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EFFICIENCY OF INSURANCE COMPANIES IN CROATIA

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Abstract

Insurance companies have an important role in the stability and growth of the financial market and the economy as a whole. Therefore, it is crucial that insurance companies operate efficiently. Due to financial consolidation that overtook the Croatian financial market, the number of insurance companies dicreased from 24 in 2015, at the start of the observed period, to 15 in 2020. Following the financial consolidation, a number of large insurance companies that dominate the Croatian insurance market was set up. The main goal of this paper is to estimate and compare the efficiency of Croatian insurance companies using traditional financial indicators and nonparametric DEA methodology in the period from 2015 until 2020. Furthermore, the paper aims to determine whether large insurers are more efficient than the medium and small insurers. The results indicate that large insurers in general achieve above-average the ROI, ROE, and ROA values and below-average the claims, expense, and debt ratios. They achieve above-average or full efficiency according to the DEA methodology. In addition, some small insurance companies tend to be efficient, while for medium insurance companies the results are more complicated. Finally, the average efficiency of insurance companies improved in the observed period, while the gap between large, medium and small insurers keeps widening.

Keywords: Insurance companies, DEA methodology, Croatian insurance market, insurance and risk

1. INTRODUCTION

Insurance companies, second to banks are the most prominent financial institutions. Insurance as an economic activity can be described as the service of risk management and risk allocation, where the insurer receives premiums for the service of insurance of an event. In the occurrence of such event, the insurer is obliged to mitigate the economic costs following the event to the insurance holder. Therefore, insurance companies are financial intermediaries that transfer periodical, recursive, in general monthly or yearly payments called insurance premiums into investments. It is important to note that premiums received by insurance companies are in much smaller amounts than the agreed payouts in the occurrence of the insured event. The time difference between the periodical premiums and the possibility of the occurrence of the insured event enables insurance companies to invest the recurring premiums with the goal of generating returns that will exceed the potential future payouts in the case of an occurrence of the insured event.

Therefore, the efficiency of insurance companies is crucial in their survival. The efficient use, i.e. the optimal allocation of inputs, for example insurance premiums into investments in combination with adequate risk management, is necessary to maximize profits (insurance premiums earned) and minimize costs (i.e. insurance policy payments). The efficiency of financial institutions is often measured using financial indicators (in general, ratios of financial or accounting data) such as, return on investments (ROI), return on equity (ROE) and return on assets (ROA). However, due to the idiosyncratic nature of the insurance business it is useful to calculate additional financial indicators, such as claims ratio, expense ratio, combined ratio and the debt ratio (Jurčević, Mihelja Žaja 2013, p. 207). Furthermore, it is possible to use more complex methods in efficiency estimation of insurance companies, such as econometric models (for example Stochastic Frontier Approach – SFA) and non-parametric models (for example Data Envelopment Analysis – DEA) that use linear programming to estimate whether a DMU (decision making unit) is operating on the frontier. While the parametric and non-parametric approaches have their advantages and disadvantages in efficiency estimation (sample size and assumptions on the production functions for the former, and the increased sensitivity to incorrect data – noise sensitivity for the latter), both approaches tend to be equally used in efficiency studies. In this paper, we focus on studies that employ the non-parametric DEA methodology, for example Barros et al (2014), Borges et al (2008), Cummins and Rubio-Misas (2006), Diacon et al (2002), and Eling and Luhnen (2010) who, in addition to the DEA methodology, employ the SFA methodology in order to compare the obtained results.

This paper deals with the efficiency of insurance companies on the Croatian financial market using financial indicators and DEA methodology in the period from 2015 until 2020. DEA methodology is used because there are only 15 insurance companies operating on the Croatian insurance market, thus making the sample size too small for the econometric models. The main point of this paper is

to evaluate whether larger insurance companies are more efficient in retrospect to medium and small insurance companies. This goal is achieved using traditional financial indicators in comparison to non-parametric efficiency estimates, since as a byproduct of financial consolidation Croatian insurance market is concentrating on a few large insurance companies. The main contribution of this paper is the evaluation of efficiency of Croatian insurance companies that is the focus of just but a few studies, therefore contributing to the growing body of studies dealing with efficiency of insurance, and whether larger insurers are more efficient than medium and small insurance companies.

