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Efficiency of insurance companies in the Czech Republic and Poland

Abstract

Research background: The insurance market is an important part of the financial system. The international concept of insurance operations brings certainty and helps to balance the economic results.

Purpose of the article: The aim of the paper is to compare the efficiency of life insurance of commercial insurance companies in the Czech Republic and Poland using the Data Envelopment Analysis model (DEA).

Methods: The methods used in the paper are descriptive statistics, DEA model and Tobit regression model. DEA models are nonparametric quantitative models for efficiency assessment. They use linear programming to transform multiple inputs into multiple outputs. The efficiency of the subjects analyzed is assessed based on the efficiency scores.

Findings & Value added: The subject of our analysis was 17 commercial insurance companies in the Czech Republic and 26 commercial insurance companies in Poland. Ten insurance companies were efficient on the common Czech-Polish insurance market. The share of efficient insurance companies was approximately equal. The arithmetic mean of the efficiency scores was higher in Poland than in the Czech Republic. The variability of the effi-

ciency scores of Czech insurance companies was greater than the variability of the efficiency scores of Polish insurance companies. The   correlations with efficiency score as the dependent variable and with market share as the independent variable of Tobit regression were very low.

Introduction

The Czech Republic and Poland joined the EU on May 1, 2004. Their economic maturity, however, is still below the level of the most developed countries in Europe. However, they are evolving at a rapid pace. After becoming part of the EU, both countries started to modify their legislative framework, resulting in a uniform legislative environment.

The insurance markets of both countries — of the Czech Republic and Poland, are an important part of their financial system. The international concept of insurance operations brings a certainty and helps to balance the economic results (Nečas & Čejková, 2014, pp. 417–424).

According to the European Insurance (2016), in 2014 the average penetration in life insurance (premiums of life insurance to GDP) of EU countries was approximately 4.6% and the average life insurance density (premiums of life insurance to population) of the EU countries was approximately €1214. Now, we will compare life insurance in the Czech Republic and Poland in 2014. Life insurance density of the Czech Republic was greater than life insurance density of Poland. Life insurance density of the Czech Republic was approximately €233. Life insurance density of Poland was approximately €176, but life insurance penetration of Poland was greater than life insurance penetration of the Czech Republic. Life insurance penetration of Poland in 2014 was approximately 1.7%, whereas life insurance penetration of the Czech Republic in 2014 was approximately 1.5% (European Insurance, 2016). These values are well below the EU average. Gross life premiums written in the Czech Republic form a smaller share of the total gross premiums written than gross non-life premiums written. They account for about 45.7%. Gross life premiums written in Poland form a larger share of the total gross premiums written than gross non-life premiums written. They account for about 54.7%. Life insurance in Poland thus shows a trend similar to developed European countries, where its share of premiums is greater than the share of non-life premiums. "The long-term segment ratio in developed European Countries remains fixed at 60:40 in favour of life insurance. The opposite trend with a slightly predominating non-life insurance share continues in the Czech Republic" (Czech Insurance Association, 2014).

It follows that the share of Czech life insurance (expressed by premium) is smaller than the share of non-life insurance. The performance of the life insurance market (expressed to GDP) in the Czech Republic is lower than in Poland. We will consider whether these facts are caused by smaller or greater efficiency of life insurance.

The basic subjects of the insurance market are commercial insurance companies. Their primary goal is profit. It is also important for them to carry out their activities efficiently. The efficiency of each insurance company is assessed based on the values of not only its indicators, but also based on the values of the indicators of other insurance companies operating on the insurance market. The efficiency score of the insurance company is thus expressed in relation to other insurance companies.

The paper has the following structure. The next section is the research goal of the paper and the data. The next section describes the methodology used, i.e. — DEA model and the Tobit regression model, which is followed by literature overview. This section is followed by data presentation and empirical analysis, which includes the expression of the technical efficiency scores and parameters of Tobit regression expressing the relationship between technical efficiency and market share. The last section includes limitations and conclusion.

