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Evaluation of the Technical Efficiency of Insurance Companies in the Visegrad Group Countries

Introduction

In the past 20 years, the insurance sector in the Visegrad countries has experienced significant changes. These changes have not been limited to the insurance sector; they have been more extensive due to overall political, economic and social development (Brokešová and Vachálková, 2016). However, within the sector, we have observed changes in the structure of insurance risks, insurance products portfolios, number of written premium, methods of selling insurance products and insurance company management (Cummins and Venard, 2007). In all developed countries, the insurance sector accumulates a considerable number of financial assets and represents an essential element of sustainable economic growth. A strong and stable insurance sector could be beneficial at the micro and macro level during all stages of development due to its stabilization function (Brokešová and Vachálková, 2016). Brokešová, Pastoráková and Ondruška (2014) focused on the examination of areas and factors that influenced the development of the insurance sector in the Visegrad countries between 1995 and 2010. In their partial results, economic determinants had a crucial effect on insurance sectors in these countries. A statistically significant effect on the insurance sector was found for variables related to the annual inflation rate, social security system and crime rate. In this vein, the efficiency of insurance companies is an important topic.

Insurance companies play a major role in every country's economy; they affect the efficiency of the whole financial system. Bank efficiency has been the subject of much research, with many research proposals and publications written (see, e.g., Palečková 2018, Dráb and Kočišová 2018 or Palečková 2015). However, the

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efficiency of commercial insurance companies has so far been a marginal area of research. It is important to emphasize that commercial insurance companies enter the financial market and affect it significantly through their investment activities. It is therefore desirable to focus on efficiency when studying insurance companies and evaluating their functioning. When selecting countries for this type of research, it is important to choose subjects with similarities in their historical and economic development. For that reason, we opt to survey countries belonging to the Visegrad Group (hereinafter referred to as the V4).

First, the term efficiency is defined. Daraio and Simar (2007) described efficiency as the distance between the quantity of input and output and the quantity of input and output that defines the production frontier for a firm in its industry. Farrell (1957) proposed that the efficiency of any firm consists of two components: technical efficiency and allocative efficiency. Technical efficiency is the ability of the firm to maximize outputs from a given set of inputs. Allocative efficiency is the ability of the firm to use these inputs in optimal proportion, given their respective prices. This paper estimates the technical efficiency of commercial insurance firms.

Our observations cover insurance companies in the V4 countries (Czechia, Slovakia, Hungary and Poland) for the period 2009–2016. The countries' common historical development has triggered similar economic development regarding their insurance sectors (Brokešová and Vachálková, 2016).

The aim of the paper is to estimate the technical efficiency of the insurance companies of the Visegrad Group countries using data envelopment analysis. In line with the aim of the paper, we focus on the following research questions: (1) how has the efficiency of the insurance companies in Visegrad countries developed in the sample period?, and (2) is the efficiency of Visegrad countries' insurance sectors similar?

We estimate the technical efficiency of insurance companies during the 2009–2016 period using the data envelopment analysis (DEA) model. We use the non-oriented slack-based measure (SBM) model with variable returns to scale.

The structure of the paper is as follows. First, we present previous empirical studies on efficiency in the Visegrad countries. Next, our methodology and data envelopment analysis procedure are described. The third section presents the data and selection of variables in the DEA model. The next section includes the empirical analysis and results, and the last section offers conclusions on the findings and results.

1. Literature review

Several authors have focused their attention on the development of insurance sectors in the V4. Ducháčková and Daňhel (2006) claimed that it was the formation and initial development of V4's insurance sectors that determined not only the role and significance of the insurance sectors in the individual countries of the V4 but also the position of these countries in the global insurance sector in the European Union. Having concluded this in their research, the authors not-

ed that there exist some similarities in the shape and structure of the insurance sectors of these countries. Differences between these sectors are caused by the different economic levels of the countries and by different insurance legislation. The reason for the rather small size of the insurance sectors in the V4 can be primarily found in the countries' economic and social development in the second half of the twentieth century. The authors stated that the shape and structure of the insurance sectors in the V4 are slowly but gradually converging with those in the other countries of the European Union.

Ducháčková et al. (2009) compiled an evaluation of the V4 insurance sectors for the period 1995–2007 in their monograph. Brokešová and Vachálková (2016) estimated the role of macroeconomic determinants in the development of insurance sectors in selected transition countries (i.a. in the V4). Pukala and Kafková (2014) analysed and compared the insurance sectors in Czechia and Poland for the period from 2004 to 2010. For their research, they used the concentration index, number of premiums written, penetration, insurance density, technical reserves and activity of commercial insurance companies.

Some authors focus their research on estimating the efficiency of insurance companies; these studies deal primarily with the Czech and Slovak insurance sectors as a whole. Estimation of the efficiency of insurance companies has not yet been conducted. Instead, the studies have aimed to estimate the development of insurance sectors according to selected indicators.

