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Technical Efficiency in a Networked Industry: a Deterministic Application of the Intermediation Approach to Assess Slovakia's Insurance Sector

Summary. Private insurance companies as we know them today are definitely among organizations characterized by a network structure. In fact, as a consequence of heavy regulation and tough competition, the entire sector is networked and interrelated. The paper investigates the technical efficiency of the Slovak insurance industry in 2013. The aim of the paper is to benchmark individual insurance companies with regard to their technical efficiency under the intermediation definition of efficiency. The non-parametric method of evaluation is employed based on the slacks-based measure (SBM) model of data envelopment analysis. The findings show that total operating costs and equity were successfully transformed into premium written and after-tax return by a majority of the insurance institutions included in the research.

Keywords: efficiency, Slovak insurance industry, SBM model, intermediation approach

1. Introduction

The productivity and efficiency of the Slovak insurance industry in 2013 was influenced by the global external macroeconomic environment. Global economic growth edged down to 3.0% in 2013 from 3.1% in the previous year with deceleration observed in both advanced and emerging economies. The contraction of the euro area economy moderated to –0.5% in 2013, from –0.7% in 2012. As far as Slovakia's economic performance is concerned, according to the Statistical Office of the Slovak Republic (SO SR), the annual growth rate of gross domestic

product at constant prices was 0.9%, down from 1.8% in 2012. Despite its deceleration, the Slovak economy was among the fastest growing economies in the euro area. External demand was the main driver of its growth, while domestic demand made a negative contribution owing largely to lower investments. In the environment of sluggish economic growth, the Slovak insurance sector in 2013 garnered profits totaling €158 million[1].

The insurance industry is primarily focused on three business lines: (1) protection, which consists of property and liability insurance, (2) financial security, which encompasses life and health insurance, and (3) investment, which is composed of asset management.

In this paper, the technical efficiency of a representative sample of Slovak insurance institutions is analysed with the use of Tone's non-radial DEA models. Two implications for managerial and regulatory purposes are then derived from the findings. First, the poorest performing insurance institutions should change their managerial procedures and adopt enhanced-incentive policies. Second, the regulatory body should focus supervisory measures upon technically inefficient insurance institutions.

The paper is organized into four sections, the first of which is introductory and the last delivers conclusions. The second section explains the intermediation approach for measuring the efficiency of insurance firms and provides an overview of some relevant studies. The third, methodological section is followed by the fourth which presents the findings and includes their interpretation.

2. Conceptual issues and an overview of relevant literature

Conceptual views of efficiency of insurance industry differ. Individual theoretical concepts concur that commercial insurances are agents of a transformation process and that during this process they transmute a set of inputs into a set of outputs. These inputs and outputs are linked in operations of insurances through a production function, which specifies the maximum attainable outputs at the given level of inputs.

Traditional literature on efficiency of insurance firms is addressing production approach and intermediation approach[2]. The production approach is seeing the

[1] National Bank of Slovakia, Annual Report 2014, p. 96. Available online: www.nbs.sk/_img/Documents/_Publikacie/AnnualReport/ARNBS14.pdf (accessed: January 31, 2016).

[2] A.N. Berger, D.B. Humphrey, *Efficiency of Financial Institutions: International Survey and Directions for Future Research*, "European Journal of Operational Research" 1997, Vol. 98, No. 2, pp. 175-212.

insurance firm as manufacturing company. However, especially the use of "claims paid" or "losses incurred" as an output of the production approach has attracted criticism because an unexpected upward change in losses (due to an environmental catastrophe or a terrorist attack) would result in efficiency enhancement of the respective company. Therefore the intermediation approach which treats an insurance company as a financial intermediary and selects inputs and output variables accordingly tries to overcome the shortfalls of the production approach. Diboky and Ubl[3] devide services provided by insurers into risk bearing (assuming risk to decrease potential personal losses), risk pooling (collecting funds from policyholders and redistributing money to those policyholders who incurred losses) and financial intermediation (borrowing funds from policyholder and investing them to financial assets until they are paid back at policy expiration date). They assume the amount of gross premium provided by a company to be a good proxy for these services, since all of them are related to this key figure. As shown below, the framework of Diboky and Ubl[4] is adopted in this contribution for selecting a combination of output variables. From the shareholders' point of view, the main objective of an insurer is to achieve a certain profit goal, e.g. a required rate of return. Therefore, the after tax return is selected as output variable as well.

