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*MEASURING AND ANALYZING THE EFFICIENCY OF FIRMS IN THE INSURANCE INDUSTRY USING DEA TECHNIQUES**

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Abstract

The insurance industry has an important role in the economy, being constantly focused on diversifying product portfolios and dispersing risks. Since the uncertainty, the asymmetric information, the current economic and social-political challenges affect the economic performance and competitiveness on the insurance market, it is necessary to focus on the evaluation of the technical efficiency of the players. One of the most complex analytical research tools with increased utility that can be applied to measure the efficiency is the Data Envelopment Analysis (DEA). Our work is designed to analyze the performance of a sample made up of the ten main players in the insurance industry in Romania. Assuming a predefined set of five inputs (total expenses, provisions, average number of employees, total placements and intangible assets) and one output (total income) selected from the firms' balance sheets, we calculate the efficiency scores with the help of DEA techniques for each year from 2016 to 2020. Our results show that Allianz and City are the most efficient firms regardless of the model type VRS or CRS, while Groupama and Omniasig fail to operate at an optimal level in any of the analyzed periods.

Keywords: insurance market, DEA method, efficiency, competition degree, factor productivity, market concentration
JEL Classification: C44, C61, D24, G22

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1. Introduction

Constantly focused on diversifying product portfolios and dispersing risks, the insurance industry has an important role in the economy. Seen both as a financial intermediary and as a provider of risk transfer and compensation, the activity of companies on the insurance market contributes to economic growth as it allows efficient management of different risk categories and leads to the mobilization of internal savings (Arena, 2008). Thus, insurance protects both microeconomic entities and households from different risk classes that can affect economic activity in various ways, being connected to the risk management process. One of the components that influence the stability and efficiency of the insurance market is consumer protection. Increasing their level of confidence and developing financial education are strategic pillars for strengthening the market.

Since the uncertainty, the asymmetric information, the current economic and social-political challenges affect the economic performance and competitiveness on this market, it is necessary to focus on the evaluation of the technical efficiency of the players. Referring to the risks specific to this market and to the available resources, each decision-making unit must know the level of risks to which it is exposed in order to consolidate a strong position on the market and face a fierce competitive environment. One of the most complex analytical research tools with increased utility that can be easily applied to such a market is the DEA technique. The nonparametric approach, the identification of the players that make up the efficiency frontier, the existence of a minimum set of hypotheses transform the DEA method into an important part of the decision-making process. Numerous studies have emphasized the advantages of this technique in modeling the operational activities for estimating the technical efficiency. Empirical orientation, the existence of unique characteristics compared to other classical financial analysis techniques have led to the utilization of DEA techniques in numerous fields, including the insurance industry, in order to estimate the efficiency frontier. DEA techniques provide significant results even for a sample consisting of few observations.

Our research paper is organized as follows. In section 2, we outline the literature review regarding the methods of evaluating the competitiveness and efficiency of the insurance industry, more precisely the DEA techniques. The following section presents the research methodology and the indicators for market concentration. In section 4, we present an overview of the insurance market in Romania, highlighting its evolution in the period 2016-2020 and identifying the main players on the market and its degree of concentration. Section 5 provides the analysis of the efficiency of firms in the insurance industry. The purpose of our analysis is to measure the technical efficiency for a sample formed by selecting the first ten players with the highest market shares. Each observation is described by six variables: total income, intangible assets, placements-total, provisions, total expenses, average number of employees. Lastly, the final section summarizes our findings.

2. Literature review

Over time, the techniques for evaluating the efficiency and performance of firms designate a special tool in quantifying the decision-making process and obtaining a competitive advantage. Since the definition of business strategies requires an information system that allows them to be interconnected, it has been proven that the one-dimensional analysis is not plausible in this sense. However, the analysis of the efficiency frontier, both parametric and nonparametric, is used to evaluate the performance of the players on a certain market. Among the many efficiency evaluation methods, Data Envelopment Analysis (DEA) has drawn the attention of many researchers because it is an easy and accurate technique to calculate the efficiency of decision-making units. This management and benchmarking technique was initially described by Charnes, Cooper and Rhodes (1978) to evaluate non-profit, public organizations.

Looking at insurance research, DEA techniques have gained attention since 1990. Among the first studies carried out are the works of Bjurek et al. (1990), Mahajan (1991), Fecher and Pestieau (1993), Cummins et al. (1996), Cummins and Zi (1998), Cummins et al. (1999). Fecher et al. (1993) analyzed the productive performance of firms in the French insurance industry using both nonparametric and parametric approach. For the nonparametric approach, the DEA model was chosen because it only imposes an "assumption of convexity of the production possibility set and disposability of input and output". Based on a representative sample of 84 firms which operates in the life insurance sector and 243 firms which operates in the general insurance sector, it was found that there was a high correlation between parametric and nonparametric results, but also a wide dispersion of inefficiency rates between firms. Fecher et al. (1993) pointed out that the level of dispersion can be reduced when controlling for variations in scale, claims ratio, distribution, ownership, and reinsurance.

Diacon et al. (2002) explored the relative efficiency for 15 European Countries based on a sample of 450 firms with characteristics from 1996-1999. Each observation in the sample was characterized by four input variables: total technical reserves, total operating expenses net of reinsurance commissions, total borrowings from creditors, total capital and three output variables: long term insurance net earned premiums, insurance net earned premiums and total investment income. Since the exploration of the differences between firms in terms of efficiency requires a two-stage approach, they generated the technical efficiency scores using the DEA VRS model, and then regressed them in relation to environmental variables. The Farrell-type efficiency scores from the second stage were estimated by a Tobit-type regression. The results show that firms are more efficient if they specialize in a single market.

As one of the most common benchmarking techniques, DEA is frequently applied in calculating the efficiency in the insurance industry. Barros et al. (2005) applied this

nonparametric technique to determine the relative efficiency of a sample of Portuguese insurance firms. An improvement in the technical efficiency of insurance industry firms was found between 1995-2001. These results reinforce the hypothesis that the insurance industry is one of the most performing industries in the Portuguese economy. The deterioration observed in the reference period was explained by the lack of use of some inputs in accordance with the related market prices.

Roman (2012) used DEA techniques to analyze the efficiency and competitiveness of various European countries in IT industry for 2003. He included in his analysis nine significant countries and showed that for this period most efficient countries were Germany and the Netherlands and less efficient countries were Bulgaria and Sweden.

The two-stage DEA model has captured attention for measuring the relative performance of insurance firms. Taking into account both the production performance and the investment performance of insurance firms, Yang (2006) proposed a DEA model to evaluate the general performance of insurance firms and how they achieve their efficiency in a systematic way. In the first stage, production and investment models were run independently. The proposed production model is suitable for evaluating the capacity of insurers to honor their obligations. In the production approach, four input variables were selected: labor expenses, capital equity, general operating expenses, and claims incurred and two output variables: net premiums written and net income. The objective of the investment model is to evaluate the ability of insurers to maximize their profits by investing in a portfolio of assets. If the production model was input oriented, the investment model is an output-oriented model with four input variables: net actuarial reserves, investment expenses, total investment, total segregated funds and two output variables: investment gains in mortgages and investment gains in equities and real estate. In the second stage of the model, a single dummy input variable was used, having as output variables the production efficiency score and the inverse of the investment efficiency score. The results obtained by Yang (2006) highlighted the efficient operation of insurance firms in the Canadian L&H industry during the reference period.