Talesh (2018) studies the USA insurance industry and points out a key role of insurance companies in modern economy. Insurance companies nowadays are offering more services than traditional insurance, along with their expertise in risk management and investment valuation, insurers in recent years began offering cyber insurance. Cyber insurance provides both first-party loss and third-party liability coverage for data breach events, privacy violations, and cyber-attacks. This type of insurance coverage is new and still in development, however its application has grown is the past years. According to Fernandes (2014; Business Wire 2015, as cited in Talesh 2018, p. 419) "*one in three organizations has insurance specifically protecting against cyber and data theft losses*". Talesh (2018) concludes that institutionalized risk management techniques developed within the insurance sector can potentially improve organizational practices that reduce risk and losses. Therefore, insurance companies by offering risk management services with cyber insurance gain significant influence on the organization's data breach and privacy law response teams.

Although, it is recognized that insurance companies are subject to the paradigm of "the theory of the firm" (for valued acknowledgement and criticism of the theory see Coase (1995), Branch (1973), Machlup (1967), Cyert and Hedrick (1972) and Demsetz (1988)) with all its assumptions and drawbacks. Insurance companies are decision making units that are driven by profit maximization and cost minimization, which in insurance terms would mean premium maximization and claims paid minimization. However, a different point of view is provided through the lenses of the agency theory. Eisenhardt (1989, p. 72) argues that "a*gency theory provides a unique, realistic, and empirically testable perspective on problems of cooperative effort",* while author's advice is not to solely focus on one paradigm, for example, on agency theory since it presents a partial view of a more complex world. For economists it is important to understand that organizational research is in Eisenhardt's words a "*polygon of theories that yields a more realistic view of organizations"* Eisenhardt (1989, p. 71). Fields and Tirtiroglu (1991) address the conflicts in insurance industry from an agency theory standpoint. Agency theory deals with the management (and other stakeholders) decisions in retrospect to their goals. Therefore, it is easy to think of situations where agency problems arise (a conflict between decision management and decision control) between stockholders and management, employers and employees, clients, government etc. In the case of insurance, a major problem is of

residual risk. In other words, the risk that the random cash-flow (inflow) of resources (from insurance activities - premiums and investment returns) will differ from the promised (sometimes guaranteed and fixed) payments, i.e. compensations to agents (wages, investors, owners and life-insurance policyholders). The authors' main conclusion is that organizational forms (stock or mutual insurance companies) survive only if they can minimize costs and deliver the demanded output efficiently. Furthermore, after a brief introduction to the agency theory in economics, management and law, Shapiro (2005) provides a sociological perspective on the agency theory. The author concludes that the approach to the agency problem in economics is currently led by abstract mathematical models that oversimplify its complexity, providing (un)useful results in mitigating agency costs. Therefore, a sociological agency theory is a generalized social theory of relationships between agents (that act on problems) and principals (that guide and "control" the agent's behavior) in complex systems. Shapiro (2005) argues that the adverse selection and moral hazard are concepts that emerged in agency theory from the insurance business. Insurers constantly deal with agency problems in breaches of fiduciary duty or professional malpractice, and it is necessary to create products that solve these situations. A rather simple conclusion to the agency theory is that agency costs (costs of recruitment, adverse selection, preferences, incentives, moral hazard, shirking, staling, corruption, monitoring and controlling, etc.) to this day are unavoidable but can be managed and minimized (Shapiro 2005).

This paper is structured in the following Sections as follow: Section 2 presents a brief literature review on insurance companies' efficiency. Section 3 deals with the interconnectedness of insurance and risk. Section 4 describes the idiosyncrasies of the Croatian insurance sector and focuses on the effects of consolidation on the profitability of insurance companies. Section 5 describes the methodology and models. Section 6 presents and discusses the attained results from the models, while Section 7 is the conclusion.

2. LITERATURE REVIEW

Efficiency of insurance companies has been the topic of several empirical studies in the past two decades. For instance, Barros et al. (2014) study the determinants of efficiency and capacity issues in Angolan insurance companies. The results suggest that: "*efficiency is driven by cultural and relational aspects with their former metropolis rather than based on scale (market share)"* (Barros et al. 2014, p. 465). Furthermore, authors predict that Angolian insurance industry could partake in the process of consolidation (mergers and acquisitions activities) since most insurance companies are small and according to the results none of the observed insurance companies is fully efficient (operating on the frontier). Additionally, there is some empirical evidence that larger financial institutions - insurance companies can benefit from its size (increased efficiency and stability).