Research goal and data

The subject of our analysis is the efficiency of life insurance offered by 17 commercial insurance companies based in the Czech Republic (see list of insurance companies in Table 1) and 26 commercial insurance companies based in Poland in 2014 (see list of insurance companies in Table 2).

The aim of this paper is to compare the efficiency of life insurance of commercial insurance companies in the Czech Republic and Poland using the Data Envelopment Analysis model (DEA).

Efficiency will be evaluated on the basis of the indicators operating costs, costs of insurance claims, premiums earned and income from financial investments. Statistical evaluation will be carried out using the statistical software Statistica. The data for Polish insurance companies were taken from the Polish Financial Supervision Authority (2014). The data for Czech insurance companies were taken from the Czech Insurance Association (2014).

Research methodology

Data envelopment analysis

According to Cyrek (2017, p. 418), a category of efficiency may be under-stood as the relationship between outputs and inputs (e.g., Kaasa, 2016, p. 12), and it is often analyzed in terms of material goals.

There are several approaches to evaluating efficiency of the analyzed subjects. In our analysis, we will focus on technical efficiency, which will be compared based on the technical efficiency score (hereinafter only re-ferred to as efficiency score).

The efficiency score can be expressed using several methods. We will use a specialized modeling tool to assess efficiency — DEA. DEA is a set of non-parametric methods based on linear programming. These models analyze the efficiency of transformation of multiple inputs into multiple outputs. According to Balcerzak *et al*., (2017, p. 55) the aim of the DEA method is to eliminate or exclude the subjectivity of using output meas-urements in relation to input.

According to Stanickova (2017, p. 388) there is a great variety of appli-cations of DEA for evaluating the performances of many different kinds of entities engaged in many different activities. BCC models belong to basic DEA models. They are based on the assumption of variable returns to scale. They express the efficiency score for each subject analyzed (DMU).

Our paper is based on the Pareto-Koopmans definition of efficiency. The efficiency score in input-oriented BCC model is less than or equal to one. Non-efficient subject have an efficiency score less than one. The lower the efficiency score of a subject, the further the subject from the data en-velopment.

Assuming that we have n homogenous DMUs U_1 to U_n and that we ob-serve m inputs and r outputs, the efficiency score θ_q in the BCC model is the solution of the linear programming task

$$\text{minimize} \quad z = \theta_q - \varepsilon\left(\mathbf{e}^T \mathbf{s}^* + \mathbf{e}^T \mathbf{s}^-\right), \tag{1}$$

$$\text{under conditions} \quad \mathbf{X}\lambda + \mathbf{s}^- = \theta_q \mathbf{x}_q, \tag{2}$$

$$\mathbf{Y}\lambda - \mathbf{s}^+ = \mathbf{y}_q, \tag{3}$$

$$\mathbf{e}^T \lambda = 1, \tag{4}$$

$$\lambda, \mathbf{s}^+, \mathbf{s}^- \geq 0, \tag{5}$$

where θ_q expresses the efficiency score of the DMU U_q, $\mathbf{X} = \{x_{ij}, i = 1\ldots, m, j = 1\ldots n\}$ is the matrix of inputs, $\mathbf{Y} = \{y_{ij}, i = 1, \ldots, r, j = 1, \ldots, n\}$ is the matrix of outputs, $\mathbf{s}^+, \mathbf{s}^-$ are deviational variables, λ is the matrix of weights, $\mathbf{e}^T = (1, 1.., 1)$, ε is the infinitesimal constant (Jablonský & Dlouhý, 2004, pp. 84–86).

Target values of inputs and outputs to reach efficiency can be obtained in one of the following ways

$$\mathbf{x}_q' = \mathbf{X}\lambda^*, \quad \mathbf{y}_q' = \mathbf{Y}\lambda^*, \tag{6}$$

where λ^* is the vector of optimal weight values calculated by the model

$$\mathbf{x}_q' = \theta_q^* \mathbf{x}_q - \mathbf{s}^{-*}, \quad \mathbf{y}_q' = \mathbf{y}_q + \mathbf{s}^{+*}, \tag{7}$$

where symbols denoted as $*$ are vectors of optimal variable values in the input-oriented BCC model.