Having as hypotheses the standard DEA model and the series relationship of the two sub-processes in which the efficiency of the decision-making process can be decomposed, Kao and Hwang (2008) developed a relational model. Since general insurance firms in Taiwan have a process similar to the two-stage model, they used variables related to these firms to distinguish between the independent and the relational model. The results of the study show that the relational model always generates significant results for the entire sample. Thus, it was demonstrated that the relationship between the process and the component sub-processes is adequately described by the relational model, which also generates plausible results in the measurement of efficiency.

Eling and Luhnen (2010) carried out a broad comparison of the efficiency of a sample of 6462 firms from both the life insurance and general insurance segments from 36 countries in

the period 2002-2006. The efficiency analysis was carried out both with the help of nonparametric techniques (DEA) and parametric techniques (SFA). In the reference period, a steady growth was noted on the analyzed market both from a technical point of view and cost efficiency, with significant differences between countries. The results show that Denmark and Japan are among the countries with the highest average efficiency, while the Philippines is the least efficient country. Also, minor deviations were found when comparing the results obtained by the two methodologies.

The measurement of relative performance represents an important part of the insurance industry analysis, which over time has been the main objective of numerous studies. Sabet and Fadavi (2013) applied the DEA model in two stages to evaluate the performance of insurers in Iran, which were active in the period 2006-2010. Being a two-stage analysis, five inputs were considered (operating cost, insurance cost, number of employees, number of branches and central offices and the number of agents who have responsible to sell insurance) and three outputs (direct insurance, total number of insurance certificates and complementary insurance) in the first stage, following that in the second stage three input variables will be taken into account (the output variables from the first stage) and three output variables (insurance profit, market share, investment return). The results of the empirical study highlight the fact that the analyzed market was largely monopolized by a limited number of insurers, the other insurers existing on the market not being able to participate effectively in the economy.

Grmanová and Strunz (2017) applied DEA models and the Tobit regression model to determine the relationship between technical efficiency and profitability of insurance firms in Slovakia. They assessed the technical efficiency scores of a sample of 15 firms for the reference period 2013-2015 using DEA techniques, following that the relationship between them and the profitability indicators should be expressed using the Tobit regression model. As a result of this study, the relationship between the technical efficiency score and the clusters formed with both asset profitability and equity profitability as selection criteria was not confirmed.

Nourani et al. (2018) proposed a new framework for the application of DEA techniques to evaluate the technical efficiency of local or foreign insurers in Malaysia according to their type of activity: life insurance, general insurance, composite insurance. The evaluation of the performance of the insurers is based on breaking down the complex activity processes into two functional divisions, namely: accumulation of premiums and investment capacity. Carrying out a dynamic analysis with the help of DEA techniques, greater efficiency was found in the case of foreign insurers than in the case of local insurers when we refer to the ability to invest. It was also highlighted that a better performance prevails in the composite segment of insurers that comprises both life and non-life insurance products if we analyze from the point of view of investment capacity and in the general segment with non-life insurance products when we analyze from the point of view of the accumulation of premiums. Among the main reasons for obtaining low efficiency are the excessive use of input variables and the lack of total

investment. Other dynamic analyzes of the insurance industry using DEA techniques were carried out by Kweh et al. (2014a) and Wanke et al. (2016).

Carrying out extensive research in the insurance industry based on DEA techniques led to the design of some surveys to outline the implications of these studies. Some of these surveys were carried out by Cummins and Weiss (2000, 2013), Eling and Luhnen (2010), Liu et al. (2013a), Kaffash and Marra (2017), Kaffash et al. (2020). It was found that the DEA technique is among the most applied techniques to measure the efficiency of insurers, which has captured the attention of financial market analysts, investors, researchers and last but not least, insurance market regulatory authorities. Kaffash et al. (2020) analyzed 132 studies that use DEA techniques as methodology between 1993 (this year was the first study that applied DEA techniques to evaluate the performance of insurers) and 2018. Through this analysis, it was found that the classic DEA model was developed to allow a dynamic analysis. For example, dynamic network DEA, dynamic slack-based measure, two-stage double bootstrapped DEA, bootstrapped-DEA are among the new methodologies adopted in this field. If we refer to the input and output variables, it was observed that the value-added approach was often used to select these variables. The most used input variables are capital and labor, and the most used output variables are losses, premiums, short and long-tailed personal line.

Continuous evaluation of sustainability performance is essential to remain competitive in any business environment. Over time, many tools have been developed to take into account the existing gaps in such evaluations. One of the approaches proven to be effective for evaluating sustainability performance is based on multi-criteria decision-making methods (MCDM), especially DEA. Beiragh et al. (2020) presented an integrated multi-criteria decision-making model to assess the sustainability performance of insurers in Iran. Using an integrated approach, they evaluated the performance of 14 insurance firms based on eight economic indices, both from a qualitative and quantitative perspective. The first step was the deduction of the main components, following which they will then be used as input and output variables in the DEA model. Finally, the results were validated by applying some correlation tests. According to the results obtained, Beiragh et al. (2020) showed that Dana, Razi and Dey are the best sustainability performing firms in Iran.

Most of the papers focused on the problem of designing optimal incentive schemes in the presence of asymmetric information and on efficiency of insurance sectors. One of the purposes of these studies is to measure the managerial performance of firms in this sector, as this is essential in increasing profitability, controlling underwritten exposures and dispersing risk. Banker et al. (2022) studied the problem of estimating managerial capacity based on two data sets from India and Iran over a period of six years. The estimation of the efficiency at the insurer level was carried out by using DEA techniques based on 228 observations, after regressing the logarithm of the technical efficiency derived from a set of variables that directly influence the performance of the insurer. The managerial capacity was estimated from the

regression residuals. Based on this empirical study, Banker et al. (2022) found that the Iranian insurance market fluctuated significantly compared to the Indian insurance market which was relatively stable. The managerial capacity and the average technical efficiency of the insurers from Iran were superior to the scores obtained for the insurers from India. Other studies carried out on this topic using DEA techniques as methodology were carried out by Kansra and Singh (2021) and Cvetkoska et al. (2022).

Even if the COVID-19 pandemic had a significant impact on financial institutions, including the insurance market, increasing efficiency still remained one of the main objectives of any firm or institution. The study carried out by Ikhwan and Rusydiana (2022) aimed to measure and analyze the efficiency of 70 insurers from 2016 to 2020. Analyzing the results obtained, it can be emphasized that the COVID-19 pandemic had a small effect on the efficiency of the analyzed insurers. Another study that aims to analyze the effectiveness of insurance during the COVID-19 pandemic was carried out by Niu et al. (2022). Through this study, it was proven that the application of DEA techniques to calculate efficiency is a consistent measure with selected IRIS reports.