Similarly, Wanke and Barros (2016) study the efficiency drivers in Brazilian insurance industry in the period from 1995 until 2013. Results

corroborate the theory that the largest insurance companies are amongst the best in terms of efficiency. Furthermore, Eling and Luhnen (2010) study the efficiency of insurance companies on an international sample in the period from 2002 until 2006. The authors' main empirical findings are the general improvement in technical and cost efficiency of international insurance companies in the observed period, with large differences between countries. The results of this study are in line with other empirical research indicating that larger insurance companies are in general more efficient than medium and small companies. Finally, since authors employ both parametric (SFA) and non-parametric (DEA) methodologies, it is showed that there is very little difference in the results between the two methodologies. Borges et al. (2008) research the efficiency of the Greek life insurance industry in the period from 1994 until 2003 using DEA methodology. The author's results suggest that scale impacts efficiency and propose that the life insurance sector would increase its efficiency through consolidation. Furthermore, it is concluded that larger life insurance companies tend to be more efficient than small life insurance companies, as well as the quoted life insurance companies tend to have higher efficiency than the non-quoted companies. In conclusion, the authors corroborate the theory that life insurance companies involved in M&A activities tend to be more efficient than life insurance companies not involved in these activities.

Evidence on the effects of deregulation, consolidation and efficiency in the Spanish insurance industry is provided by Cummins and Rubio-Misas (2006). The authors study the causes and the effects of consolidation in the Spanish insurance industry in the period from 1989 until 1998. The results indicate that the number of firms in the Spanish insurance industry fell dramatically in the observed period (a decrease by 35%). Reasons for such a decline in insurance companies' numbers are primarily due to firm failures, insolvencies, and mergers and acquisitions (M&A). As a byproduct of consolidation, average firm size increased and general efficiency improved during the observed period. Furthermore, results show that larger insurance companies tend to be more cost efficient.

Cummins and Xie (2016) examine the efficiency and productivity of US property liability insurers using DEA methodology. The authors estimate pure technical, scale, cost, revenue and profit efficiency in the period from 1993 until 2011. The results indicate that the US property liability insurers improved its efficiency and productivity through the observed period. However, on average, the insurance industry operates with low cost and revenue efficiency. Contrary to other studies, authors find evidence that M&A activities from large insurers may not have a positive impact on efficiency. Furthermore, the authors suggest that the efficient use of capital tends to be an important driver of performance in the insurance industry, suggesting that efficient risk management could positively affect insurers cost efficiency. On a similar note, Cummins and Weiss (2010) examine the potential for U.S. insurance industry to cause systemic risk events that spill over to other segments of the economy. The authors conclude that the core activities of the U.S. insurers do not pose systemic risk. Insurers are in general smaller than banks in terms of assets. Therefore, they are not large enough to be systemically

important. Furthermore, even if interconnection is high inside the insurance industry, it is small between the insurance and banking industry, therefore not posing a systemic risk. However, the authors state that the non-core activities (trading in derivatives such as credit default swaps, asset lending, asset management and financial guarantees) of insurers do constitute a source of systemic risk.

Diacon (2001) explores the efficiency of UK general insurance businesses in comparison to five European countries (France, Germany, Italy, Netherlands and Switzerland) using DEA BCC model. The empirical results show that the largest and the smallest insurance companies according to their assets tend to be efficient, while medium companies seem to be less efficient. Furthermore, the second stage Tobit regression shows that efficiency is impacted by the concentration of investments in certain classes and that solvency positively affects efficiency in the Netherlands and UK (the relationship is negligent or negative in other observed countries). Finally, the author concludes that there is no evidence that risk and efficiency are positively related while on average, French and German insurers are more efficient than UK and other observed countries' insurance companies. On the other hand, Grmanová and Strunz (2017) study the relationship between technical efficiency and profitability of Slovakian insurance companies. The results from DEA CCR and BCC models and subsequent Tobit regression show that there is no statistically relevant relationship between technical efficiency and profitability (in values of ROA, ROE and total assets).

Fukuyama (1997) investigates the productive efficiency and productivity changes of Japanese life insurance companies. The author concludes that there is no difference in technology between mutual and stock insurance companies and that the major source of overall technical inefficiency is pure technical inefficiency for mutual insurance and scale efficiency for stock insurance companies. Finally, the total productivity growth was primarily due to technological progress during the times of expansion. Barros et al. (2005) observe the efficiency and productivity of insurance companies in Portugal. Using the Malmquist Index, the authors measure the total productivity of the Portuguese insurance sector. The authors conclude that European integration positively contributed to the efficiency scores, while Portuguese insurance companies improved its technical efficiency in the observed period, they suffered deterioration in terms of technological change that indicates poor use of inputs in retrospect to their market prices. Additionally, the authors conclude that increasing governance and transparency of insurance companies from state regulators and supervisors would yield increased efficiency of insurance companies in Portugal.