Grmanová and Jablonský (2009) estimated the efficiency of Slovak and Czech insurance companies using data envelopment analysis models with 2007 data. They came to the following conclusions: There is a larger relative share of efficient insurance companies in the Czech than in the Slovak insurance sector. The arithmetic mean of the technical efficiency rate is larger in the Czech insurance sector than that in the Slovak insurance sector. While estimating efficiency, the authors used insurance payment costs and operating costs as inputs and earned premiums and other yields as outputs. Zimková (2015) estimated the technical efficiency of insurance institutions in Slovakia using data for 2013. She used total operating expenses and capital for inputs and written premiums and after-tax results for output. Her findings revealed that among the 13 Slovak insurance companies under evaluation, the AXA poisťovna, a.s. was the most efficient. A transmission approach showed that the technical efficiency of insurance institutions in Slovakia differs from one unit to another.

Grmanová and Čejková (2016) estimated the efficiency of Czech and Slovak insurance companies with data for 2013. These authors used two models, which differed in inputs. In the first model, they used insurance payment costs and operating costs as inputs. Insurance premiums and financial placement costs were used as outputs. In the second model, they added liabilities to inputs. This research indicated that there are fewer efficient insurance companies in the smaller Slovak insurance sector and that the average efficiency rate is smaller among Slovak firms than that of Czech insurance companies. However, the difference between Slovak and Czech firms was not found to be statistically significant.

To the authors' knowledge, the efficiency of insurance companies in Hungary has not yet been examined. We can mention the research of Kafková and Kračinovský (2008), who dealt with the development and comparison of the insurance sectors in Slovakia and Hungary in 1996–2007. These authors focused their attention on selected important indicators: gross written premiums, indemnity costs, technical reserves, investment activity and concentration in the insurance sector. Their research found that overall both insurance sectors advanced positively on the basic indicators.

According to the research of Grmanová and Pukala (2018), the share of efficient insurance companies in Poland and Czechia is approximately equal. They found that the arithmetic mean of the efficiency scores is higher in Poland than in Czechia. The variability of the efficiency scores of Czech insurance companies is greater as compared with the Polish insurance companies. The correlations between the efficiency score as the dependent variable and the sector share as the independent variable of a Tobit regression were very low. The authors used operating costs, costs of insurance claims, premiums earned and income from financial investments for evaluating efficiency.

The above mentioned literature shows that few studies deal with the efficiency of insurance companies in the V4. This article may thus fill the gap that currently exists in the empirical literature.

2. Methods

The two general approaches used to assess the efficiency of an entity, parametric (econometric) and non-parametric (mathematical programming) methods, employ different techniques to envelop a data set with different assumptions for random noise and for the structure of the production technology.

The non-parametric methods are data envelopment analysis (DEA) and free disposal hull, which are based on linear programming tools. The parametric methods most widely used in empirical estimations are the stochastic frontier approach, distribution free approach and thick frontier approach, which assume a specific functional form for the cost function or production technology and allow for an error term composed of a symmetrically distributed random error term and truncated inefficiency term. This paper is focused on technical efficiency, and we use the non-parametric approach of data envelopment analysis.

2.1. Data envelopment analysis

Data envelopment analysis is a mathematical programming method that measures the relative efficiency of a decision-making unit (DMU) relative to other similar DMUs, with the simple restriction that all DMUs lie on or below the efficiency frontier (Seiford and Thrall, 1990). The DMU can be described as a production unit that can spend several inputs to produce several outputs (Jablonský 2007). In this paper, a DMU is an individual insurance company. Moreover,

DEA identifies, for inefficient DMUs, the sources and level of inefficiency for each of the inputs and outputs (Charnes et al., 1995).

The term DEA was first introduced by Charnes et al. (1978) based on the research of Farrell (1957). The Charnes, Cooper and Rhodes model (called CCR model) is the basic DEA model introduced by Charnes et al. (1978). This model was modified by Banker et al. (1984) and became the BCC model, which accommodates variable returns to scale. The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant returns to scale (CRS), and it delivers the overall technical efficiency. The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. However, in practice, firms or DMUs might face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of technical efficiency will be contaminated with scale efficiencies. Banker et al. (1984) extended the CCR model by relaxing the CRS assumption. The resulting BCC (Banker, Charnes and Cooper) model was used to assess the efficiency of DMUs characterized by variable returns to scale (VRS). Due to this condition, we calculate technical efficiency using the variable returns to scale model.