3. Methodology

3.1 DEA as an Efficiency Measurement Method. Basic Concept

In this paper, we use the term *decision-making unit* (hereafter DMU) to denote any entity capable of transforming inputs into outputs, being evaluated by the way in which this conversion is achieved.

The *efficiency* of a decision-making unit results from the comparison between the results called generic output and the means used called generic inputs. *Inefficiency* is reached by a DMU either when its results could have been obtained with fewer means, or when the means at its disposal could generate a greater output.

A decision-making unit is declared *efficient relative* to a group of similar DMUs if the performance of these units does not show that some of the inputs or outputs can be improved without worsening others.

Technical *efficiency* and *allocative efficiency* are the two measures of the efficiency of a DMU defined by Farrel (1957) in an article that represented the beginnings of DEA, which through their combination ensures the measurement of the *total efficiency* of a DMU. Technical efficiency reflects the ability of a DMU to obtain the maximum output from a given set of inputs, while allocative efficiency illustrates the ability of a DMU to consume inputs in an optimal proportion, associating the respective prices and production technology.

In this framework, the technique known as Data Envelopment Analysis (DEA) is a methodology for measuring the relative efficiency of a group of DMUs with comparable inputs and outputs based on linear programming techniques and enveloped surface.

A useful way, in the calculation of efficiency, to describe the existing relationships between the inputs and outputs of a production technology is the production function. The main goal is to identify, from a multitude of analyzed DMUs, those that constitute the enveloped surface or the empirical production function. The DEA technique renders for the set of analyzed DMUs the *efficiency frontier* or *enveloped surface*, according to which the evaluation of each DMU is made and the association of the relative efficiency as the case may be. Efficient DMUs in the DEA sense are those DMUs that are on the efficiency frontier. On the contrary, they are considered inefficient and a score of inefficiency is assigned to them.

An important first step in the application of DEA techniques is the definition of exogenous variables (inputs) and endogenous variables (outputs) that decisively impact the activity of the analyzed DMUs. The actual performances will not be reflected by the relative efficiencies determined when one of the variables is omitted. Testing the correlations between variables is a way to reduce the number of inputs, respectively outputs. If there is a perfectly positive correlation between the variables, then one of them can be eliminated without influencing the results obtained. When there is a positive correlation between variables, but not equal to unity, and one of the variables is eliminated, the efficiency scores associated with inefficient DMUs will be reduced. Efficient DMUs will not be impacted.

Thus, the DEA technique involves solving some linear programming problems in order to build an enveloped surface. By solving the linear programming problems associated with each DMU, a support hyperplane is obtained which constitutes a part of the enveloped surface. The efficiency measurement for each DMU refers to the calculation of the distance between the observed point and the projected point of the hyperplane on the enveloped surface. The advantages and limitations of DEA techniques are presented in figure no. 1.

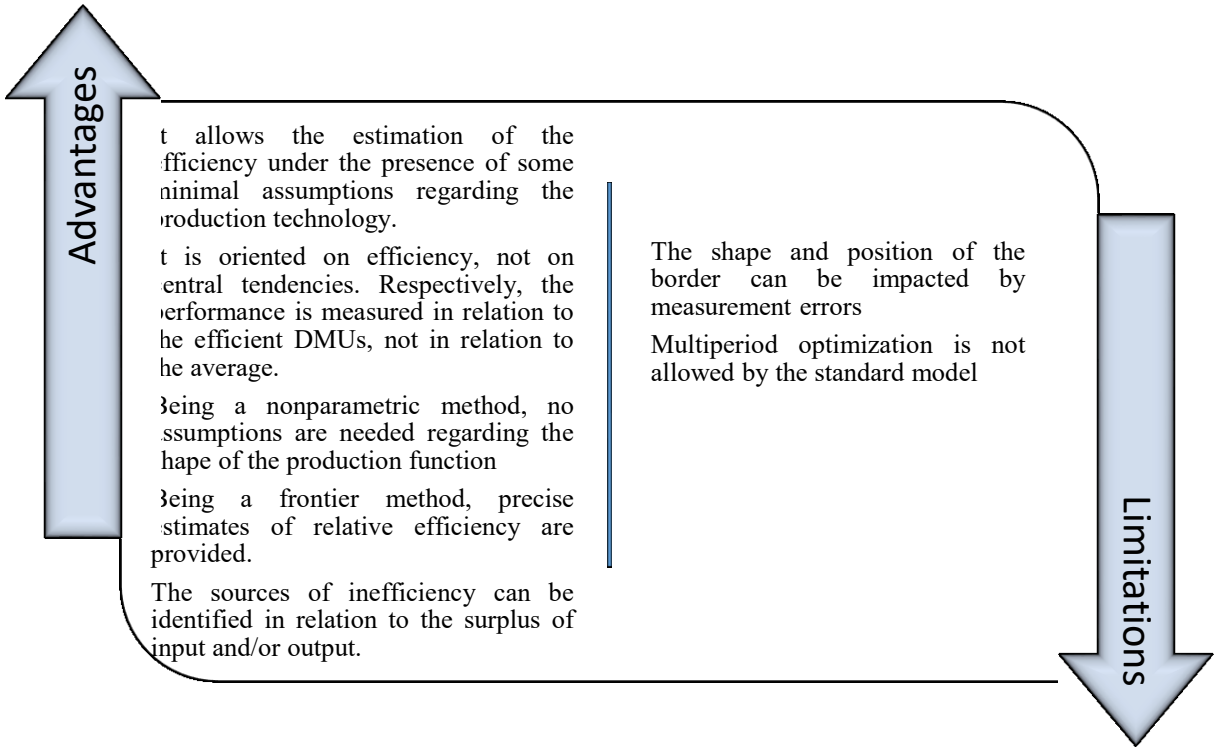


Figure no. 1: The main advantages and limitations of DEA techniques

Source: author's representation

Initially, Charnes, Cooper and Rhodes (1978) proposed an input-oriented model under the assumption of *constant returns to scale* (CRS), a model referred to in the specialized literature as the *CCR model*. Taking that reference model as a benchmark, alternative hypotheses were adopted. Therefore, Banker, Charnes and Cooper (1984) initiated a model under the assumption of *variable returns to scale* (VRS), a model referred to in the literature as the *BCC model*.