Consistent with traditional efficiency literature, most decisive inputs are specified: labour, business services and capital. The quantity of labour and business services is defined as total operating costs. They consist of both the costs associated with selling and issuing new policies (acquisition costs) and the costs of maintaining existing policies (maintenance costs). The operating costs of life insurance can be classified broadly into labor-related expenses, capital expenses, and materials consisting of all other expenses[5] (Segal, 2000, p. 4). Labor is defined as the total number of employees and agents employed by the company. The total cost of employees is the sum of salaries, contributions for benefit plans, payments under non-funded benefit plans and other employee welfare. Capital is defined as the sum of capital expenses: rent, equipment rental, and depreciation. The third input, materials, consists of all other expenses Most of the expense items are directly related to selling new policies and servicing existing policies. The total operating expence in our contribution covers labor-related expenses and other expences (especially asset and liability management expences), therefore the capital is included as addidional input variable.

There has been considerable research on measuring efficiency of commercial insurances and their benchmarking. It is probably not possible to give an exhaustive

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[3] F. Diboky, E. Ubl, *Ownership and Efficiency in the German Life Insurance Market: A DEA Bootstrap Approach*, "Working Paper University of Vienna" 2007, pp. 15-17.

[4] Ibidem, p. 16.

[5] D. Segal, *An Economic Analysis of Life Insurance Company Expenses*, North American Actuarial Journal, 2003, No. 6(4), pp. 81-94.

overview of the relevant literature on this topic. In consequence of this, the scope of the presentation here is limited only to the research that focused on the non--parametric approach of the data envelopment analysis (DEA). Table 1 summarizes empirical studies that are devoted to this topic and lists especially those studies that have applied the non-parametric approach based on a DEA model.

As it is clear from the above table, studies currently exist on several international insurance markets. However, the Slovak insurance market is covered only by the study of Grmanová and Jablonský[6]. They utilized in their research basic DEA models, the model by Charnes, Cooper and Rhodes addressed conventionally as the CCR model and the model by Banker, Charnes and Cooper addressed conventionally as the BCC model. In this paper, the model by Tone, a more advanced DEA model, is utilized and this model is usually called the SBM (slack-based measure) model.

Table 1. Empirical studies which applied DEA methodology (in the alphabetical order)

Authors	Countries covered	DEA methodology
Barros et al. (2010)	Greece	Bootstrapped DEA
Barros, Barroso (2005)	Portugal	Malmquist index
Cummins et al. (1996)	Italy	DEA input distance function, Malmquist index
Cummins et al. (1998)	USA	DEA deterministic cost function, Malmquist index
Cummins et al. (1999)	USA	DEA input distance function, Malmquist index
Diboky, Ubl (2007)	Germany	X-Efficiency
Grmanová, Jablonský (2009)	Czech Republic, Slovakia	CCR, BCC, Super-efficiency
Fukuyama (1997)	Japan	Malmquist index
Mahlberg, Url (2003)	Austria	Malmquist index

Source: own.

The previous research centered on selected aspects of technical efficiency of the Slovak insurance sector and its operating conditions. In their research they applied three main approaches to estimation of efficiency frontier in insurance, so called the service-oriented, the intermediation oriented and the profit oriented approach. Moreover, they published research based on the Malmquist index application on the productivity change in the insurance industry, which reflects

[6] E. Grmanová, J. Jablonský, *Analýza efektívnosti slovenských a českých poisťovní pomocou modelov analýzy obalu dát*, "Ekonomický časopis" 2009, No. 57, č. 9, pp. 857-869.

technological changes and technical efficiency changes in the Slovak insurance sector. To the best knowledge of the author this is the first study which apply the SBM model on the Slovak insurance industry, which allows to gain not radial results essential for the efficiency improvement of the technical efficiency of the Slovak insurance sector.