DEA starts from a fractional programming formulation. Assume that there are n DMUs to be evaluated. DMU_j consumes x_{ij} amounts of i-th input to produce y_{rj} amounts of the r-th output. It is assumed that these inputs, x_{ij}, and outputs, y_{rj}, are non-negative, and each DMU has at least one positive input and output value. The efficiency of a DMU can be written as:

$$h_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \tag{1}$$

In this equation, u and v are the weights assigned to each input and output. By using mathematical programming techniques, DEA optimally assigns the weights subject to the following constraints. The weights for each DMU are assigned subject to the constraint that no other DMU has efficiency greater than 1 if it uses the same weights, implying that efficient DMUs will have a ratio value of 1. The objective function of the DMU is the ratio of the total weighted output divided by the total weighted input:

$$\max h_0(u,v) = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \tag{2}$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1, 2, ..., j_0, ..., n, \tag{3}$$

$$u_r \geq 0, r = 1, 2, ..., s, \tag{4}$$

$$v_i \geq 0, i = 1, 2, ..., m, \tag{5}$$

where h_0 is the technical efficiency of DMU_0 to be estimated, u_r and v_i are weights to be optimized, y_{rj} is the observed amount of output of the r^{th} type for the j^{th} DMU, x_{ij} is the observed amount of input of the i^{th} type for the j^{th} DMU, r indicates the s different outputs, i denotes the m different inputs, and j indicates the n different decision-making units.

The conditions of the CCR model are as follows:

$$\max h_0 = \sum_{r=1}^{s} u_r y_{r0}, \tag{6}$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1, \tag{7}$$

$$\sum_{r=1}^{s} u_r y_{r0} - \sum_{i=1}^{m} v_i x_{i0} \leq 0, \tag{8}$$

$$v_i \geq 0, \quad u_r \geq 0, \quad j = 1, 2, ..., n, \quad i = 1, 2, ..., m, \quad r = 1, 2, ..., s, \tag{9}$$

The conditions of the BCC model are as follows:

$$\max h_0 = \sum_{r=1}^{s} u_r y_{r0} + u_0, \tag{10}$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1, \tag{11}$$

$$\sum_{r=1}^{s} u_r y_{r0} - \sum_{i=1}^{m} v_i x_{i0} + u_0 \leq 0, \tag{12}$$

$$v_i \geq 0, \quad u_r \geq 0, \quad j = 1, 2, ..., n, \quad i = 1, 2, ..., m, \quad r = 1, 2, ..., s, \tag{13}$$

where index $_0$ shows the DMU whose efficiency is estimated, denotes inputs, denotes outputs, is the efficiency value of the DMU, n shows the number of DMUs, m is the number of inputs, s is the number of outputs, and denotes returns to scale.

We use the slack-based measured model that was introduced by Tone (2001). This model has three variations, i.e., input-oriented, output-oriented and non-oriented. The non-oriented model indicates both input and output orientations. In this paper, we use the non-oriented model. The slack-based measure model takes into account input and output slack and ensures that the slack is taken into account in the efficiency scores.

3. Data and selection of variables

The data set consists of insurance companies from the four Visegrad countries (V4). The V4 includes Czechia (CZ), Hungary (HU), Poland (PL), and Slovakia (SK). The data set was obtained from the Orbis database from Bureau van Dijk for the period 2009–2016. However, data for 2016 were not available for all insurance companies (especially companies in Slovakia and Hungary). The unbalanced panel data set consists of 533 observations and covers data from 62–79 insurance companies (see Table 2) in the Visegrad countries. All the data are reported on an unconsolidated basis and were converted into EUR.

The most important decision for the estimation of efficiency is the selection of inputs and outputs. In the empirical literature, we can find three major approaches for measuring outputs in the financial services industry. We can distinguish the intermediation or asset approach, the user-cost approach, and the value-added approach (more information on this topic appears in the study of Berger and Humphrey (1992)).

The intermediation (assets) approach treats financial services firms as pure financial intermediaries (Brocket et al., 1998) that borrow funds from their customers and invest and then transform the funds into assets (Micajkova 2015). The main objective of this approach is to simultaneously maximize the value of claims ownership and capital return adjusted to risk (Jarraya and Bouri, 2013). The limitation of taking into consideration only the intermediation service of insurance companies is the main disadvantage of this approach. Insurance companies offer other services in addition to financial intermediation. Ignoring these other insurance company services, such as risk-pooling and risk-bearing, leads to erroneous results in efficiency studies (Micajkova 2015).

An alternative is the user-cost approach developed by Hancock (1985). This approach differentiates between inputs and outputs based on the net contribution to revenues: if a financial product yields a return that exceeds the opportunity cost of funds or if the financial costs of a liability are less than the opportunity costs, it is deemed a financial input; otherwise, it is considered a financial output (Eling and Luhnen, 2010). At the theoretical level, this approach is the most ideal, but at a practical level, it is almost impossible to find the necessary data (Jarraya and Bouri, 2013).

