance function to estimate the technical efficiency and a Malmquist index to analyse changes in technical efficiency. Their results show that technical efficiency in the Italian insurance industry ranges from 70% to 78%, during the sample period.

Hardwick (1997) analyses the cost inefficiency of the United Kingdom life insurance companies using a stochastic frontier approach, between 1989 and 1993. The author concludes that the life insurance industry is very inefficient, namely, that it is possible to produce the same level of output with less 30% of

[iv] Coelli, Rao and Battese (1998) provide a detailed comparison between parametric and non-parametric methodologies.

costs. The author also observes that larger life insurance companies are less inefficient than smaller, which he attributes to exploitable scale economies.

Noulas et al. (2001) investigates efficiency of non-life insurance companies in Greece applying a DEA methodology. His sample includes 12 companies for the period 1991 to 1996. His results show an average efficiency of 65%, with a great dispersion between companies. The author concludes that non-life insurance firms are very inefficient, and their survival in the market implies reduction in costs and an improvement in productivity, that is, an improvement in efficiency.

Mahlberg and Url (2003) and Ennsfellner, Lewis and Anderson (2004) study the Austrian insurance market. These studies use different methodologies to study the impact on efficiency of the single market and of the deregulation in the insurance industry. The former measures the effects of liberalization on technical efficiency an on productivity between 1992 and 1999, using DEA for the estimation of efficient frontiers and also construct a Malmquist index for the transition period. The authors find that, despite the full implementation of the financial single market in 1994, the Austrian insurance industry is inefficient, with an average score of about 75%, and that it is possible to reduce costs adjusting the size of the companies. They also observe a reduction in the dispersion of the efficiency scores and in productivity over time, which they explain by an increase in competition. The later study uses a Bayesian stochastic frontier (a parametric approach) and analyses a similar period, 1994 to 1999. Their conclusions are consistent with the Mahlberg and Url (2003), showing that efficiency increased in the period, from 61.7% in 1944 to 84.8% in 1999.

There are three studies about Spanish insurance industry. Fuentes et al (2001), analyse the change in productivity in the period 1987 to 1994, and find that deregulation had little impact on productivity growth. Cummins and Rubio-Misas (2003) study the period between 1989 and 1998 and conclude that industry consolidation was efficiency-enhancing; In a study of the same period, Cummins, Rubio-Misas and Zi (2004) analyse Spanish stock and mutual insurers and their conclusions are in line with their previous work.

Barros, Borges and Barroso (2005) study the efficiency and productivity of the Portuguese insurance market in the period 1995 to 2001, using a Malmquist index, and find that a large proportion of companies experienced productivity growth while some experienced a decrease in productivity. They argue that, for a significant number of the companies, there is still room for improvement of managerial skills, which would translate as an increase in technical efficiency.

Finally, we must refer Diacon, Starkey and O'Brien (2002), a paper that provides comparisons between European countries, which is relevant in the context of globalisation. Using Standard & Poor's Eurothesis database for the years 1996 to 1999, they analyze technical efficiency of European insurers in different countries, and find striking differences in efficiency. The higher levels of technical efficiency are found in UK, Spain, Sweden and Denmark[v].

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[v] A previous study on the efficiency and productivity of the insurance industry in the OECD countries is Donni and Fecher (1997).

Most of these papers replicate previous research and techniques, with little improvement in methodology. We have not found studies on the European insurance markets applying more up-to-date techniques, such as Fourier frontiers (Altunbas et al., 2001), input distance functions (Coelli and Perelman, 1999, 2000), nor have we found studies using non-traditional DEA models, such as the Cone-Ratio DEA model of Charnes et al. (1990) and the Assurance Region DEA model of Thompson et al. (1986, 1990). We believe that the use of more modern techniques is a relevant avenue for further research on the efficiency of European insurance markets.