3. Methodology

In order to determine the technical efficiency of organizational units of the Slovak insurance sector under the intermediation approach, the SBM analysis was applied on the data of fifteen organizational units of the Slovak insurance sector characterizing their performance in 2013. The methodological procedure stands on several characteristic points or assumptions that shape the line of research and they are summarized in brief in the following text.

The dataset comprises the data on 15 organizational units (insurances) operating in the Slovak Republic and it covers the great majority of Slovak insurance industry (as the total of included insurances exceeds 80 percent of the Slovak insurance assets). The organizational units considered in the paper are listed in Table 2. Firms not included into our panel typically represent small insurers. In order to assure consistency of the analysis, insurance institutions which concentrate on life insurance only and decision making units with negative input or output data are subject to exclusion. The source of the data is TREND Holding, s.r.o., Bratislava.The data used in the empirical analysis are the yearly data of balance-sheet items disclosed by the fifteen organizational units of the Slovak insurance sector during 2013.

Table 2. Organizational units of the Slovak insurance sector included in the analysis

Organizational unit	
Allianz – Slovenska Poistovna	Poistovna Slovenskej sporitelne, Vienna IG
Kooperativa, Vienna IG	Union Poistovna
Generali Slovenska Poistovna	Poistovna Cardif Slovakia
Komunalna poistovna, Vienna IG	QBE Insurance Limited
MetLife Amslico Poistovna	AXA Pojistovna
Uniqa Poistovna	Poistovna Postovej banky
CSOB Poistovna	HDI Versicherung AG
Wustenrot Poistovna	

Source: own.

The data used in the empirical analysis are the yearly data of balance-sheet items disclosed by the fifteen organizational units of the Slovak insurance sector during 2013.

Two inputs and two outputs are recognized in the study. The input selected under the intermediation approach is total operating expenses and the capital, while output to be maximized is represented by written premium and after tax result.

The employment of the SBM model. In this paper, the assumption of variable returns to scale is formed (which, of course includes a specific case of constant returns to scale) and combined with a non-oriented SBM model in evaluating the organizational units of the Slovak insurance sector on a comparative basis.

In the exact formulation of the SBM model, it is assumed that the data on n production units are available, where any production unit o, $o \in \{1, ..., n\}$, produces s desirable outputs out of m inputs. The values of inputs of production unit o are represented by vector $\boldsymbol{x}_o = (x_{o1}, ..., x_{om})'$ and the values of outputs by vector $\boldsymbol{y}_o = (y_{o1}, ..., y_{os})'$. The elements of both vectors are positive. Individual inputs and outputs have corresponding vectors of potential slacks $\boldsymbol{s}^{\mathbf{x}}_o = (s^{\mathbf{x}}_{o1}, ..., s^{\mathbf{x}}_{om})'$ and $\boldsymbol{s}^{\mathbf{y}}_o = (s^{\mathbf{y}}_{o1}, ..., s^{\mathbf{y}}_{os})'$, which states how individual inputs and outputs must be improved in order that production unit o become efficient (whereas vector of inputs $\boldsymbol{x}_o$ need be reduced by $\boldsymbol{s}^{\boldsymbol{x}}_o$ and vector of outputs $\boldsymbol{y}_o$ need be increased by $\boldsymbol{s}^{\boldsymbol{y}}_o$). These slacks are to be identified by the DEA and serve as an exclusive basis of efficiency calculation for respective production unit o.