The value-added approach counts outputs as important if they contribute significant added value based on operating cost allocations (Berger et al., 2000). Usually, several types of outputs are defined, representing the single lines of business under review (Eling and Luhnen, 2010).

The value-added approach considers all asset and liability categories to have some output characteristics. Those categories that have substantial value added are then used as the important outputs. The remaining categories are treated as unimportant outputs, intermediate products, or inputs. Jarraya and Bouri (2013) considered the value-added approach to be the most appropriate method for measuring the output of financial firms. This approach is most commonly used in the insurance sector for measuring the efficiency (see, e.g., Eling and Luhnen, 2010; Eling and Huang, 2013; Jarraya and Bouri, 2013 or Micajkova 2015).

Researchers usually subdivide inputs into three principal categories: business services and materials, capital and labour (Jarraya and Bouri, 2013). The quantity of labour and business services is defined as total operating costs. These consist of both costs associated with selling and issuing new policies and the costs of maintaining existing policies. Labour is defined as the total number of employees and agents employed by the company. In empirical evidence, several studies use operating expenses as an input that represents both labour and business services and materials (Cummins, Tennyson and Weiss, 1999; Cummins and Weiss, 2000).

Capital is defined as the sum of capital expenses: rent, equipment rental, and depreciation (Zimková 2015). The capital category contains three types: equity, debt and physical capital (Jarraya and Bouri, 2013). Materials consist of all other expenses. Most of the expense items are directly related to selling new policies and servicing existing policies (Zimková 2015).

Following Diboky and Ubl (2007) or Zimková (2015), we use two inputs (total operating expenses and capital) and two outputs (gross premiums written and profit after tax). The selection of these inputs is influenced by the fact that total operating expenses include labour expenses and other expenses (especially asset and liability management expenses); therefore, capital is included as the second input variable. As Zimková (2015) stated, total operating expenses and capital cover the input part of the production process in the insurance sector.

Regarding outputs, Diboky and Ubl (2007) stated that the amount of gross premiums provided by a company is a good proxy for its services, since all of the services are related to this key figure. Gross written premiums can be defined as the total premiums written and assumed by an insurer before deductions for reinsurance and commissions (Brokešová and Vachálková, 2016). From the company owners' point of view, the main objective of an insurer is to achieve a certain profit goal, e.g., a required rate of return. Therefore, net income is selected as an output variable as well (Diboky and Ubl, 2007). We tested the data to verify our independence assumption using correlation analysis. We found that there is no dependence between the individual variables. Next, we tested the separability assumption using regression-based tests in accordance with Ruggiero (2005). Nataraja and Johnson (2011) concluded that regression analysis is easily implemented and performs better than, e.g., the bootstrap approach. Ruggiero (2005) suggested a variable selection approach in which an initial measure of efficiency is obtained from a set of known production variables. Efficiency is then regressed against a set of candidate variables; if the coefficients in the regression are statistically significant and have the proper sign, the variables are relevant to the production process. We found that all variables are significant with an adequate coefficient value. All variables are relevant and are potential explanatory variables for the efficiency results. All test results are available on request from the authors. The descriptive statistics of the inputs and outputs are presented in Table 1.

Table 1
Descriptive statistics of inputs and outputs (in the EUR)

	Capital	Gross premiums written	Total underwriting expenses	Profit after tax
Mean	146 039.47	257 771	232 574.02	25 552.49
Median	37 588	88 626	83 121.09	3077
Min	638.98	0	0	–213 621.85
Max	3 469 798.72	4 589 596.31	399 4190.45	916 410.07
St. dev.	401 015.82	540 642.99	481 239.73	96 340.74

Source: authors' calculation.

4. Results and discussion

We employ the traditional DEA model that can evaluate the technical efficiency of decision-making units. First, we evaluate the relative efficiency of the four Visegrad countries' insurance sectors. We use the non-oriented slack-based measure (see Tone 2001) DEA model to estimate efficiency under the assumptions of variable returns to scale. We investigate the mean and median value of technical efficiency in four insurance sectors.

The development of average technical efficiency in the insurance sector during the period 2009–2016 is described in Table 2.

Table 2

Relative technical efficiency of insurance companies in the Visegrad countries

	2009	2010	2011	2012	2013	2014	2015	2016
Mean	0.70	0.78	0.77	0.73	0.75	0.69	0.73	0.74
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum	0.04	0.19	0.19	0.20	0.23	0.06	0.05	0.03
Median	0.73	0.80	0.80	0.72	0.75	0.71	0.72	0.83
First quartile	0.49	0.63	0.64	0.60	0.60	0.50	0.57	0.51
Third quartile	1.00	1.00	0.99	1.00	1.00	0.92	1.00	1.00
St. dev.	0.26	0.21	0.21	0.22	0.22	0.24	0.22	0.25
No. of observation	68	69	71	79	79	74	70	62

Source: authors' calculation.