3. Overview of the Greek Insurance Market

The Greek insurance market is the least developed in the group of EU-15 countries. For this group of insurance markets, the relative share of the Greek market increased from 0.3% in 1994 to 0.4% in 2003, in terms of total premiums. Table 1 below shows that the volume of total premiums in the Greek market increased from €1,050 million to €3,235 million between 1994 and 2003. In the same period, the inflation-adjusted average annual growth rate of total premiums was 6.8%, while in the EU-15, it was 4.8%. For the life sector, the inflation-adjusted average annual growth rate was 6.0% (EU-15: 7.3%), whereas for the non-life sector, it was 7.5% (EU-15: 2.3%). This means that most of the growth in the volume of business in the Greek insurance market in the period 1994-2003 came from the faster growth of the non-life sector. This is explained by the fact that Greece has not yet completed the reform of its pensions system. This reform process has contributed substantially to the rapid growth of the life insurance sector in most European insurance markets. It should not be surprising, therefore, that the share of life premiums exhibits a reduction between 1994 and 2003, an evolution that is opposite to the observed in EU-15 in the same period. While the Greek share of life premiums in total premiums has reduced from 48% to 44%, in the EU-15 that share has increased from 44% to 57%.

Table 1: Basic Characteristics of the Greek Insurance Market (values in Euro)

Characteristic of the Insurance Market	1994	2003
Number of Insurance Companies	161	100
Employment	10,000	9,500
Total Premium	1,050 million €	3,235 million €
Life	506 million €	1,435 million €
Non-Life	544 million €	1,800 million €
Average Size of Company	1050/161=6.5	3235/100=32.3
Life Premium share	48%	44%
Nonlife Premium share	52%	56%
Market Concentration (in terms of premium)		
1. Life:		
Big 5	68.7% (EU-15: 45%)	62.5% (EU-15: 54%)
Big 10	82.9% (EU-15: 63%)	88.9% (EU-15: 75%)
Big 15	90.6% (EU-15: 72%)	97.2% (EU-15: 84%)
2. Non-Life:		
Big 5	39.3% (EU-15: 32%)	42.8% (EU-15: 46%)

Big 10	50.9% (EU-15: 48%)	58.4% (EU-15: 62%)
Big 15	59.1% (EU-15: 59%)	70.8% (EU-15: 71%)
Total Premium/GDP	1.5% (EU-15: 5.9%)	2.1% (EU-15: 7.7%)
Life Premium/GDP	0.7% (EU-15: 2.6%)	0.9% (EU-15: 4.4%)
Non-Life Premium/GDP	0.8% (EU-15: 3.2%)	1.2% (EU-15: 3.3%)
Investments/GDP	1.8% (EU-15: 24%)	4.5% (EU-15: 44%)

Source: CEA (2005), European Insurance in Figures: 2003-2004

The number of insurance companies fell from 161 in 1994 to 100 in 2003, corresponding to a decrease of about 38%, when the respective decrease in the EU-15 area was 6.5%. Most of the market exits of insurance companies were due to insolvencies, while others were taken over in mergers and acquisitions. The reduction in the number of insurance companies led to the beneficial effect of increasing the average company size by five times in the period 1994-2003. The volume of employment in the insurance sector decreased from 10,000 in 1994 to about 9,500 in 2003; a decrease of 0.5%, on an annual basis (EU-15 decrease in the same period: 0.3%).

Table 1 also shows the market concentration in the Greek insurance market. Historically, concentration has been very high in the life sector, much more so than the corresponding ratios in the EU-15 area, although this difference has been narrowing. In contrast, concentration in the non-life sector is comparable to EU-15 standards, reflecting a movement towards an increase in concentration.

The relative importance of the Greek insurance market in the domestic economy is not significant. While on the one hand, the underdeveloped nature of the Greek insurance market may imply inefficiency and low competition, on the other hand, it offers significant opportunities for development and growth. We may observe from Table 1 that the ratio of total premiums to GDP increased from 1.5% in 1994 (EU-15: 5.9%) to 2.1% in 2003 (EU-15: 7.7%). The respective ratios of total investments of insurance companies relative to GDP were 1.8% (EU-15: 24%) and 4.5% (EU-15: 44%)

4. Methodological Framework

Following Farrell (1957), Charnes, Cooper and Rhodes (1978) first introduced the term DEA (Data Envelopment Analysis) to describe a mathematical programming approach to the construction of production frontiers and efficiency measurements corresponding to the constructed frontiers. The latter authors proposed a model that had an input orientation and assumed constant returns-to-scale (CRS). This model is known in the literature as the CCR model. Later studies have considered alternative sets of assumptions. Banker, Charnes and Cooper (1984) were the first to introduce the assumption of variable returns-to-scale (VRS). This model is known in the literature as the BCC model. There are four other basic DEA models, used less frequently in the literature: the additive model of Charnes et al. (1985), the multiplicative model of Charnes et al. (1982), the Cone-Ratio DEA model of Charnes et al. (1990) and the Assurance-Region DEA model of Thompson et al. (1986, 1990). The latter two models include *a priori* information (e.g. expert opinion, opportunity costs, rate of transformation or rate of substitution) to restrict the results to just one best DMU (Assurance-Region DEA model) or to link DEA with multi-criteria analysis (Cone-Ratio DEA model).[vi]