Eling and Schaper (2017) provide a more comprehensive study on the efficiency of European insurance companies. In the period from 2002 until 2013, the authors analyze the impact of regulations, capital market developments, and competition on productivity and efficiency of 970 life insurance companies from 14 European countries using DEA methodology. The results of this study confirm that there is a significant impact of the business environment on life insurer

efficiency. Diacon et al. (2002) focus on the efficiency of European specialist and composite long-term insurers in the period from 1996 until 1999 using DEA methodology. The authors, by estimating pure technical efficiency (profit maximization), scale efficiency (the effect of increasing or decreasing returns to scale) and mix efficiency (or allocative efficiency – the combination of inputs and outputs properly - ideally utilized) conclude that size is an important driver for technical efficiency for small and large insurance companies. Furthermore, the results indicate that increased solvency positively affects technical efficiency, while the opposite is true for scale efficiency. Finally, the authors conclude that there is no relationship between efficiency and liquidity and that insurers from the UK, Spain, Sweden and Denmark are likely to have, on average, the highest levels of technical efficiency.

Pavić Kramarić et al. (2018) research the impact of board diversity and size (the board of directors and the supervisory board) on the performance of insurance companies. The results of this empirical study showed that board gender diversity negatively affects financial performance, as well as, the size of the supervisory board and the board of directors. Furthermore, the authors conclude that problems with communication, coordination and decision-making arise as the number of directors' increases. Finally, it is found that larger insurance companies (by assets) have higher profit efficiency, presumably due to economies of scale and scope. Alipour (2012) studies the effect of intellectual capital on firm performance. Author's findings reveal that there is a significant positive relationship between human capital efficiency and profitability of Iran insurance companies, meaning that insurance company's employees are an important input in the insurance business since they enhance firm's performance. Therefore, the author concludes, that intellectual capital positively influences insurance company's performance measured in ROA values.

This section focused on empirical evidence on efficiency of insurance companies. In general, the results show that efficiency improved through time and that larger insurance companies are more efficient. The following section deals with the interconnectedness of insurance business and risk.

3. INSURANCE AND RISK

The interconnectedness of insurance and risk is well documented since insurance exists to transfer risk, and financially mitigate the unwanted outcomes for an agreed fee – premium[1]. As defined earlier, insurers receive premiums over

[1] In the insurance business, Written Premiums and Earned Premiums are distinguished. Written Premium is the sum of all premiums on all policies that a company has issued in some period of time, as opposed to "earned premiums" (Vaughan E.J. and Vaughan T.M., 2007, p. 720). Written Premium is reduced by premiums allocated to reinsurance companies, and increased by all reinsurance assumed. Earned Premium is the sum of all premiums for which protection has been provided. When a premium is paid in advance for a policy period, the company "earns" a portion of that premium only as time elapses during that period (Vaughan E.J. and Vaughan T.M., 2007, p. 705). For a more detailed explanation on Earned Premium see Vaughan E.J. and Vaughan T.M. (2007, p. 149).

time (in general monthly or yearly payments), while their major expenses are uncertain as well as of unknown amount, in the form of insurance claims in the near or far future. Performance of insurance companies is traditionally measured by simple and easy to use accounting ratios, often called financial indicators. The most popular are return on assets (ROA), return on equity (ROE) and return on investments (ROI). Furthermore, in insurance business it is useful to calculate the claims ratio, expense ratio and debt ratio (Jurčević, Mihelja Žaja 2013, p. 207).

Borde et al. (1994) focus on indicators of insurance company risk, where in their opinion, depending on management's activity, higher returns are related to higher risk (which is a common postulate in finance) or there is an inverse relationship between return and risk. Therefore, higher returns are the product of riskier investments, or in the case of superior operating performance (greater input optimization and resource allocation - lower operating costs - i.e. higher cost efficiency equals higher profits) authors state that there may be an inverse relationship between return and risk (Borde et al. 1994, p. 180). Their findings also conclude that leverage is positively related to the insurance company risk. In economic literature, solvency of insurance companies is often stressed as the most important risk that insurers need to manage. This conclusion comes from the current regulatory framework and capital requirements (Solvency II). The focus on solvency in retrospect to liquidity differentiates insurance companies from banks from a risk management standpoint.