Influence of market share on efficiency

We will deal with the following research question: Does the market share of life insurance affect the efficiency of insurance companies? The Tobit model was used to analyse the relations between the market share of life insurance and the efficiency score.

Tobit regression

The method that use Tobit regression consists of two steps. In the first step, linear programming is used to express the efficiency score using traditional non-environmental variables. In the second step, the regression analysis is employed to determine the correlation between efficiency and market share of life insurance.

The efficiency score, which is the dependent variable in the regression, has values in the range of $\langle 0, 1 \rangle$. It is therefore a limited dependent variable. Therefore, we will use the censored regression model called Tobit regression.

The standard Tobit model can be defined as follows for observation

$$y_i^* = \beta^T x_i + \varepsilon_i, \quad y_i = y_i^*, if \ y_i^* \geq 0 \ and \ y_i = 0, otherwise \qquad (8)$$
$$\varepsilon_i \sim N(0, \sigma^2)$$

where:
x_i and β are the vectors of explanatory variables and unknown parameters,
y_i^* is a latent variable,
y_i is the efficiency score (Güneş & Yilmaz, 2016, p. 220).

Literature overview

An important factor for the subjects in practice is their achieved efficiency. The goal of the subjects is to achieve maximum efficiency. There are several methods available to assess efficiency. They are divided into parametric and nonparametric ones. DEA models belong to non-parametric methods for assessing efficiency. The first DEA model, also referred to as the CCR model, was published by Charnes *et al.* (1978, pp. 429–444). This model is based on the conditions of constant returns to scale. Several types of models have been published so far. One of the basic models is also the BCC model (Banker *et al.,* 1984, pp. 1078–1092), which is based on the conditions of variable returns to scale.

The worldwide theoretical and empirical research on the efficiency of commercial insurance companies is not as extensive as the theoretical and empirical research on the efficiency of banks. Cummins *et al.*(1998, pp. 1–52) evaluated the efficiency of life insurance companies in the United States. At the same time, they researched whether the merger of insurance companies had a positive impact on their efficiency. Diacon (2001, pp. 1–33) evaluated the efficiency of insurance institutions. He compared the efficiency of insurance companies from 6 European countries.

Several authors have examined the insurance market of the V4 countries, i.e. also of the Czech Republic and Poland. Pukala & Kafková (2014, pp. 285–306) compared and analyzed insurance markets in the Czech Republic and Poland in the period from 2004 to 2012. Brokešová *et al.* (2014, pp. 471–492) focused on factors influencing the development of national insurance markets in the analyzed countries. They have concluded that from 1995 to 2010 the development on national insurance markets of the V4 countries was influenced by various factors. Bernat (2009, pp. 33–45) tried to answer the question of whether the creation of mergers and acquisitions of insurance companies in Poland increases their efficiency in the

long-term perspective. Rezač and Rezač (2013, pp. 285–306) deal with outsourcing in insurance practice on the Czech insurance market. They address the question of its impact on efficiency.

Several authors have dealt with the influence of size of insurance companies on their efficiency. Based on the analysis of insurance companies in China Yao *et al.* (2007, pp. 66–86) conclude that small insurance companies are less efficient than large insurance companies. These conclusions were formulated by Cummins and Zi (1997, pp. 1–43) in the analysis of 445 life insurance companies in the US from 1988 to 1992. Huang and Eling (2013, pp. 577–591) investigated the impact of size on the efficiency score of insurance companies. They pointed out the positive and significant impact of the size of an insurance company measured by logarithm of total assets. Klumpes (2004, pp. 257–274) assessed the efficiency of 40 insurance companies in the UK that sold life insurance or pensions. They assessed the difference in efficiency of insurance companies based on their size. Yakob *et al.* (2014, pp. 1439–1450) used DEA models and the Tobit regression model to identify exogenous factors affecting the efficiency of insurance companies in Malaysia from 2003 to 2007. A similar research analysing the influence of market share of insurance efficiency. Barros *et al.* (2010, p. 435) conclude that logarithm of the market share has a positive impact on efficiency.