The development of average efficiency in the insurance sector can be divided into several main phases (Table 2). The first phase is characterized by an increase in average efficiency during the period 2009–2011. Since 2008, the slowing economy has adversely influenced the non-life insurance sector in the Visegrad countries (Wieczorek-Kosmala 2016). Nevertheless, premium growth in life insurance in the Visegrad countries was positive in 2010. Premium volume grew most strongly in the Czech insurance sector (Staib and Bevere, 2011). A similar trend can be seen in Hungary, where the single premium business (unit linked as well as endowment products) compensated for falling premium volumes for all other product types. On the other hand, during the period 2009–2010, in most of the countries, there was weak growth or shrinking of the non-life insurance sector. In addition, in 2010, several of the analysed countries experienced a number of severe natural hazard events – heat waves, wildfires and floods – that drove up loss ratios in property insurance lines (Staib and Bevere, 2011).

During the period 2012–2015, average efficiency decreased in the insurance industry in the V4. In 2012, the weak performance of many life insurance sectors in the region reflected the gradually deteriorating economic environment of 2011 and the fact that the private sector was still highly indebted in many countries

(Staib and Bevere, 2013). Insurance premiums declined in the V4 in 2014. Tax changes related to interest earned on savings products, as well as poor investment performance due to capital market weakness, continued to affect sales. In some of the life insurance sectors (Hungary and Slovakia) premiums continued to grow, while in Czechia contraction slowed or stabilized. Non-life premiums in Poland stagnated as demand for motor insurance remained weak and competition kept rates down. The situation was reversed in Czechia and Hungary, where overall non-life premiums grew based on stronger motor insurance sales (Staib and Bevere, 2015).

Since 2015, average efficiency has slightly increased in Visegrad insurance sectors. Life insurance premiums could stabilize with continued strong growth. However, savings products remain unattractive due to still-low interest rates. The Polish insurance sector should benefit from a strengthening economy, falling unemployment and rising disposable incomes, but the introduction of a new tax on bank and insurers' assets could negatively impact demand and insurer profitability, depending on whether the cost can be passed on to consumers. Economic recovery in the Visegrad countries continued in 2016, leading to lower unemployment and increased consumption and, in turn, stronger premium growth. However, regulatory changes, such as the insurance tax in Poland, could hurt overall efficiency (Staib and Bevere, 2016).

In addition, the financial crisis had an effect on the insurance sector in the V4 countries. The crisis led to changes in regulatory measures on financial markets. A significant change was the implementation of Solvency II in the insurance sector. According to Vávrová (2012), events in the financial sector of the world economy in recent years have shown that the financial crisis was caused by non-compliance with fundamental principles for risk management in insurance companies. Implementation of the new Solvency II regulation is likely to contribute to a better fulfilment of the stabilizing role of the European and global insurance sectors. Onder (2010) also pointed out that shortcomings in the financial risk management system, including insurance companies, were highlighted by the financial crisis. Since 2016, the Solvency II regulation has been applied in all EU countries.

Next, we describe the technical efficiency in the individual insurance sectors in the Visegrad countries. Table 3 presents the results of the relative technical efficiency of the Visegrad Group's insurance companies using the DEA model. The most efficient were the Hungarian (average relative efficiency of 80%) and Polish (average relative efficiency of 77%) insurance companies, and the least efficient were the insurance companies in Slovakia (average efficiency of 62%). We register the differences in efficiency among the individual insurance companies in the Visegrad Group countries (Table 3).

When evaluating the development of the Czech insurance companies, we used data provided by the Czech National Bank in its Financial Market Supervision Report. In 2010 and 2011,the efficiency of Czech insurance companies increased. The reason for this may be found in the economic recovery of the insurance sec-