In the programming method, DEA "floats" a piece-wise linear surface to rest on the top of an observation (Seiford and Thrall, 1990). The facets of the hyperplane define the efficiency frontiers, and the degree of inefficiency is quantified and partitioned by a series of metrics that measure various distances from the hyperplane and its facets. In order to solve the linear-programming problem, the user must specify three characteristics of the model: the input-output orientation system; the returns-to-scale; and the relative weights of the evaluation system. In relation to the first of these, the choice of input-oriented or output-oriented DEA is based on the market conditions of the DMU. As a general rule of thumb, in competitive markets, DMUs are output-oriented, since we assume that inputs are under the control of the DMU, which aims to maximize its output subject to market demand (something that is outside the control of the DMU). With exogenous inputs, the production function is the natural choice (Kumbhakar, 1987). In monopolistic markets, the units analyzed (DMU) are input-oriented, because the output is endogenous in this market, while the input is exogenous; therefore, the cost function is the natural choice. The input-orientation system searches for a linear combination of DMU_i that maximizes the excess input usage of DMU_i, subject to the inequality constraints presented below. With regard to returns-to-scale, these may be either constant or variable. We calculate both forms (the CCR and the BCC model) for comparative purposes. With reference to the relative weights that may be placed on inputs and outputs in the objective function, these are subject to the inequality constraints mentioned. Weights are endogenously defined by the algorithm and measure the distance between the DMU and the frontier.

The DEA-CCR and DEA-BCC models do well at identifying the inefficient units, but are weak in discriminating among the efficient units (Seiford and Zhu, 1999). The DEA-CCR and DEA-BCC models often rate too many units as efficient. To overcome this problem, we use the Cross-Efficiency DEA model (Sexton, Silkman and Hogan, 1986; and Doyle and Green, 1994) and the Super-Efficiency DEA model (Andersen and Petersen, 1993).

5. Empirical Analysis

5.1 Data

To estimate the production frontier, we use panel data for the years 1994 to 2003, obtained from the Association of Insurance Companies of Greece, on 17 Life insurance companies. Each company is observed for a period of 10 years, allowing us to obtain 170 observations. The insurance companies included in our

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[vi] Extensions of the DEA model are the DEA-Malmquist model, which disentangles total productivity change into technical efficiency change and technological efficiency change (Malmquist, 1953), and the DEA-allocative model, which disentangles technical and allocative efficiency.

analysis represent almost 90% of the market, thus being abundantly representative of the Greek life insurance market. We respect the DEA convention that the minimum number of DMUs is greater than three times the number of inputs plus output (Raab and Lichty, 2002).

We measure insurance production according to a generalized Cobb-Douglas production function. The determination of inputs and outputs is based on the conclusions of the review article by Cummins and Weiss (2000). Therefore, we measure output by: (i) invested assets; (ii) losses incurred; (iii) reinsurance reserves and (iv) own reserves; and measure inputs by: (v) labour cost, (vi) non-labour cost and (vii) equity capital. We draw attention to the fact that the values of the variable "losses incurred" are the sum of "life benefits" and "change in reserves". All variables are deflated to obtain implicit quantities, dividing the value by the GDP deflator (1994=100) obtained from the Annual Report of the Central Bank of Greece.

Table 2: Statistics of inputs and outputs of Greek Life companies, 1994-2003. (units: thousands Euros)

Variables	Minimum	Maximum	Mean	Stand. dev.
Outputs				
Invested assets	88.90	661664.19	53784.71	121004.81
Losses incurred	1.59	106494.47	8498.63	18888.64
Reinsurance reserve	0.67	8251.10	446.55	1397.65
Own reserves	0.18	33920.37	2643.37	6125.23
Inputs				
Labour cost	1.15	43387.43	3829.14	8007.41
Non-Labour cost	0.58	24758.99	2283.64	4380.69
Equity Capital	64.04	197755.97	12516.61	30002.19

5.2 Results

The DEA index can be computed in several ways. In this study, we estimate an output-oriented, technically efficient (TE) DEA index, assuming that the Greek life insurance companies aim to maximize profits resulting from their activity. In this context, inputs are endogenous and outputs exogenous, because of the competitive environment in which the units compete (Kumbhakar, 1987).