Pentikäinen (1967, p. 237-238) describes two definitions of solvency, from the management's point of view, and from the supervising authorities' point of view. The management's point of view assumes that solvency at its core has the continuation of the function and existence of the company. On the other hand, the supervising authorities' point of view focuses on the security of benefits of the claimants and policyholders. Therefore, from these two perspectives of solvency, it is possible to conclude that the definition of solvency is to assure the existence and activity of the insurance company, as well as, the security of the benefits to the claimants and policyholders. Certainly, there are more accurate definitions of solvency; however, the proposed one incorporates the crucial role of solvency in insurance companies. Babbel and Merrill (2005, p. 5) state that: *"As the firm increases in insolvency risk beyond some moderate level, firm market value increases, and as it decreases in risk below that same moderate level, again there is an increase in firm value"*. Surprisingly, the authors clearly state the activities that insurers partook in to skew the regulatory requirements years before the financial crisis occurred, accurately predicting it. Since the paper was written two years before the financial and economic crisis, it is astonishing to see the author's accurate predictions on risk taking, risk exposure and risk management of insurance companies. Consequently, to the financial and economic crisis of 2007 the regulatory framework of financial institutions (mainly banks) was reworked and supplemented with greater capital requirements and a more prudent approach to financial institutions activities from regulators.

Acharya et al. (2009) state that the main focus of regulators was on the banking sector, disregarding the importance of the interconnectedness of the insurance companies. Authors rise an important note in the "agency theory" and "theory of the firm" (profit maximization) in the sense that the firm will strive to prevent its collapse, but will not necessarily do the same for the system. In Acharya et al. (2009, p. 11) words: "*While each individual firm is clearly motivated - or can be motivated by its stakeholders - to prevent its own collapse, each firm is unlikely to act to prevent a collapse of the system as a whole".* Furthermore, Acharya et al. (2009) state that American regulators are generally supportive of the widespread consolidation in insurance that was proceeding rapidly. The process of consolidation, as it will be shown in the following sections is still active on the Croatian insurance market, where there are just a handful of insurers that dominate the insurance market, by assets and by earned premiums.

Additionally, Schich (2010) studies the relationship between the insurance companies and the financial crisis. More accurately, the author discusses the vulnerabilities in the insurance sector and its role in the financial crisis. At the time of the financial crisis, American Investment Group (AIG) was the most prominent example to the importance of the stability of the insurance sector as well as the interconnectedness between the insurance and banking business. It is stressed that AIG, deemed by some observers as the world's largest insurance company, inadequately managed risks undertaken by credit default protection through derivatives, therefore being significantly exposed to future collateral calls or write-downs concluding in a government bailout. The fallout after the financial crisis demonstrated that insurance companies undertook riskier activities (credit default guarantees, derivatives investments) and that commercial banks become more similar to investment banks in their investment activities and operations. Furthermore, Schich (2010) concludes that the spillovers from institution's units conducting investment and similar activities have significantly affected the stability and survival of the whole insurance company, therefore it is necessary for the insurer to ensure prudence in future operations.

Kielholz (2000) defines the cost of capital for insurance companies as the expected returns to investors in the insurance company. The traditional and in economics widely used measure of cost of capital is the capital asset pricing model (CAPM), while another option would be using the discounted cash flow analysis. Furthermore, Kielholz (2000) stresses that it is necessary to incorporate a risk-based capital requirements and risk management activities (for example Value-at-Risk - VaR and dynamic financial models) in measuring the cost of capital in insurance companies, since this approach would allow for the allocation of capital to individual risks or risk types. Meyers and Read (2001) demonstrate that it is possible to efficiently allocate capital of insurance companies using option-pricing methods. In other words in defining the surplus required by the line of insurance. On the other hand, Gründl and Schmeiser (2007) argue that the approach for capital allocation in Meyers and Read (2001) is not ideal since there are no reasons for the allocation of equity capital according to the lines of business for the purpose of

pricing insurance contracts. Authors conclude that the central pitfall of capital allocation is the common cost of allocation "*because the equity capital of the insurer serves as safety capital for the whole company"* (Gründl and Schmeiser, 2007, p. 314). Bracket et al. (2005) study the efficiency of the marketing distribution channel and organizational structure for insurance companies using the financial intermediary approach and DEA RAM (Range Adjusted Measure) model. The authors conclude that stock companies are more efficient than mutual companies are, while agency marketing is more efficient than direct marketing. The following section deals with the Croatian insurance industry and its idiosyncrasies.