3.2 DEA Models

Constant Return to Scale (CSR) DEA Model

One of the most widespread ways to analyze the efficiency of many DMUs is to consider the objective function in the form of the ratio. Thus, for each $DMU_j (j = \overline{1,n})$ in the analyzed set, a measure of the ratio between all outputs and all inputs is sought such as $\frac{u`Y_j}{v`X_j}$. Under these assumptions, u is a $Mx1$ vector of output weights, and v is a $Kx1$ vector of input weights. The objective function of the associated problem is to maximize this ratio. By solving the linear programming problem (1), the optimal weights are obtained.

$$\begin{cases} \max\limits_{u,v} \frac{u`Y_j}{v`X_j} \\ u`Y_i < v`X_i, \ \ i = \overline{1,N} \\ u, v \geq 0 \end{cases} \quad (1)$$

Being a linear model, it is desired to transform it into a linear programming problem, respectively a problem with multipliers. The solution of such a program consists in finding the values for u and v so that the efficiency of DMU_j is maximized, having as a restriction the existence of unitary efficiencies. The transformation into a linear programming problem consists in adding the restriction $v`X_j = 1$ as the model offers an infinite number of solutions and change of variables (μ, δ instead of u, v). The new program is described in equation (2).

$$\begin{cases} \max\limits_{u,v} \mu`Y_j \\ \delta`X_j = 1 \\ \mu`Y_i - \delta`X_i \leq 0, \ \ i = \overline{1,N} \\ \mu, \delta \geq 0 \end{cases} \quad (2)$$

This program is referred to as the multiplicative or multiple form of a DEA linear programming problem.

Also, an equivalent envelopment form of this problem can be determined by writing the dual problem:

$$\begin{cases} TE_j = \min\limits_{\theta,\lambda} \theta \\ Y_j + Y\lambda \geq 0 \\ \theta X_j - X\lambda \geq 0 \\ \lambda \geq 0 \end{cases} \quad (3)$$

where TE represents technical efficiency, θ is a scalar and λ is an *Nx1*-dimensional vector of constants. The efficiency score for each DMU is given by the value of θ, which satisfies the following relation:

$$\theta \leq 1 \quad (4)$$

If the relation (4) satisfies the equality, then we identify a technically efficient DMU which implicitly is on the frontier, the other DMUs for which the equality is not satisfied being inefficient. It should be noted that problem (3) must be solved for each DMU in order to obtain the efficiency (θ) score associated with each one.

Variable Returns-to-Scale (VRS) DEA Models

The studies carried out in this direction highlight the fact that the hypothesis of constant returns to scale is plausible only when DMUs of the analyzed set operate at the optimal scale, leading most of the time to measures of technical efficiency confused with scale efficiencies. The existence of imperfect competition that best describes the economic reality and the

presence of financial restrictions often prevent a DMU from operating on an optimal scale. The solution consists in using the hypothesis of variable returns to scale.

The extension of the DEA model with constant returns to scale proposed by Banker, Charnes and Cooper (1984) in order to analyze situations with variable returns to scale consists in adding a convexity restriction. Thus, the new program is described as follows:

$$\begin{cases} \min\limits_{\theta,\lambda} \theta \\ -Y_j + Y\lambda \geq 0 \\ \theta X_j - X\lambda \geq 0 \\ N_1\lambda = 1 \\ \lambda \geq 0 \end{cases} \quad (5)$$

where N_1 is a vector Nx1 components of values 1. In this case, the result highlights a convex coverage of intersecting planes that envelops the data closer than the conical coverage resulting from the DEA-CRS model, obtaining higher technical efficiency scores or equal than those of problem (3). Moreover, solving such problems also allows the calculation of scale efficiencies.

It is also important to select the orientation of the DEA model: input orientation (minimizing inputs and keeping outputs constant) or output orientation (maximizing outputs without changing the input vector). Regardless of the orientation of the DEA model, the same frontier will be estimated, but the magnitudes of the efficiencies associated with the inefficient DMUs obtained through the two orientations may vary. There is a similarity between the input-oriented DEA model and the output-oriented DEA model. For example, program (5) can be easily modified to describe an output-oriented DEA model with variable returns to scale:

$$\begin{cases} \min\limits_{\vartheta,\lambda} \vartheta \\ \vartheta Y_j + Y\lambda \geq 0 \\ X_j - X\lambda \geq 0 \\ N_1\lambda = 1 \\ \lambda \geq 0 \end{cases} \quad (6)$$

Where $\vartheta \epsilon [1, \infty)$. For each DMU, ϑ-1 denotes the proportional increase that can be attributed to the output keeping the input level constant. The ratio $\frac{1}{\vartheta} \in [0,1]$ defines the size of the technical efficiency.

3.3 Market concentration indicators

In order to evaluate the degree of competition at the market level, we calculate a series of relevant economic indicators that are the basis of the methodologies proposed by the Competition Council: [1]

- Concentration Rate (CR)

$CR_k = \sum_{j=1}^{k} ms_j$, where ms_j represents the market share of the first k DMUs (7)

- Herfindahl-Hirschman Index (HHI)

$HHI = \sum_{j=1}^{n} {ms_j}^2$, where n represents the total number of DMUs (8)

- Hall-Tideman Index (HTI)

$HTI = \frac{1}{2\sum_{j=1}^{n} {ms_j}^2 - 1}$ (9)

- Comprehensive Concentration Index (CCI)

$CCI = s_1 + \sum_{j=1}^{n} {ms_j}^2 (2 - ms_j)$, where s_1 represents the market share of the leader. (10)

4. Romanian Insurance Market

Informational asymmetry, the volatility of financial markets, the investment structure of insurers, the microeconomic and macroeconomic context are the key elements that have a significant impact on the financial stability, both in the medium and long term, of any player in the insurance sector, essential for resistance to economic shocks. Recently, the insurance sector was subjected to challenges generated by the COVID-19 pandemic, which created disruptions in economic systems both nationally and globally. Both the liabilities and assets of insurance companies were exposed to the uncertainty brought by the COVID-19 pandemic, as there were shocks to demand, changes in consumer behavior, changes in reference interest rates, as well as volatility on the financial market, changes of financial behavior. Also, the insurers had to reorganize their operating system in order to be able to carry out their activity during the COVID-19 crisis. Thus, accelerating the digitization process, simplifying interaction with clients and improving operational efficiency are the main opportunities created by this crisis for insurers.

The data selected for the analysis of the insurance market in Romania are relevant to capture its dynamics, to identify the main players on the market, the type of competitors, the degree of concentration, but also to measure and analyze the efficiency of companies in this industry with

[1] https://www.consiliulconcurentei.ro/wp-content/uploads/2020/01/report_on_competition_in_romania_2011.pdf

the help of DEA techniques. Data type is panel, because the variables show the results of measurements carried out in successive moments of time on the same units of a sample on several characteristics that are subject to the study. This analysis uses official data developed and published by the Ministry of Public Finance, EIOPA and TotalFirme.ro, related to the 2016-2020 reference period.