The variable-returns-to-scale (VRS) methodology is preferred, because we assume that there was strong disposability of inputs and outputs in the period under analysis. If strong disposability of inputs and outputs is assumed, technical efficiency can be decomposed into two different components: pure technical efficiency and scale efficiency (Fare, Grosskopf and Lovell, 1994). The VRS scores measure pure technical efficiency only. However, the constant-returns-to-scale (CRS) index is composed of a non-additive combination of pure technical and scale efficiencies. A ratio of the overall efficiency score to the pure technical efficiency score provides a measurement of scale efficiency.

The relative efficiency of Greek life insurance companies is presented in Table 3, in which the companies are ranked according to the BCC model results.[vii]

Table 3: CCR-DEA Model and BCC-DEA Model, Technical Efficiency Scores for Greek Life Insurance Companies, average values for the period 1994-2003

No.	Name	Technical efficiency, Constant Returns-to-Scale CCR model	Technical efficiency, Variable Returns-to-Scale BCC model	Scale efficiency	Position of the company on the frontier
1	AGROTIKI LIFE	1.000	1.000	1.000	—
2	GENERALI LIFE	1.000	1.000	1.000	—
3	IMPERIO LIFE	1.000	1.000	1.000	—
4	ELLINOBRETANIKI LIFE	1.000	1.000	1.000	—
5	INTERAMERICAN INT. LIFE	1.000	1.000	1.000	—
6	INTERAMERICAN LIFE	1.000	1.000	1.000	—
7	NORDSTERN LIFE	1.000	1.000	1.000	—
8	INTERSALONICA LIFE	0.852	1.000	0.852	irs
9	AKMI / EFG LIFE	0.569	1.000	0.569	irs
10	UNIVERSAL LIFE	0.690	0.739	0.933	irs
11	OLYMPIAKI / VICTORIA LIFE	0.524	0.564	0.929	irs
12	ALLIANZ LIFE	0.525	0.526	0.998	Irs
13	HELVETIA / POSEIDON LIFE	0.473	0.520	0.909	drs
14	METROLIFE LIFE	0.449	0.475	0.945	Irs
15	COMMERCIAL UNION LIFE	0.432	0.453	0.953	Irs
16	SCOPLIFE	0.427	0.446	0.957	Irs
17	INTERNATIONAL LIFE	0.412	0.438	0.940	Irs
—	Mean	0.727	0.774	0.938	—
—	Median	0.690	1.000	0.690	—
—	Std. Dev	0.258	0.255	1.009	—

A number of comments can be made from Table 3. First, the insurance companies with an efficiency score equal to one are efficient; therefore, there are at least seven companies on the efficient frontier. Second, best-practice calculations indicate that the middle level of technical efficiency in the period was 0.727. This result implies that there is room for the mean insurance company's efficiency to be upgraded by at least 27.3%. Third, all technically efficient CRS insurance companies, which are those with efficiency scores equal to one, are also technically efficient in VRS, since the VRS score is also one, signifying that the dominant source of efficiency is scale. Fourth, on the basis of the BCC results, which measure pure technical efficiency due to management skills, nine insurance companies are efficient in the period. Fifth, according to the scale efficiency, only seven companies exhibit constant returns to scale, while most of the rest exhibit increasing returns to scale. It may be noted that life insurance companies with

[vii] GAMS software (Brooke, Kendrick and Meeraus, 1992) is used to generate these results.

DRS (decreasing returns to scale) are too large in size; scale should be decreased if decreasing returns to scale prevail. On the other hand, insurance companies with IRS (increasing returns to scale) are too small in size; thus, scale should be increased if increasing returns to scale prevail. Therefore, the overall conclusion is that Greek life insurance companies reflect management of average quality, as far as pure technical efficiency is concerned. However, scale makes a difference and therefore, the life insurance sector is in great need of consolidation in order to increase the scale of operations.

Table 4 presents the results of the Cross-Efficiency DEA model and the Super-Efficiency DEA model, which were applied to the Greek life insurance companies with two objectives: first, to cross-validate the DEA-CCR and DEA-BCC models; and second, to restrict the number of DMUs on the best practices frontier.