4. CROATIAN INSURANCE MARKET

Croatian insurance market is an important part of its financial market. In 2020 there were 15 insurance companies operating in Croatia. Classified by type, there were 8 composite insurance companies (that offer both life and non-life insurance, these companies are: Allianz Hrvatska d.d., Croatia osiguranje d.d., Generali osiguranje d.d., Grawe Hrvatska d.d., Merkur osiguranje d.d., Triglav osiguranje d. d., Uniqa osiguranje d.d., Wiener osiguranje Vienna Insurance Group d.d.), 4 non-life insurance companies (Adriatic osiguranje d.d., Euroherc osiguranje d.d., HOK-osiguranje d.d., Hrvatsko kreditno osiguranje d.d.), 3 life insurance companies (Adriatic osiguranje d.d., OTP Osiguranje d.d. (on September 7th 2021 changed its name to Groupama osiguranje d.d.)*, and Wüstenrot životno osiguranje d.d.)*, and zero reinsurance companies.

Life insurers provide insurance services regarding death of an insured person that pays yearly life insurance premiums or payed a lump sum premium upon contracting the insurance (in Croatia usually around 10,000 €). In the occurrence of death of an insured client, a contractually defined lump sum of money is paid, usually to the insurer's spouse, or in general its family. However, in retrospect to the non –life insurance that is the insurance of persons heath and assets (non-life insurance policies offer financial protection against healthcare costs, environmental damage and theft to homes, damages to cars, liability costs, travel, etc.) life insurance also provides an investment component in the case the insured person outlives the insured period (usually longer than 10 years) or decides to prematurely terminate the insurance contract. Yearly or one time lump sum life insurance premiums are invested by an investment fund with the goal of generating positive returns that will increase the cumulative premiums paid at the end of the insured period or the termination of the insurance contract. Insurance companies – investment funds, do not guarantee positive returns. However, to incite the demand for life insurance some insurers guarantied returns greater than markets average (see Kong and Singh, 2005). Therefore, it is necessary that potential life insurance clients keep in mind that they are to some degree exposed to investment and (particularly in Croatia) currency risk.

Compared to the situation in 2015 when there were 24 insurance companies (1 reinsurance, 8 composite, 9 non-life and 6 life insurance companies),

number of insurance companies in 2020 represent a decrease of 37,5%. Therefore, there is evidence that the Croatian insurance market consolidated in the observed period. The process of consolidation on the Croatian financial market, that is predominantly bank-centric, is present for the last two decades. Even if the number of insurance companies decreased in the observed period, total assets of insurance companies steadily increased, adding around HRK 10 billion in six years and nearing to HRK 50 billion in total assets (CFSSA, 2021).

Similarly, the decrease in the number of insurers did not negatively affect the insurance industry in Croatia. Insurance companies in 2019 recorded annual growth of 6.3% in total gross written premium (amounting to HRK 10.5 billion). The main contributor to the yearly growth was non-life insurance whose gross written premium rose by 10.3% and amounted to HRK 7.4 billion, while life-insurance decreased by 2.2%, totaling HRK 3.1 billion. Non-life insurance premium growth was achieved by the rise in credit insurance, consequently to banks intensified credit activity (attributing 47.2% to total non-life insurance gross premiums), comprehensive car insurance (18.6%) and health insurance (16.5%). Furthermore, claims settled amounted to HRK 6 billion in 2019, which was a 7.6% over year increase (CFSSA, 2020).

In spite of low interest rates that influence the profitability of insurance companies, both life and non-life insurance generated profits in 2019. Life insurance companies generated profit of HRK 205 million that is an annual growth of 11.9%. On the other hand, non-life insurance companies generated a profit of HRK 575.5 million (annual growth of 1.2%). Croatian insurance companies predominantly invest in government bonds (64.5% of insurance companies' total investments in 2019), followed by investments in property (7.9% of total investments), loan investments attribute to 6.8% of total investments, while investments in investment funds contribute to 4.9% of total investments (CFSSA, 2020).