Table 3
Relative efficiency of insurance companies

Czechia								
Year	2009	2010	2011	2012	2013	2014	2015	2016
Mean	0.69	0.73	0.76	0.73	0.75	0.66	0.71	0.65
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum	0.04	0.25	0.19	0.21	0.25	0.06	0.09	0.03
Median	0.74	0.77	0.79	0.70	0.72	0.65	0.68	0.57
First quartile	0.44	0.60	0.70	0.54	0.65	0.47	0.56	0.49
Third quartile	1.00	0.88	0.92	1.00	1.00	0.91	0.90	0.90
St. dev.	0.29	0.19	0.20	0.23	0.22	0.26	0.23	0.28
No. of observations	21	22	24	26	27	27	25	19
Hungary								
Year	2009	2010	2011	2012	2013	2014	2015	2016
Mean	0.82	0.71	0.89	0.79	0.78	0.75	0.83	0.84
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum	0.25	0.50	0.19	0.21	0.25	0.06	0.03	0.19
Median	0.74	0.77	0.77	0.69	0.71	0.65	0.67	0.95
First quartile	0.50	0.66	0.69	0.55	0.50	0.51	0.50	0.51
Third quartile	0.85	0.88	1.00	0.99	0.99	0.90	0.90	1.00
St. dev.	0.23	0.15	0.22	0.22	0.23	0.25	0.27	0.29
No. of observations	10	13	13	20	22	22	22	21
Poland								
Year	2009	2010	2011	2012	2013	2014	2015	2016
Mean	0.75	0.87	0.82	0.75	0.79	0.73	0.72	0.75
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum	0.20	0.50	0.27	0.28	0.23	0.11	0.05	0.43
Median	0.79	0.99	0.89	0.75	0.89	0.82	0.75	0.85
First quartile	0.57	0.75	0.70	0.66	0.58	0.56	0.58	0.48
Third quartile	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00
St. dev.	0.24	0.18	0.21	0.22	0.24	0.28	0.32	0.26
No. of observations	23	20	20	18	16	13	13	13
Slovakia								
Year	2009	2010	2011	2012	2013	2014	2015	2016
Mean	0.56	0.74	0.66	0.64	0.68	0.61	0.58	0.51
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.72	0.66
Minimum	0.26	0.39	0.25	0.20	0.32	0.22	0.42	0.43
Median	0.50	0.77	0.65	0.64	0.65	0.60	0.59	0.44
First quartile	0.39	0.58	0.56	0.48	0.55	0.43	0.50	0.43
Third quartile	0.69	0.88	0.80	0.76	0.84	0.78	0.70	0.66
St. dev.	0.21	0.18	0.20	0.22	0.19	0.22	0.11	0.13
No. of observations	14	14	14	15	14	12	10	9

Source: authors' calculation.

tor, which manifested itself in year-to-year growth of gross premiums written. Life insurance paid on a one-time basis significantly contributed to the growth of total written premiums in 2010. Net profit of the insurance companies increased by 39% between 2010 and 2011, which positively affected the efficiency of the insurance sector. In 2012, the efficiency of the Czech insurance sector was lower because the net profit of most insurance companies decreased. In the same year, net operating costs increased. Both of these factors contributed to the decrease in efficiency. Moreover, in 2012, life insurance premiums fell due to a decline in the single premiums business, while regular premiums increased marginally. In 2013, efficiency increased again because gross premiums written rose by 1.9% and net profit rose by 9.7%. Additionally, net operating costs were lower. In 2014, the efficiency decreased. Net profit decreased by 37%. The net profit decrease in commercial insurance companies was caused mainly by poor economic results of the Export Guarantee and Insurance Corporation. The volume of net operating costs remained the same. In 2015, the efficiency of the Czech insurance sector increased again. Gross premiums written decreased by 2.8% compared to their level in 2014. Life insurance decreased by 12.4%, while non-life insurance grew by 5.0%. Written premiums of life insurance decreased in this year due to less interest in capital life insurance and as a result of the removal of tax deductibility on single premiums, which made these premiums less attractive. Net profit of the total insurance sector grew by 19.7%. In 2016, the efficiency decreased, caused by a decrease of 6.6%in life insurance premiums written. In total, written premiums decreased by 2.5%. Net profit decreased by 7.7% and net operating costs increased. The efficiency results for 2016 do not necessarily reflect the average values of the Czech insurance sector, because data for some insurance companies are unavailable. In Czechia, life insurance premiums fell by 8.5% that year, with traditional life insurance premiums declining by close to a third. Once again, fewer new contracts were concluded in 2016 than in 2015. The environment for life savings products remains unattractive, as interest rates are still at record lows (Staib and Bevare, 2017).

When evaluating the development of the Slovak insurance sector, we used data provided by the Slovak National Bank in the Slovak Financial Sector Analysis. In 2010, the efficiency of the Slovak insurance sector grew. The reasons for this may be found in the general revival of interest in life insurance products and the growth of written premiums. Total profit decreased by 2.9% in 2010. This result was significantly affected by one of the insurance companies. Without this company, total net profit would have grown by one third. The costs related to cancelled life insurance contracts grew more slowly. In 2011, the efficiency of the insurance sector decreased. At the end of this year, total technical reserves of the insurance sector decreased. Historically, this was the first decrease in the total volume of technical reserves in the monitored period. At the same time, the expense-to-revenue ratio increased slightly. In 2014 and 2015, the efficiency of insurance companies decreased. Life insurance written premiums decreased by 0.27% between 2013 and 2014. The profit of insurance companies grew by 13.3% in 2014. In other words, the technical results worsened, while the financial results

improved. In 2015, profits dropped by 20%. This was caused by the decrease of financial results as well as worse technical results of the non-life insurance sector.