For each production unit o, $o \in \{1, ..., n\}$, it is necessary to solve the following task of linear programming of the non-oriented SBM model under the assumption of variable returns to scale,

$$\rho_0\,(\lambda, s^x, s^y) = \frac{1 - \frac{1}{m}\sum_{i=1}^{i=m} s^x_{oi} \,/\, x_{oi}}{1 + \frac{1}{s}\sum_{j=1}^{j=s} s^y_{oj} \,/\, x_{oj}} = !\min \tag{1}$$

with respect to

$$s^x = x_0 - \sum_{i=1}^{i=n} \{\lambda\}_i\, x_i \geq 0$$

$$s^y = y_0 - \sum_{i=1}^{i=n} \{\lambda\}_i\, y_i \geq 0$$

$$\sum_{i=1}^{i=n} \{\lambda\}_i = 1,\ \lambda \geq 0$$

The symbol "≥" denotes at a vector that respective elements of this vector are non-negative and at least one element is non-zero. The restrictions of the

optimization task constructs the production possibility set with respect to n production units and their observed inputs $\boldsymbol{x}_1, ..., \boldsymbol{x}_n$ and outputs $\boldsymbol{y}_1, ..., \boldsymbol{y}_n$ as well as their convex linear combinations in $\Re^m$ and $\Re^s$ respectively. The coefficient ρ takes values at interval [0, 1] and it is the SBM score of technical efficiency (in this case of production unit o whose task (1) is subject to optimization. If for some production unit $\rho = 1$ happens to be the case, this production unit is called SBM-efficient, which means that it is technically efficient in the sample of n production units to be evaluated. In the paper, the role of production units is undertook by individual organizational units in the Slovak insurance sector in the year 2013.

4. Findings

The data used in the empirical analysis are the 2013 yearly data of balance--sheet items disclosed by the TREND Holding, s.r.o., Bratislava.

Table 3. Variables used in the technical efficiency analysis (EUR ’000)

Variable	Definition	Abbreviation
Inputs		
Total operating costs	Labor-related expenses and materials consisting of all other expenses	OC
Equity	Equity	E
Outputs		
Premium written	Premium written	PW
After-tax result	After-tax result	ATR

Source: own.

Inputs in insurance business should reflect the amount of labor, capital, and intermediate inputs used by individual companies. Variables total operating costs include labor-related expenses and other expenses as administration and distribution costs. Therefore together with equity they cover input part of the production process in the insurance industry.

Chosen outputs reflect the economic theory on the production of insurance services. Services provided by commercial insurers can be divided into risk bearing (to decrease potential personal losses), risk pooling (collecting funds from policyholders and redistributing money to those policyholders who incurred losses) and financial intermediation (borrowing funds from policyholder and investing them in financial assets until they are paid back at policy expiration

Table 4. Technical efficiency scores and slacks

No.	DMU	Score	Excess OC S – (1)	Excess E S – (2)	Shortage PW S + (1)	Stortage ATR S + (2)
1	Allianz – Slovenská Poistovňa	1	0	0	0	0
2	Kooperativa, Vienna IG	1	0	0	0	0
3	Generali Slovensko Poistovňa	0,42	34 237	62 686	0	0
4	Komunálna poisťovňa, Vienna IG	1	0	0	0	0
5	MetLife Amslico Poisťovňa	1	0	0	0	0
6	Uniqa Poisťovňa	0,52	23 235	9 424	0	1 045
7	CSOB Poisťovňa	1	0	0	0	0
8	Wustenrot Poisťovňa	0,43	14 796	8 023	0	1 985
9	Poisťovňa Slovenskej sporiteľne, Vienna IG	1	982	16 831	0	81
10	Union Poisťovňa	0,28	8 466	13 642	0	2 564
11	Poistovna Cardif Slovakia	0,39	2 190	7 581	0	1 985
12	QBE Insurance Limited	1	0	0	0	0
13	AXA Pojisťovna	0,44	17 359	88	9 881	0
14	Poisťovňa Poštovej banky	0,32	0	6 317	24 888	0
15	HDI Versicherung AG	1	0	0	0	0

Source: own.

date). Following Diboky[7] we assume the amount of premium written provided by a company to be a good proxy for these services, as all of them are related to this key figure. From the insurance shareholders point of view, the main objective of a running of business is the profit maximization in the long run. Therefore the after tax result is selected as output.

All DEA computation were done by DEA-Solver learning version 3.0 and the results are listed in Table 4, which presents information about the non-oriented technical efficiency score, ranking each individual insurance institution under the research.