Table 4: Cross-Efficiency DEA Model and Super-Efficiency DEA Model, Technical Efficiency Scores for Greek Life Insurance Companies, average values for the period 1994-2003

No.	Name	Technical efficiency, Cross-Efficiency scores	Technical efficiency, Super-Efficiency scores
1	AGROTIKI LIFE	1.352	1.347
2	GENERALI LIFE	1.232	1.228
3	IMPERIO LIFE	1.220	1.215
4	ELLINOBRETANIKI LIFE	1.218	1.212
5	INTERAMERICAN INT. LIFE	1.215	1.207
6	INTERAMERICAN LIFE	1.187	1.173
7	NORDSTERN LIFE	1.153	1.151
8	INTERSALONICA LIFE	0.938	1.032
9	AKMI / EFG LIFE	0.853	1.012
10	UNIVERSAL LIFE	0.735	0.932
11	OLYMPIAKI / VICTORIA LIFE	0.673	0.831
12	ALLIANZ LIFE	0.620	0.815
13	HELVETIA / POSEIDON LIFE	0.615	0.804
14	METROLIFE LIFE	0.605	0.732
15	COMMERCIAL UNION LIFE	0.592	0.712
16	SCOPLIFE	0.591	0.708
17	INTERNATIONAL LIFE	0.580	0.702
—	Mean	0.905	0.989
—	Median	0.853	1.012
—	Std. Dev	0.294	0.223

We observe in Table 4 that the scores from both the Cross-Efficiency and the Super-Efficiency DEA models rank the Greek life insurance companies unequivocally, and that they maintain the same ranking, thereby overcoming the difficulty that the CCR-DEA and BCC-DEA models have in discriminating between the efficient units. The main advantage of the results of Table 4 in relation to Table 3 is the unequivocal ranking of all Greek life insurance companies. In comparing the results in Table 4 with those in Table 3, note that the efficiency scores are no longer normalised between zero and one, since some of the insurance companies within the frontier of best practices have an efficiency score higher than one. The interpretation for the inefficient units, i.e., those below one, is maintained. But the two models of Table 4 are very useful in determining a new ranking for the efficient companies of Table 3, indicating that some companies are more efficient than others.

5.3. Efficiency by Different Types of Life Insurance Companies

Having established the efficiency rankings of the Greek life insurance companies, we now test some hypotheses related to the rankings obtained. The Mann-Whitney U-Test, which tests for differences among the various efficiency scores, is conducted. The Mann-Whitney U-Test is recommended for the non-parametric analysis of DEA results by Brockett and Golany (1996), as well as by Grosskopf and Valdamanis (1987). It is used here because the efficiency scores do not fit within a standard normal distribution. The Super-Efficiency scores are chosen because they discriminate adequately among the units analysed. The following hypotheses are tested:

Hypothesis 1: Large life insurance companies are not more efficient than small life insurance companies.

This is a traditional hypothesis in financial institution efficiency studies, where size and efficiency are related (Cummins, Rubio-Misas and Zi, 2004). The separation of the insurance companies between large and small is based on the book value of assets; the sample is split into two parts, with half of the sample defined as large and half defined as small. Since we have 17 life insurance management companies and 170 observations, the split restricts each of the two subsamples to 8 companies and 85 observations. We expect the larger companies to be more efficient, based on the economies of scale observed in this activity.

Hypothesis 2: Quoted life insurance companies are not more efficient than non-quoted insurance companies.

This is also a traditional hypothesis in financial institutions efficiency studies, similar to the distinction between mutual and stock insurers. The separation between quoted and non-quoted life insurance companies is based on their status. We have only two quoted companies in the sample. We compare the observations relative to these two quoted companies (20 observations relative to AGROTIKI LIFE and INTERAMERICAN LIFE) with the two average efficient non-quoted companies, based on the fact that they have a similar output portfolio. We expect the quoted companies to be more efficient since they have higher efficiency scores. This different ranking is supported in the principal-agent relationships that are observed in non-quoted entities relative to the highly-scrutinised quoted companies (Jensen and Meckling, 1976).

Hypothesis 3: Companies involved in mergers and acquisitions are not more efficient than those that were not involved in such processes.