When evaluating the development of Polish insurance companies, we used data provided by the Polska Izba Ubezpieczeń Association in its Annual Reports. In 2009, written premiums were still high compared to their levels after further developments. As of 2016, the insurance sector had not yet fully recovered. Written premiums decreased by 15% between 2008 and 2016. The high result of written premiums in 2008 was achieved by extraordinary growth in life insurance due to sales of group investment insurance through bancassurance. In 2010, growth in life and especially non-life premiums was driven mainly by property, while motor damage continued to decline and motor third-party liability grew slightly (Staib and Bevere, 2011). In 2011 and 2012, the efficiency of Polish insurance companies decreased. This was probably because in 2011 profits decreased by 10% and administration costs increased by 2.6%. In 2012, administration costs increased by another 8.5%. Moreover, Wieczorek-Kosmala (2016) concluded that the consequences of crisis were still influential in this period, with competitive pricing, deterioration of underwriting profitability, and weak investment and consumption activity. Nevertheless, underwriting results recovered in Poland with lower natural catastrophe losses (Staib and Bevere, 2013). In 2013, the efficiency of the insurance sector increased. The reasons for this may be found in the reduction of administration costs by 9% and rapid increase of profits by 42%. The years 2014 and 2015 brought lower efficiency for Polish insurance companies. This was probably caused by the profit decrease by 14% in 2014 and 24% in 2015, as well as the decrease in premiums written by 5% in 2014 and the increase of administration costs by 2%. Another factor responsible for the decrease in efficiency in 2015 was probably the growth of administration costs by 3%. In 2015, life insurance premiums fell by 4.9%, with the majority of the decline coming from single premiums savings products due to low interest rates and a new tax on interest payments for short-term products to policyholders (Staib and Bevere, 2016).

When evaluating the development of the Hungarian insurance companies, we used data provided by the Magyar Biztosítók Szövetsége Association in its Hungarian Insurers' Yearbook. The year 2012 showed increased signs of the economic crisis that had unfolded in the previous years, which was also reflected in the performance indicators of the insurance companies. The decrease in gross premiums written by insurance companies continued in 2012 (a decrease by 6% from the level recorded in the preceding year). In other words, the total sector shrank even more significantly than it had weakened in 2011. In addition, in 2012, Hungary saw a sharp premium volume drop by more than 10%, mainly on the declining motor business, while property insurance performed better. Between 2013 and 2016, Hungarian insurance companies showed a rise in efficiency. This may have been due to the growth of gross premiums written. In 2013, the premiums written by insurers began to rise again and were 5.4% higher than the previous year's revenue. In 2014, 2015 and 2016, the insurance companies continued to increase their premiums written. In 2014, premiums written were 5% higher

than their level in the previous year. In 2015, premiums written were 2.2% higher than in the previous year. Moreover, the national bank is considering stricter fee limits on unit-linked products in an attempt to ensure cost transparency for consumers, which could provide a boost to life insurance sales. In addition, motor insurance boosted real premium growth to 6.7% as motor rates increased. In 2016, gross premiums written were 7.5% higher than their level in the previous year.

Conclusions

The aim of the paper was to estimate the technical efficiency of the insurance companies in the Visegrad Group countries using data envelopment analysis. We employed the non-oriented slack-based measure DEA model with variable returns to scale to estimate the efficiency of insurance companies in the Visegrad countries. We found that the average efficiency was approximately 65–80% during the period of study. The main reasons for the inefficiency of the insurance sector were the high level of operating costs and the decrease in net income of insurance companies. We also found differences in efficiency among the individual insurance companies in this group of countries. This result is in line with that of Zimková (2015), who evaluated the differences in efficiency of individual insurance companies in Slovakia.

What is the overall trend in the development of efficiency of the insurance companies in the Visegrad countries? We found that, on average, the development was almost constant. We found a significant decrease in insurance efficiency in 2012 and 2014. This decrease was caused mainly by the decrease in premiums written and net profit.

Is the efficiency of the Visegrad countries' insurance sectors similar? We found that there are differences in the efficiency of insurance companies across these countries. The results showed that the most efficient were the Hungarian and Polish insurance sectors. On the other hand, the least efficient was the insurance sector in Slovakia. We can confirm the findings of Grmanová and Pukala (2018) and Grmanová and Jablonský (2009), who concluded that the Polish insurance sector was more efficient and that the Slovak insurance sector was less efficient than the insurance sector in Czechia. However, we found that the development of efficiency was similar across the Visegrad group. Insurance sector efficiency significantly decreased in 2012 in all countries; this was probably a result of the debt crisis.

This research regarding the efficiency of insurance companies can be used as a part of the financial stability planning of insurance companies. Pavić Kramarić et al. (2019) mentioned that the financial stability or soundness of insurance companies has gained importance over the years, especially after the financial crisis of 2008. Various stakeholders, such as policymakers, regulators, the insured, etc., are interested in keeping the insurance sector stable, since it contributes to overall financial stability. Moreover, insurance companies can be important for the stability of financial systems mainly because they are large investors in

financial markets, because there are growing links between insurers and banks and because insurers safeguard the financial stability of households and firms by insuring them against risk (ECB, 2009).