From the gained results it comes out that transformation of total operating costs and equity into premium written and after-tax result was successfully achieved by more than half of insurance institution under the research: Allianz – Slovenská Poisťovňa, a.s., Kooperativa, Vienna IG, a.s., Komunálna poisťovňa, Vienna IG, a.s., MetLife Amslico Poisťovňa, a.s., CSOB Poisťovňa, a.s., Poisťovňa Slovenskej sporiteľne, Vienna IG, a.s., QBE Insurance Limited, a.s., HDI

[7] F. Diboky, E. Ubl, op. cit., p. 16.

Versicherung AG. a.s. The worst results have got Union Poisťovňa, a.s., Poisťovňa Poštovej banky, a.s., followed by Poisťovňa Cardif Slovakia, a.s. In those cases managers should change their procedures and adopt enhanced-incentive policy.

The excess slacks of input variables point how much a technically un--efficient insurance company has to decrease its inputs to become technically efficient. On the contrary the shortage slacks of output variables bring out how much a technically un-efficient insurance company has to increase its outputs to become technically efficient.

5. Conclusion

Changes in the external environment would create growth opportunities for insurance companies in order to deliver the shareholders' expectations. The companies will have to balance between growth, profitability and risk as they go forward. This would entail marked changes in the business strategy and the same would be cascaded to operational decisions related to product design, pricing, channel monitoring, and operational effectiveness. Companies with a one--dimensional focus on growth or on profitability would lose competitive power either due to strain on capital or due to insignificance of the scale. This would support the trend of overall profitable growth for the industry. Insurances have to develop complex and sustainable business models. The technical efficiency studied in this contribution is an inevitable part of it.

Overall we can state, that in 2013, a year in which the European sovereign debt crisis and the political efforts towards combating the crisis were still the predominant issue, the insurance institutions in Slovakia showed satisfactory development. Empirical results of this paper regarding the technical efficiency of insurance institutions in Slovakia in 2013 under transmission approach show that the level of efficiency differ from one insurance to another. More than half of institutions under research were found technically efficient by applying SBM under variable return to scale.

The technically efficient institutions operating under variable return to scale in the Slovak Republic in 2013 were found Allianz – Slovenská Poisťovňa, a.s., Kooperativa, Vienna IG, a.s., Komunálna poisťovňa, Vienna IG, a.s., MetLife Amslico Poisťovňa, a.s., CSOB Poisťovňa, a.s., Poisťovňa Slovenskej sporiteľne, Vienna IG, a.s., QBE Insurance Limited, a.s., HDI Versicherung AG. a.s. The worst results have got Union Poisťovňa, a.s., Poisťovňa Poštovej banky, a.s., followed by Poisťovňa Cardif Slovakia, a.s. In those cases managers should change their procedures and adopt enhanced-incentive policy.

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Techniczna efektywność w usieciowionej gałęzi gospodarki: deterministyczne zastosowanie podejścia intermediacyjnego do oceny słowackiego sektora ubezpieczeniowego

Streszczenie. Współczesne prywatne firmy ubezpieczeniowe bez wątpienia zaliczyć wypada do organizacji o strukturze sieciowej. Usieciowienie i wzajemnie powiązania są w istocie cechą całego sektora, zarówno z uwagi na ciasny gorset regulacji, jak i panującą w nim silną konkurencję.

Artykuł bierze pod lupę techniczną efektywność słowackiego sektora ubezpieczeniowego w roku 2013. Jego celem jest ocena poszczególnych podmiotów sektora pod kątem technicznej efektywności definiowanej z punktu widzenia realizacji funkcji pośrednictwa (Intermediation Approach). Badanie przeprowadzono za pomocą nieparametrycznej metody analizy obwiedni danych (DEA – Data Envelopment Analysis), opierając się na modelu SBM (Slacks-Based Measure). Uzyskane rezultaty wskazują, że większość analizowanych firm ubezpieczeniowych zadowalająco radziła sobie z przekładaniem kosztów operacyjnych i kapitału własnego na składki ubezpieczeniowe i zysk po opodatkowaniu.

Słowa kluczowe: efektywność, słowacka branża ubezpieczeniowa, model SBM, podejście intermediacyjne