Figure no. 2: Distribution GWP per country

Source: the map created by the authors on MapChart.net based on data from eiopa.europa.eu

In figure no.2 we can see the structure of gross written premiums (both general insurance and life insurance) in the total insurance sector made up of 30 European countries in 2020. The comparative analysis was carried out on the basis of gross written premiums (hereafter GWP) collected by on the EIOPA website. The data show that in 2020 the GWP level for Romania is very low compared to the average of GWP of the insurance industry at the European level. The volume of insurance in Romania represented approx. 0.19% of the size of the entire sector, this trend being noticed throughout the analyzed period, 2016-2020. Analyzing the geographical distribution of the GWP from the figure no. 2, we notice that Romania is part of the same country group as Portugal, Finland, Czech Republic, Malta, Liechtenstein, Greece, Hungary, Slovenia, Bulgaria, Romania, Slovakia, Croatia, Cyprus, Estonia, Lithuania, Latvia, Iceland, each representing between 0.04% and 0.79% of the total GWP of the 30 analyzed countries. Germany, France, Italy are the countries that have the largest weight in the European insurance sector from the point of view of the considered variable, representing 25.25%, 23.2%, and 11.32% respectively of the size of the entire sector. Regarding the low share of GWP registered

in the insurance sector in Romania, the standard of living, financial education, the low degree of trust of the population in the insurance industry, the correlation between the development and diversification of the product portfolio and the needs of consumers are the main factors that have a significant impact on the results obtained, as they constitute the prospects for consolidation and development of the insurance sector in Romania.

In the reference period, the number of players in the insurance sector in Romania, authorized and regulated by the ASF, did not vary significantly, from 31 companies to 28 companies. According to the reports published by the ASF, the total volume of GWP was explained in a proportion of 87%-89% by ten players from the Romanian insurance sector during the entire analyzed period. The ten players are:

- City Insurance S.A. ("City")
- Omniasig Vienna Insurance Group S.A. ("Omniasig")
- Allianz-Tiriac Asigurari S.A. ("Allianz")
- Euroins Asigurarea Reasigurare S.A. ("Euroins")
- Groupama Asigurari S.A. ("Groupama")
- NN Asigurari de Viata S.A. ("NN")
- Asirom - Vienna Insurance Group S.A. ("Asirom")
- Generali România Asigurare Reasigurare S.A. ("Generali")
- BCR Asigurari de Viata Vienna Insurance Group S.A. ("BCR")
- Uniqua Asigurari S.A. ("Uniqua")

Considering the market share, we refer to the most representative ten players for analizing the insurance sector in Romania. Their market share for 2020 is presented in figure no. 3. Only in 2016, BCR failed to occupy a place in the top ten players which accounted for 87.44% of the size of the sector. In 2020, City, Omniasig, Allianz, Euroins, Groupama were the leaders on the market, representing 64.18% of the size of the entire sector in terms of GWP. If we analyze the evolution of the players in this ranking of the first five players, we notice that in 2016 only City was not part of the top five, in 2017 only Groupama, and in 2018-2019 all the players from 2020 occupied the first five positions.[2]

Subject to a complex and dynamic system of risks, the insurance industry in Romania is constantly growing. In order to consolidate a stable and strong position on the market, insurers seek to win the trust of clients through transparency policies, the timely payment of indemnities and by offering a sustainable service from the point of view of the price-quality ratio. In the process of defining development strategies, each player seeks to launch products that meet the current and diverse needs of customers, but also take into account the adaptation to economic and legislative changes.

[2] https://www.asfromania.ro/ro/a/188/arhiva

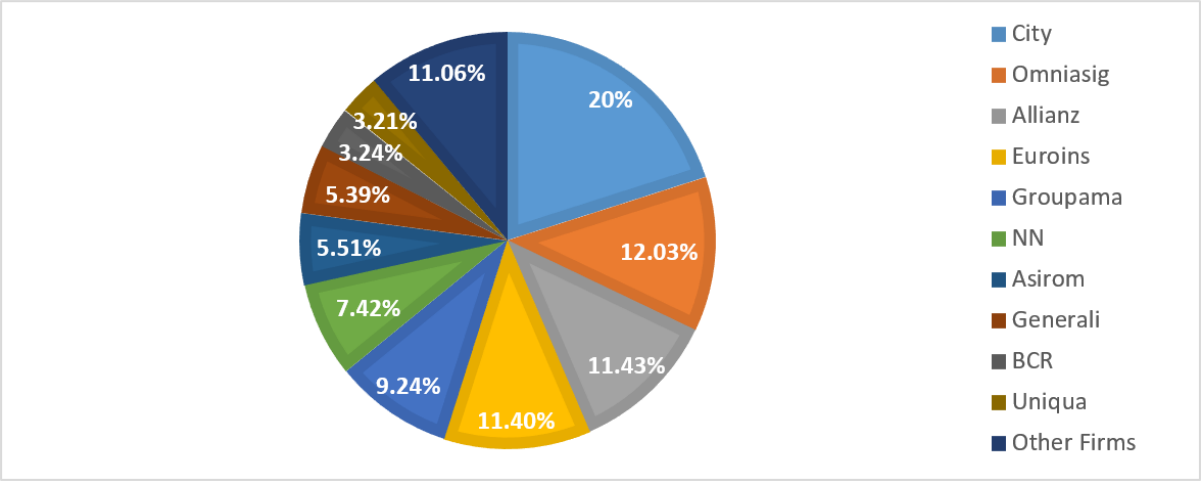


Figure no. 3: Market share 2020

Source: author's representation based on ASF report data[3]

The growth of business lines, especially of life insurance, implies increasing the degree of awareness of the need for consumer protection, but also awareness of the fact that insurance products are more than a financial instrument.

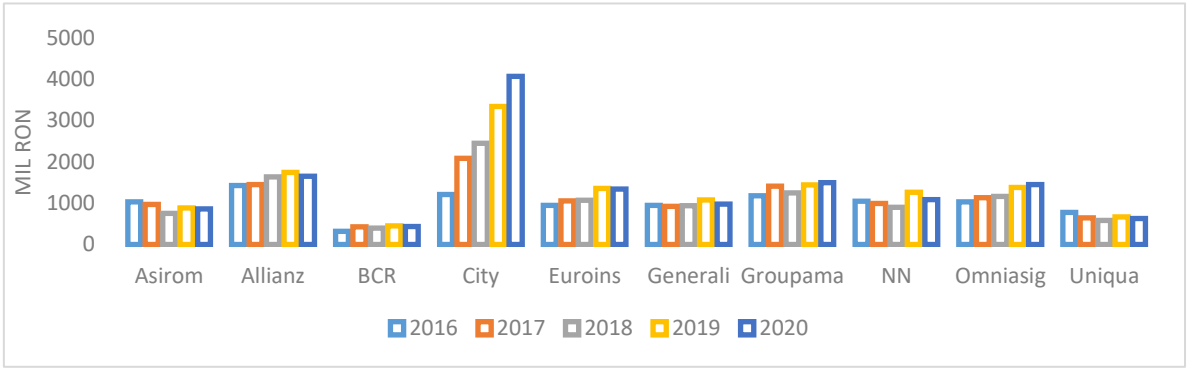


Figure no. 4: Total incomes during 2016-2020

Source: author's representation based on mfinante.gov.ro data

Analyzing figure no. 4, we can observe the dynamics of the total incomes of the ten players considered represented for the market. City and Omniasig presented an increasing income trend in the period 2016-2020. The same can be said for Allianz and Euroins with the exception of 2020, when these players recorded lower incomes compared to 2019. NN, Asirom and Uniqa recorded increases in total income only in 2019, in all other years (2017, 2018, 2020) recording a decrease in this variable. Between 2017 and 2020, City recorded the highest total incomes, followed by Allianz which was leader only in 2016. BCR registered the lowest incomes during the entire analyzed period. It should be mentioned that the largest share of the insurers' activity is owned by general insurance. Income from premiums and financial income are key elements

[3] https://www.asfromania.ro/ro/a/190/2020

that are included in the total income component. Thus, players pay more attention to underwriting performance and investment performance.