Insurance companies are facing constant changes regarding their business activities due to changes in the insurance sector environment, including regulatory, technological, and macroeconomic changes, among others. This poses enormous challenges to regulators, policymakers, and standard-setting bodies for introducing improved policies and procedures, i.e., regulatory frameworks. This should all be done to ensure safe and stable insurance sectors for the benefit and protection of policyholders and to contribute to overall financial stability (Pavić Kramarić et al., 2019).

In addition to the useful insights obtained with this research, the authors are aware of its limitations, which should be addressed in future research. In this paper, we consider efficiency using two inputs and two outputs. We did not include other determinants in the analysis of the efficiency of the insurance companies. In further research, we would like to focus on the other determinants of insurance efficiency. We can add macroeconomic and insurance-specific factors to the analysis and estimate the determinants of efficiency. We can also consider other inputs and outputs, adopt a different approach for the selection of variables and compare the results in regards to insurance efficiency.

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EVALUATION OF TECHNICAL EFFICIENCY OF INSURANCE COMPANIES IN THE VISEGRAD GROUP COUNTRIES

Summary

The aim of the paper is to estimate the technical efficiency of insurance providers in the Visegrad Group countries in the period 2009–2016 using data envelopment analysis (DEA). The insurance sector in these countries underwent significant changes in the analysed period. during the last two decades. According to the results of the analysis, the average efficiency of insurance companies was approximately 65–80% in the period under study. There were, however, considerable differences among individual insurance companies as well as among the national insurance sectors. The most efficient insurance sectors were those of Hungary and Poland, and the least efficient that of Slovakia. The overall development of efficiency was almost stable, and efficiency decreased in 2012 and 2014. The reason for the inefficiency fall was the decrease in number of premiums written and net income and the high level of costs.

Keywords: insurance sector, technical efficiency, DEA, Visegrad Group countries

JEL: G22, G14, C23

OCENA EFEKTYWNOŚCI TECHNICZNEJ FIRM UBEZPIECZENIOWYCH W KRAJACH GRUPY WYSZEHRADZKIEJ

Streszczenie

Celem artykułu jest oszacowanie i ocena efektywności technicznej firm ubezpieczeniowych w krajach Grupy Wyszehradzkiej w okresie 2009–2016. Ocena ta została dokonana na podstawie analizy przeprowadzonej metodą DEA. Sektor ubezpieczeniowy w tych krajach podlegał znacznym zmianom w badanym okresie. Wyniki analizy wskazują, że w okresie tym średnia efektywność firm ubezpieczeniowych wynosiła około 65–80%. Istniały jednak pod tym względem znaczne różnice pomiędzy poszczególnymi firmami ubezpieczeniowymi i poszczególnymi krajami. Najwyższą efektywność wykazywał sektor ubezpieczeniowy na Węgrzech i w Polsce, a najniższą w Słowacji. Ogólnie biorąc, w bada-

nym okresie występowała prawie stabilna tendencja wzrostu efektywności, ze spadkiem odnotowanym w latach 2012 i 2014. Przyczyną tego spadku był spadek liczby ubezpieczonych jednostek, spadek dochodów netto i wysoki poziom kosztów.

Słowa kluczowe: sektor ubezpieczeniowy, efektywność techniczna, analiza DEA, kraje Grupy Wyszehradzkiej

JEL: G22, G14, C23

ОЦЕНКА ТЕХНИЧЕСКОЙ ЭФФЕКТИВНОСТИ СТРАХОВЫХ ФИРМ В СТРАНАХ ВЫШЕГРАДСКОЙ ГРУППЫ

Резюме

Целью статьи является расчет и оценка технической эффективности страховых фирм в странах Вышеградской группы в период 2009–2016 гг. Эта оценка была произведена на основе анализа, проведенного с помощью метода DEA. В течение исследуемого периода страховой сектор в этих странах подвергался значительным переменам. Результаты анализа указывают, что за этот период средняя эффективность страховых фирм составила около 65–80%. Вместе с тем наблюдались значительные различия между отдельными страховыми фирмами и отдельными странами. Самую высокую эффективность страховой сектор проявлял в Венгрии и в Польше, а самую низкую в Словакии. В целом за исследуемый период наблюдалась довольно стабильная тенденция роста эффективности, с понижением, отмеченным в 2012–2014 гг. Причиной этого понижения было сокращение количества застрахованных единиц, понижение доходов нетто и высокий уровень издержек.

Ключевые слова: страховой сектор, техническая эффективность, анализ DEA, страны Вышеградской группы

JEL: G22, G14, C23