Results

The largest share of life premiums of insurance companies in the Czech Republic had POJIŠŤOVNA ČESKÉ SPOŘITELNY, A.S., VIENNA INSURANCE GROUP. The smallest market share of life premiums had HASIČSKÁ VZÁJEMNÁ POJIŠŤOVNA, A.S. Market shares of life premiums of insurance companies are presented in Table 1.

The largest share of life premiums of insurance companies in Poland had PZU ŻYCIE S.A. The smallest share of life premiums had INTER — ŻYCIE S.A. Market shares of life premiums of Polish insurance companies are presented in Table 2.

At the beginning of the efficiency analysis, we expressed the basic descriptive statistics of the indicators, based on which we estimated the efficiency score of the subjects analyzed. Statistical evaluation was carried out using the statistical software Statistica.

The arithmetic mean of all the indicators analyzed for Czech insurance companies was lower than the arithmetic mean of the indicators analyzed for Polish insurance companies. The variability of the indicators expressed

by the coefficient of variation was greater for all indicators of Polish insurance companies. Czech and Polish insurance companies had the lowest variability of operating costs. Czech insurance companies had the highest variability expressed by the coefficient of variation for the costs of insurance claims. Polish insurance companies had the highest variability expressed by the coefficient of variation for the income from financial investments.

The biggest difference in variability between Czech and Polish insurance companies was in the income from financial investments. Czech insurance companies had a significantly lower variability of this indicator. Minimum values of the costs of insurance claims, operating costs and premiums earned had one insurance company in the Czech Republic, HASIČSKÁ VZÁJEMNÁ POJIŠŤOVNA, A.S. Minimum values of these indicators had three different insurance companies in Poland. Minimum costs of insurance claims had MACIF ŻYCIE TUW. Minimum operating costs were borne by REJENT LIFE T.U.W. Minimum premiums earned had ING S.A. Minimum income from financial investments in the Czech Republic was shown by MAXIMA POJIŠŤOVNA, A.S. Minimum income from financial investments in Poland was shown by SIGNAL IDUNA ŻYCIE S.A. One insurance company in Poland had the maximum values of all indicators — PZU ŻYCIE S.A. Several insurance companies in the Czech Republic had maximum values of the indicators. The maximum costs of insurance claims were taken by ČESKÁ POJIŠŤOVNA, A.S. The maximum operating costs were borne by KOOPERATIVA POJIŠŤOVNA, A.S. The maximum premiums were earned by POJIŠŤOVNA ČESKÉ SPOŘITELNY, A.S. The maximum income from financial investments had ALLIANZ POJIŠŤOVNA, A.S. The highest share of the costs of insurance claims on the premiums earned in the Czech Republic was shown by ČSOB POJIŠŤOVNA, A.S., ČLEN HOLDINGU ČSOB. The costs of insurance claims amounted to 153.45% of the premiums earned. The largest share of the costs of insurance claims for the premiums earned in Poland had ING S.A. The costs of insurance claims amounted to 146.30% of the premiums earned. The highest share of the operating costs on the premiums earned in the Czech Republic was observed in the case of WÜSTENROT, ŽIVOTNÍ POJIŠŤOVNA, A.S. Operating expenses amounted to 73.5% of the premiums earned. The company with the highest share of the operating costs on the premiums earned in Poland was CARDIF POLSKA S.A. The operating costs represented 80% of the premiums earned.

In the next step, we calculated the efficiency scores of all insurance companies on the market in Poland, on the market in the Czech Republic,

and on the common market in an input-oriented BCC model using the EMS software.