Solvency of Croatian insurance companies remains high despite a significant decrease of the median solvency ratio in 2019. The decrease is a consequence of a decrease in reference interest rates that are used for discounting insurance companies' technical provisions and resulted in a significant raise of provisions. For all groups of insurers, the median solvency ratio of the insurance companies is still higher than the regulatory minimum (CFSSA, 2020). To authors' knowledge, there is just one study that examines efficiency of Croatian insurance companies. The study conducted by Jurčević and Mihelja Žaja (2013) addresses the efficiency of banks and insurance companies in Croatia in the period of financial crisis (2005-2010). Traditional performance measures are simple and easy to use ratios of accounting data, such as return on assets (ROA) and return on equity (ROE). Regarding the idiosyncratic activities of insurance companies, it is possible to use other financial indicators that focus insurance companies' to study their performance. Following Jurčević and Mihelja Žaja (2013), several financial indicators for insurance companies in the sample are calculated and presented.

Insurance companies' activities are primarily intangible services such as the intermediary function of the insurance business. Insurance companies are financial intermediaries that similar to bank deposits, pool premiums from policyholders and invest funds from premiums in financial assets. Furthermore, the invested funds are necessary for incurred claims that need to be paid to policyholders, as well as to fund withdrawals, predominantly from life insurance. However, financial intermediation is a secondary function to insurance companies in retrospect to their core functions of risk-pooling and risk-bearing services. Insurance companies provide a system through which policyholders that are exposed to potential losses can reduce its risk exposure through insurance and risk pooling. The insurer bears the risk for a fee and pools risk, diversifying it and reducing its exposure. Finally, insurance companies provide a slew of other services to policyholders that employ their expertise in cost reduction, risk management, financial planning, loss prevention and provision of legal defense in liability disputes.

Therefore, while observing the efficiency and performance of insurance companies it is necessary to take into account the specific activities that insurers conduct on the financial markets. As Jurčević and Mihelja Žaja (2013, p. 207) point out, when supervising the operations of insurance companies, it is possible to use the following financial indicators: claims ratio, expense ratio, combined ratio and return on investment (ROI). As stated before, the claims are paid from the premiums earned. Therefore, it is useful to monitor the relationship between these two variables. Claims ratio is calculated as a ratio between claims paid and net premiums earned, describing the percentage of premiums needed to cover the claims incurred. Therefore, it is beneficial for an insurer to have a smaller ratio, meaning that premiums earned are higher in value than claims incurred. Furthermore, expense ratio is calculated as a ratio between operating expenses and gross written premiums, describing the percentage of gross written premiums to cover operating expenses. It is necessary that the variables are at least equal, but the usual values for insurance companies vary from 20% to 30% (Jurčević and Mihelja Žaja 2013). Combined ratio is the sum of the before mentioned claims and expense ratios and provides information on the profitability of operations prior the inclusion of income from investments. Return on investment is a widely used financial indicator in corporate finance since its ratio net returns from investments over the investment sum. For investors ROI is crucial for effective decision making. The lower the invested funds, and the higher the returns from these investments are the higher the ROI values will be, which indicates higher profitability. Investments are an important part of the insurance business (premiums paid from policyholders are invested mainly in securities with fixed returns) allowing for more affordable insurance policies, as well as, more room for larger than predicted claims to be paid.

In Croatia, as stated before, insurance companies predominantly invest in government securities. According to Kong and Singh (2005) the insurance companies in emerging markets are limited in investing long-term and are crippled

by shallow domestic capital markets that produce severe asset and liability mismatches. This can furthermore hinder insurance companies' portfolio diversification and efficient asset allocation. Kong and Singh (2005, p. 6) state that in general, "*insurers invest in local securities and try to extend the duration as much as possible in the local market, providing support to the development and stability of the emerging market securities markets*". Insurers are in general "buy and hold" investors. Guaranteed minimum returns may put pressure from the liability side of the business, therefore, authors' state that few countries, Thailand, Croatia, and Korea reportedly have guaranteed returns higher than the market rate. Traditionally, the performance of insurance companies is measured using financial indicators (as already mentioned in some studies presented earlier) such as return on investment (ROI), and return on equity (ROE) and assets (ROA) measured as the ratio between profit after taxes and equity (ROE) or assets in case of ROA. Furthermore, as stated before, it is specifically useful for insurance companies to calculate the claims ratio, expense ratio, combined ratio, and the debt ratio. The mentioned financial indicators period averages are calculated and presented in the following Table 1.