We carry out a post-acquisition analysis, splitting the sample in two, with three companies of the sample related to mergers and acquisitions and the others not related to the M&A activity. This splitting process is similar to the one adopted in Hypothesis 1. Since we have three insurance companies with M&A activity during the period, the split restricts the sample to three companies and 30 observations. We expect M&A-involved insurance companies to be more efficient, as Cummins, Tennyson and Weiss (1999) found in the US insurance market. In Table 5, we also present the Mann-Whitney Z-Test, in addition to the U-Test.

Table 5: Mann-Whitney Test of Differences in Efficiency

Reference	Number	Mann-Whitney U-Test	Mann-Whitney Z-Test	Asymptotic significance (two-tailed)
Large insurance companies vs. small insurance companies	8 vs. 8	201.00	-1.21	0.029*
Quoted companies vs. Non-quoted insurance companies	2 vs. 2	143.00	-1.82	0.025*
Insurance companies involved in mergers and acquisitions vs. insurance companies not involved in mergers and acquisitions	3 vs. 3	173.00	-1.52	0.051*

** Indicates significance at a 5% level.*

The minus sign of the Z-score indicates that we reject the null, in all three hypothesis. Thus, large life insurance companies tend to have higher efficiency scores than small life insurance companies, which is contrary to Cummins, Rubio-Misas and Zi (2004), who find that larger insurance companies are neither dominated nor dominant for the Spanish market. The present result is supported by the economies of scale observed in the life insurance industry and may be explained by the fact that the Greek financial sector is less competitive than the Spanish financial sector.

Moreover, quoted life insurance companies tend to have higher efficiency scores than non-quoted companies, which is consistent with the findings of Cummins and Santomero (1999).

Finally, life insurance companies involved in mergers and acquisitions (M&A) tend to be more efficient than those companies not involved in an M&A process, which is consistent with Cummins, Tennyson and Weiss (1999), which showed that acquisition targets tend to show larger efficiency gains in the post-acquisition period in the U.S. life insurance industry.

How do our results compare with those of similar research? Cummins, Tennyson and Weiss (1999) find an average technical efficiency score of 0.990 for the U.S. life insurance sector. Fukuyama (1997) finds an average technical efficiency score of 1.164 for the Japanese life insurance industry. Barros, Borges and Barroso (2005) find a technical efficiency score of 0.981 for the Portuguese life insurance sector.

Some limitations of the present research are worth mentioning. On one hand, the conclusion relative to the quoted vs. non-quoted companies is based on a small data span and therefore, it should be interpreted with caution. On the other hand, the split between companies involved in M&A vs. non involved in M&A is based on M&A activity during the period under analysis. Consequently, it should again be taken into consideration that enlarging the sample period may produce different results. Finally, the measurement of scale by the invested assets is debatable, since it could alternatively be based on other alternative financial measurements.

Some extensions of the present paper can also be envisaged, such as analysing life insurance companies with heterogeneous stochastic frontier models (Orea and Kumbhakar, 2004), or adopting alternative DEA models such as the Malmquist index model (Malmquist, 1953).

6. Conclusions

In this article we employ the DEA framework for the comparative evaluation of Greek life insurance companies and the efficiency of their operational activities. The analysis is based on the DEA-CCR and the DEA-BCC models, which allow for the use of multiple inputs and outputs in determining relative efficiencies. We estimate an average inefficiency gap of 27% for the period under consideration. Our findings suggest that Greek life insurance companies display relatively average management skills, being VRS-efficient for the most part. Moreover, these companies do not display equivalent scale efficiency, meaning that scale acts as a restriction on the efficient performance of small life insurance companies. Based on this result, the overall conclusion is that scale is of paramount importance to insurance companies and thus, the DEA-CCR models should not be used alone in the evaluation of their performance. A further refinement of the classification of the efficient insurance companies is undertaken by employing the Cross-Efficiency and Super-Efficiency models, which render an unequivocal ranking of all life insurance companies.

Moreover, the Mann-Whitney Z-Test confirms that large and quoted life insurance companies, as well as those involved in mergers and acquisitions, are more efficient. From this result, it emerges that scale, quotation, and M&A activity are all issues of major importance in this industry.

The importance of scale in this sector stems from the fact that most insurance companies operate with increasing returns to scale. Different managerial styles may explain part of the behaviour observed. Any attempts to overcome the identified inefficiencies should start with an analysis of the scale of activities and the adoption of a competitive strategy. There is great need for further consolidation in the Greek life insurance sector.

7. References

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