Ten insurance companies were efficient on the common market. Four insurance companies were from the Czech Republic and six ones were from Poland. Efficient were the insurance companies ALLIANZ POJIŠŤOVNA, A.S., HASIČSKÁ VZÁJEMNÁ POJIŠŤOVNA, A.S., KOMERČNÍ POJIŠŤOVNA, A.S., UNIQA POJIŠŤOVNA, A.S., AVIVA — ŻYCIE S.A., CARDIF POLSKA S.A., ERGO HESTIA STUnŻ S.A., OPEN LIFE S.A., PZU ŻYCIE S.A., REJENT LIFE T.U.W. The arithmetic mean of the efficiency scores in the Czech Republic was equal to 52.35%; the arithmetic mean of the efficiency scores in Poland was equal to 61.82%. The variability of the efficiency scores of Czech insurance companies was greater than the variability of the efficiency scores of Polish insurance companies. Descriptive statistics of the efficiency scores in Poland and in the Czech Republic are shown in Table 3. Descriptive statistics of the efficiency scores on the common market are shown in Table 4.

We used the Matrixer software to analyze the relationship between the efficiency score and the market share.

The dependent variable was the efficiency score (θ) and the independent variable was the market share (SP).

Thus, the following relationship applies to the jth insurance companies

$$\theta_j = \beta_0 + \beta_1 SP_j + \varepsilon_j \quad \varepsilon_j \sim N(0, \sigma^2) \tag{9}$$

The coefficient β_1 of Tobit regression in Poland is a positive, but very small, number (Table 5). The coefficient of determinations is a very small number, too (only 10.64%).

The coefficient β_1 of Tobit regression in the Czech Republic is a positive, but very small, number (Table 5). The coefficient of determination is a very small number too (only 5.87%).

The coefficient β_1 of Tobit regression on the common market is a positive, but very small, number (Table 5). The coefficient of determination is very small number too (only 1.45%).

Thus, the following relationship applies to the jth insurance companies

$$\theta_j = \beta_0 + \beta_1 \log SP_j + \varepsilon_j \quad \varepsilon_j \sim N(0, \sigma^2) \tag{10}$$

The coefficient β_1 of Tobit regression in Poland is a positive, but very small number (Table 6). The coefficient of determination is a very small number too (only 0.31%).

The coefficient β_1 of Tobit regression in the Czech Republic is a negative but a very small number (Table 6). The coefficient of determination is very small number too (only 0.42%).

The coefficient β_1 of Tobit regression on the common market is a negative but a very small number (Table 6). The coefficient of determination is very small number too (only 1.40%).

The coefficients β_1 are almost 0. The correlations between the variables were very low. Conclusions of Barros *et al*., (2010), that market share has a positive impact on efficiency has not been demonstrated.

Conclusions

Our goal in this paper was to evaluate the efficiency of life insurance in the Czech Republic and Poland. Ten insurance companies were efficient on the common insurance market. Four insurance companies were from the Czech Republic and six insurance companies were from Poland. The share of efficient insurance companies was approximately equal.

The arithmetic mean of the efficiency scores was higher in Poland than in the Czech Republic. The variability of the efficiency scores of Czech insurance companies was greater than the variability of the efficiency scores of Polish insurance companies. The coefficients β_1 of Tobit regression are almost 0. The correlations between the variables were very low. The positive impact of market share on efficiency has not been demonstrated.

Our study had some limitations as well. There may be minor differences in the methodology of expressing the indicators on national insurance markets. The research should be extended to a longer period of time to see whether changes occur. The practical significance for insurance companies should be the reason for greater variability of the efficiency of Czech insurance companies compared to Polish insurance companies. Three insurance companies with the highest market share in Poland were efficient. Three insurance companies with the highest market share in the CR were not effective. Finding the cause of this difference could be relevant for practice.

Suggestions for further research include studying the impact of other factor on the efficiency score. We think that these findings may be important for the management of insurance companies as they could help improve their efficiency and the position of the insurance company on the insurance market too.