Another defining variable for insurers' performance is total expenses. It is important for any player to identify the risk factors in time in order not to create a financial imbalance. In the reference period, the total expenses of the players analyzed and represented in figure no. 5 were located below the level of total revenues, the largest difference between the two variables being recorded in 2017 (484.89 million RON), and the smallest in 2018 (99.9 million RON). Referring to the evolution of total expenses, we note that City recorded the highest expenses between 2017 and 2020, and Allianz only in 2016. For Asirom there is a decreasing trend of expenses, and for Euroins and Omniasig an increasing trend. Indemnities paid by insurers are an important component of total expenses.

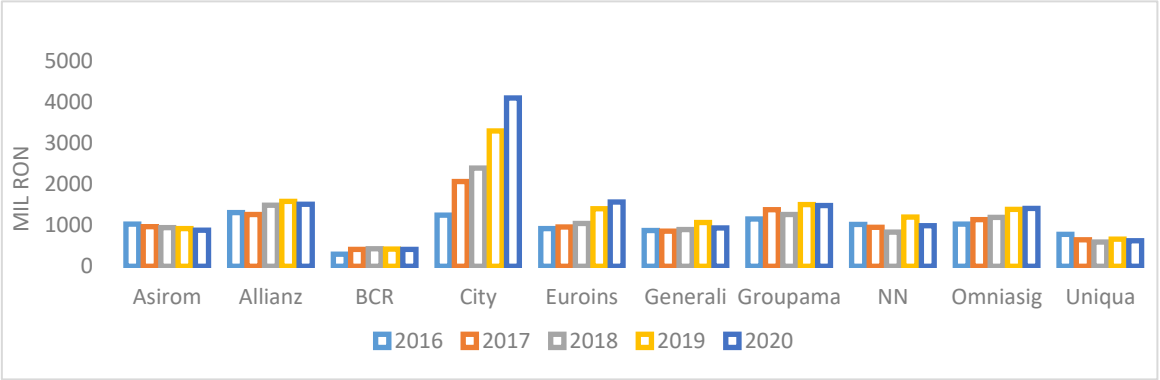


Figure no. 5: Total expenses during 2016-2020

Source: author's representation based on mfinante.gov.ro data

City is the player who practiced an aggressive and unsustainable sales policy to register a substantial market share that led to bankruptcy in 2021. Following this event, the insurance market went through a real challenge, that of managing obligations and of redistribution of the insured related to this player. Also, many players on the market have reviewed their strategies for each business line in order to create a stable and sustainable business model, which will ensure their risk dispersion and continuity on the market. Carpatica Asig and Astra Asigurari are two other players that have gone bankrupt in the past.

Compared to the other players for whom the intangible assets are mainly represented by computer programs and licenses, Omniasig has the commercial fund as part of the intangible assets. This component showed a decreasing trend during the analyzed period, the maximum being reached in 2016 (approximately 391 million RON). This explains the high values recorded for the intangible assets recorded by Omniasig compared to the other players on the market.

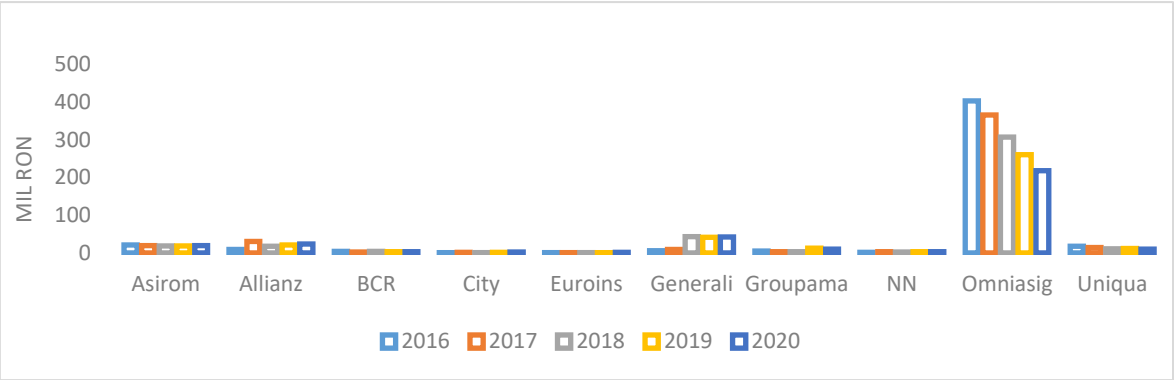


Figure no. 6: Intangible assets

Source: author's representation based on mfinante.gov.ro data

Euroins shows the lowest values for intangible assets (between 0.49 million RON and 1.9 million RON), followed by City (between 0.4 million RON and 2.25 million RON). The intangible assets registered by Generali registered a significant increase in 2018 (from 9.18 million RON to 42.96 million RON).

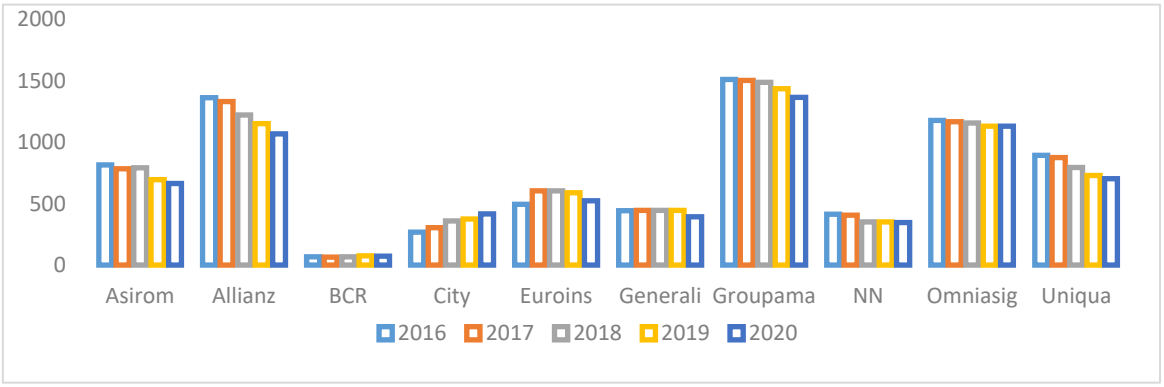


Figure no. 7: Evolution of the average number of employees

Source: author's representation based on mfinante.gov.ro data

Referring to the evolution of the number of employees in the period 2016-2020 represented in figure no. 7, we observe a decreasing trend for the players Allianz, NN, Groupama, Omniasig and Uniqa. City is the only player that shows an increasing trend in the evolution of this indicator, reaching an average number of 416 employees in 2020. The main categories of this indicator are management, operative and administrative staff. Even if an increasing trend of this indicator has not been identified, each player is focused on increasing the professional level of each employee, providing them with all the necessary resources for professional development and training.