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Annex

Table 1. Market shares of insurance companies based in the Czech Republic

Insurance companies	Share of life premiums (%)
AEGON POJIŠŤOVNA, A.S.	2.57
ALLIANZ POJIŠŤOVNA, A.S.	6.65
AXA ŽIVOTNÍ POJIŠŤOVNA, A.S.	4.20
BNP PARIBAS CARDIF POJIŠŤOVNA, A.S.	0.56
ČESKÁ POJIŠŤOVNA, A.S.	15.97
ČESKÁ PODNIKATELSKÁ POJIŠŤOVNA, A.S.	3.62
ČSOB POJIŠŤOVNA, A.S. ČLEN HOLDINGU ČSOB	7.37
ERGO POJIŠŤOVNA, A.S.	0.36
GENERALI POJIŠŤOVNA, A.S.	5.33
HASIČSKÁ VZÁJEMNÁ POJIŠŤOVNA, A.S.	0.01
KOOPERATIVA, POJIŠŤOVNA, A.S.	15.75
KOMERČNÍ POJIŠŤOVNA, A.S.	14.67
MAXIMA POJIŠŤOVNA, A.S.	0.05
METLIFE POJIŠŤOVNA , A.S.	3.98
POJIŠŤOVNA ČESKÉ SPOŘITELNY, A.S., VIENNA INSURANCE GROUP	16.55
UNIQA POJIŠŤOVNA, A.S.	1.98
WÜSTENROT, ŽIVOTNÍ POJIŠŤOVNA, A.S.	0.37

Source: Czech Insurance Association and own processing.

Table 2. Market shares of insurance companies based in Poland

Insurance companies	Share of life premiums (%)
AEGON S.A.	3.58
ALLIANZ ŻYCIE POLSKA S.A.	2.71
METLIFE TUnŻ S.A.	6.17
AVIVA - ŻYCIE S.A.	7.33
AXA ŻYCIE S.A.	4.21
BZWBK-Aviva TUnŻ S.A.	1.31
CARDIF POLSKA S.A.	1.00
COMPENSA ŻYCIE S.A.	5.55
CONCORDIA CAPITAL S.A.	0.20
ERGO HESTIA STUnŻ S.A.	5.39
EUROPA ŻYCIE S.A.	3.67
GENERALI ŻYCIE S.A.	3.21
ING S.A.	5.49
INTER - ŻYCIE S.A.	0.03
MACIF ŻYCIE TUW	0.05
PKO ŻYCIE TU S.A.	2.59

Table 2. Continued

Insurance companies	Share of life premiums (%)
OPEN LIFE S.A.	8.56
POLISA - ŻYCIE S.A.	0.75
PRAMERICA S.A.	0.71
PZU ŻYCIE S.A.	29.17
REJENT LIFE T.U.W.	0.05
SIGNAL IDUNA ŻYCIE S.A.	0.19
SKANDIA ŻYCIE S.A.	1.55
SKOK ŻYCIE S.A.	0.30
UNIQA ŻYCIE S.A.	0.80
WARTA TUnŻ S.A.	5.43

Source: Polish Financial Supervision Authority and own processing.

Table 3 Descriptive statistics of the efficiency scores in Poland and in the Czech Republic

	Number	Arithmetic mean	Median	Standard deviation
Czech Republic	17	0.6313	0.6004	0.3032
Poland	26	0.7496	0.6978	0.2329

Table 4. Descriptive statistics of the efficiency scores on the common market

	Number	Arithmetic mean	Median	Standard deviation
Czech Republic	17	0.5235	0.4211	0.2996
Poland	26	0.6182	0.5511	0.2739
Czech Republic and Poland	43	0.5807	0.5187	0.2847

Table 5. Tobit regression

	Only Poland	Only CR	Common CR and Poland market
Constant	0.6988	0.5601	0.5537
Coefficient β_i	0.0132	0.0121	0.0058

Table 6. Tobit regression

	Only Poland	Only CR	Common CR and Poland market
Constant	0.7470	0.6379	0.5895
Coefficient β_1	0.0168	-0.0213	-0.0409