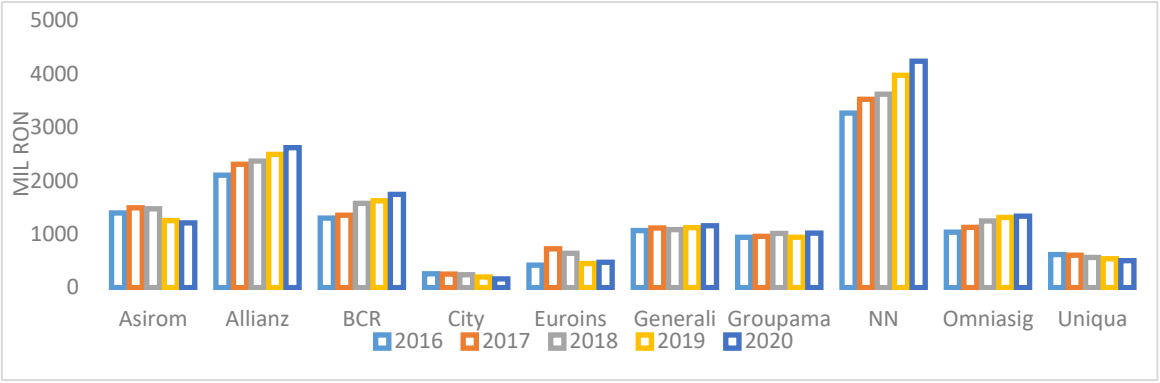


Figure no. 8: Placements-total

Source: author's representation based on mfinante.gov.ro data

Regarding the total placements, we can see in figure no. 8 an increasing trend for the players Allianz, NN, which recorded maximum values throughout the analyzed period, BCR and Omniasig. Also, we can observe for Uniqa and City, which recorded the minimum values for the entire analyzed period, a decreasing trend.

Table no. 1: Market concentration indicators

Indicators	2016	2017	2018	2019	2020
CR_{10}	0.880	0.894	0.898	0.903	0.904
HHI	0.083	0.093	0.102	0.109	0.123
HTI	0.088	0.096	0.103	0.106	0.113
CCI	0.252	0.294	0.319	0.336	0.366
No. of active firms	31	31	29	28	28

Source: author's calculation based on totalfirme.ro data and ASF reports

Knowing the information about the structure and intensity of the competition is essential for the description of any market. In this sense, we calculated the shares on the market based on the turnover for all the players who were active at every moment of time in order to be able to calculate a series of indicators that reflect the degree of concentration of the market presented in table no.1. If we analyze the concentration rate (CR) and the comprehensive concentration index (CCI), we notice that the market is very fragmented, at each moment of time there were ten players controlling a significant part of the market, that can indicate an oligopolistic market.

If we analyze the Herfindahl-Hirschman Index (HHI) and the Hall-Tideman Index (HTI) we identify a low degree of concentration, which is often associated with a high degree of competition. The insurance market is monitored by the Competition Council, which ensures a normal development, without anti-competitive agreements. Therefore, the players must promote a fair and loyal competition, thus avoiding reputational damage and financial losses. Over time, the players on this market have been sanctioned for anti-competitive practices. Among them are the fines applied by the Competition Council for several players following an exchange of information regarding the increase in RCA tariffs between October 2012 and

November 2016.[4] Among the players fined are Euroins, Generali, Groupama, Omniasig, Uniqa, Allianz and UNSAR which acted in court and won. One of the most recent sanctions is the one in the amount of EUR 26 million for the practice of fixed prices for spare parts and labor rates used by car services in relation to certain players on the insurance market: Groupama, Allianz, Omniasig, Uniqa, Euroins, Asirom, Astra.[5] Another recent sanction is the one applied to the players of Generali S.p.A. UK Branch, Generali, Omniasig and an insurance broker (Aon Romania) for anti-competitive practices on the aviation insurance market in Romania.[6]

5. Analysis of the efficiency of firms in the insurance industry

Since DEA techniques are some of the most used efficiency analysis methods, when we want to use mathematical programming, we use these models to study the performance of a sample made up of the ten DMUs on the insurance market in Romania, whose importance was demonstrated in Section 4. For each unit observed in the sample, the following six characteristics taken from the Ministry of Public Finance are recorded:

- Total income
- Intangible assets
- Placements-Total
- Provisions
- Total expenses
- Average number of employees

In spite of the fact that in many specialized papers the input-oriented model is used for the analysis of the efficiency of a sample that reflects the activity of certain DMUs, we consider the exogenous resources and opt for the output-oriented model. In order to capture as correctly as possible the activity of the analyzed DMUs, we choose total revenues as output. Thus, we chose to present a model specific to the output, since the players are rational and aim to maximize the total income resulting from the values related to the five inputs selected for analysis. To be able to use DEA techniques in the study of the performance of the selected DMUs, we use the DEAP 2.1 program as software.

Analyzing the technical efficiency results presented in table no. 2, we notice that in several years (2016, 2018, 2020) the number of efficient companies decreases in the case of the model with constant returns to scale (CRS) compared to the model with variable returns to scale (VRS). It should be remembered that the CRS model is suitable only when all DMUs operate at the optimal scale. We must also note that Allianz and City are on the efficiency frontier

[4] https://www.consiliulconcurentei.ro/wp-content/uploads/2018/12/amenzi_asigurari_dec_2018.pdf

[5] https://www.consiliulconcurentei.ro/wp-content/uploads/2022/12/Com-amenzi-acodaren-dec-2022.pdf

[6] https://www.consiliulconcurentei.ro/wp-content/uploads/2022/12/amenzi-asigurari-aviatie-dec-2022.pdf

throughout the analyzed period, while Groupama and Omniasig fail to operate at an optimal level in any of the analyzed periods. The average technical efficiency in the case of the CRS model drops significantly in 2018, when only three of the ten analyzed DMUs are on the efficiency frontier.

Table no. 2: Efficiency summary 2016-2020

Year	2016		2017		2018		2019		2020	
DMUs	**crste***	**vrste****	**crste***	**vrste****	**crste***	**vrste****	**crste***	**vrste****	**crste***	**vrste****
Asirom	0.961	0.988	1	1	0.733	0.755	0.878	0.908	0.921	0.938
Allianz	1	1	1	1	1	1	1	1	1	1
BCR	1	1	1	1	0.904	1	1	1	1	1
City	1	1	1	1	1	1	1	1	1	1
Euroins	1	1	1	1	0.998	1	1	1	1	1
Generali	1	1	0.991	0.993	0.996	1	0.95	0.975	0.997	1
Groupama	0.974	0.995	0.937	0.97	0.952	0.953	0.915	0.927	0.98	1
NN	1	1	0.973	0.98	1	1	1	1	1	1
Omniasig	0.937	0.963	0.9	0.91	0.912	0.922	0.934	0.945	0.984	0.99
Uniqua	0.969	1	1	1	0.928	1	0.946	1	0.969	1
Mean	**0.984**	**0.995**	**0.98**	**0.985**	**0.942**	**0.963**	**0.962**	**0.975**	**0.985**	**0.993**

Source: author's calculation using DEAP 2.1

**crste=technical efficiency from CRS DEA*

*** vrste=technical efficiency from VRS DEA*

If we refer to the model with variable returns to scale, we identify five DMUs that operated at an optimal level throughout the analyzed period, namely: Allianz, BCR, City, Euroins, Uniqua. Allianz and City are the only DMUs that are on the efficiency frontier when we refer to the CRS model. It should also be noted that Groupama and Omniasig are not on the efficiency frontier even when applying the VRS model. NN operated at an optimal level only in 2017, and Generali in 2017 and 2019, while Asirom found itself on the efficiency frontier only in 2017. Regarding the performance improvement, we note that Asirom could improve its performance by 24.5% in 2018, while the other inefficient companies could improve their performance by a maximum of 10% over the entire analyzed period.

Table no. 3: Return to scale of insurance firms, 2016-2020

Year	2016		2017		2018		2019		2020	
DMUs	scale		scale		scale		scale		scale	
Asirom	0.973	Drs	1	-	0.97	irs	0.967	irs	0.981	irs
Allianz	1	-	1	-	1	-	1	-	1	-
BCR	1	-	1	-	0.904	irs	1	-	1	-
City	1	-	1	-	1	-	1	-	1	-
Euroins	1	-	1	-	0.998	irs	1	-	1	-
Generali	1	-	0.998	drs	0.996	irs	0.974	irs	0.997	irs
Groupama	0.978	Drs	0.966	drs	0.999	irs	0.988	irs	0.981	irs
NN	1	-	0.993	drs	1	-	1	-	1	-
Omniasig	0.973	Drs	0.989	drs	0.988	irs	0.988	irs	0.994	irs
Uniqua	0.969	Irs	1	-	0.928	irs	0.946	irs	0.969	irs

Source: author's calculation using DEAP 2.1

In 2016, we find decreasing returns to scale for Asirom and from 2017 to 2020 this DMU recorded increasing returns to scale indicating a possible positive evolution. Also, between 2016 and 2017, we find decreasing returns to scale for Groupama and Omiasig indicating a future possible negative evolution, but in the upcoming periods (from 2018 to 2020), we find only increasing returns for these DMUs.

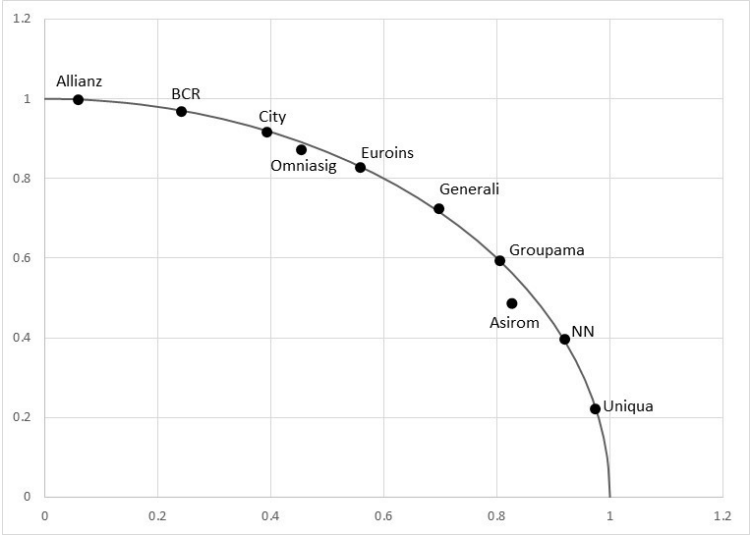


Figure no. 9: Insurance efficiency in Romania by DEA method-2020

Source: author's representation based on efficiency scores

6. Conclusions

Our research paper aimed to evaluate and analyze the efficiency of a group of ten entities on the Romanian insurance market in the period 2016-2020. This evaluation was carried out using one of the most applied techniques in microeconomic analysis, the DEA technique, using the DEAP program.

Initially, we reviewed the most relevant references for the objectives of the research of interest, the next step being the assembly presentation of the DEA techniques and the relevant indicators for identifying the degree of concentration of the analyzed market.

Our paper is centered on the case study which consist of two sections: the insurance market description and the efficiency analysis. The former began with identifying the position of the Romanian insurance market within the European insurance sector consisting of 30 countries. It was found that the volume of insurance in Romania represented approx. 0.19% of the size of the entire sector, this trend being noticed throughout the analyzed period, 2016-2020. Regarding the low share of GWP registered in the insurance sector in Romania, the standard of living, financial education, the low degree of trust of the population in the insurance industry, the correlation between the development and diversification of the product portfolio and the

needs of consumers are the main factors that have a significant impact on the results obtained, as they constitute the prospects for consolidation and development of the insurance sector in Romania. Calculating the concentration rate, Herfindahl-Hirschman and Hall-Tideman indices, the compressive concentration index, it was found that the insurance market is very fragmented with a low degree of concentration. The evolution of the market was highlighted through the lens of the first ten players in the ranking of market shares presented in the ASF reports and five variables: total incomes, intangible assets, total expenses, average number of employees and total placements.

In order to perform the efficiency analysis, we selected five inputs: total expenses, average number of employees, total placements, intangible assets, provisions and an output: total revenues, then integrated into the output-oriented model. We noticed that in 2016, 2018 and 2020 the number of efficient companies decreases in the case of the CRS model compared to the VRS model. We must also note that Allianz and City were on the efficiency frontier throughout the analyzed period, while Groupama and Omniasig failed to operate at an optimal level in any of the analyzed periods. The average technical efficiency in the case of the CRS model dropped significantly in 2018, when only three of the ten analyzed DMUs were on the efficiency frontier. If we refer to the VRS model, we identified five DMUs that operated at an optimal level: Allianz, BCR, City, Euroins, Uniqua. Allianz and City were the only DMUs that were on the efficiency frontier when we refer to the CRS model. It should also be noted that Groupama and Omniasig are not on the efficiency frontier even when applying the VRS model. NN operated at an optimal level only in 2017, and Generali in 2017 and 2019, while Asirom found itself on the efficiency frontier only in 2017.

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