Table 1

Financial indicators averages of Croatian insurance companies 2015 – 2020

Insurance companies	Claims ratio	Expense ratio	Combined ratio	Debt ratio	ROI	ROE	ROA
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	40.24%	46.16%	86.40%	53.06%	4.11%	5.67%	2.66%
AGRAM LIFE OSIGURANJE D.D.	71.71%	22.12%	93.83%	75.06%	4.78%	4.13%	1.03%
ALLIANZ HRVATSKA D.D.*	57.39%	29.61%	87.00%	80.52%	4.47%	9.79%	1.90%
CROATIA OSIGURANJE D.D.*	51.96%	33.04%	85.00%	73.26%	5.93%	5.99%	1.67%
EUROHERC OSIGURANJE D.D.*	41.48%	45.68%	87.16%	58.82%	4.51%	8.50%	3.49%
GENERALI OSIGURANJE D.D.	42.46%	31.58%	74.03%	87.43%	4.24%	3.60%	0.44%
GRAWE HRVATSKA D.D. *	80.71%	32.16%	112.87%	80.74%	5.04%	5.51%	1.00%
HOK - OSIGURANJE D.D.	52.35%	39.10%	91.45%	75.15%	4.29%	9.61%	2.39%
HRVATSKO KREDITNO OSIGURANJE D.D.	30.95%	49.41%	80.36%	37.39%	3.73%	1.24%	0.77%
MERKUR OSIGURANJE D.D.	69.68%	26.09%	95.77%	87.10%	3.84%	6.49%	0.82%
OTP OSIGURANJE D.D.	30.34%	58.74%	89.08%	63.77%	4.42%	6.26%	2.29%
TRIGLAV OSIGURANJE D. D.	59.03%	36.53%	95.56%	81.29%	5.75%	-3.69%	-0.65%
UNIQA OSIGURANJE D.D.*	106.41%	35.29%	141.70%	84.61%	5.00%	5.73%	0.86%
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.*	58.52%	31.65%	90.17%	83.48%	5.73%	5.23%	0.86%
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	12.00%	57.05%	69.05%	70.08%	3.85%	-5.27%	-1.91%
Average	53.68%	38.28%	91.96%	72.78%	4.65%	4.59%	1.18%
Standard deviation	22.24%	10.53%	16.45%	13.68%	0.69%	4.15%	1.29%

*Source: author's calculations using financial statements data; * denotes 6 largest insurance companies by total assets*

Higher levels of profitability indicators, such as ROI, ROE and ROA indicate higher profit efficiency, indicating profit maximization activities of insurance companies. These indicators will be higher as investment income is higher (total investments being equal), or in case of ROE and ROA, when higher profit is achieved while using a defined amount of equity or total assets. From Table 1 it is visible that larger (by assets) insurance companies (denoted with * in the table) achieve above average profitability results. In this paper, large insurance companies are categorized as insurance companies with total assets over HRK 3 billion, medium are between HRK 3 and 1 billion, and small are below HRK 1 billon (for more information see Table A in the Attachment). For example, Croatia osiguranje d.d. as the largest insurance company attains above average results, as well as, the largest ROE values, presumably due to scale. On the other hand, higher levels of claim, expense and debt ratio indicate lower efficiency since higher claims will decrease profit, as well as, higher operating expenses, while higher debt ratio indicates questionable financial stability of the insurance company (traditionally debt ratio under 50% is acceptable, however average debt ratio of insurance companies is 72.78%). Therefore, the ratios mentioned can be regarded as an indicator of cost minimization activities of insurance companies, since diminishing claims incurred, operating costs and total liabilities will decrease the ratios, increasing the efficiency of insurance companies. Similarly to the performance indicators, larger insurance companies (such as Croatia osiguranje d.d.) achieve below average levels of claims, expense and debt ratio.

5. DATA AND METHODOLOGY

Additionally to the financial indicators as estimates of efficiency there are several other methods to estimate the efficiency of insurance companies. Firstly, it is possible to use econometric models in efficiency estimation (such as Stochastic Frontier Approach that is predominantly used) that require the specification of the production function, adequate sample size, and assumptions on distributions. Secondly, it is possible to use non-parametric methods such as DEA (Data Envelopment Analysis) that is a linear programming method that benchmarks the DMU's (decision making units) regarding their distance to the efficiency frontier. DEA methodology is used in this paper for several reasons. Firstly, the number of insurance companies (non-life, life, and mixed) on the Croatian market is small, as already mentioned only 15 insurance companies operate in Croatia. Therefore, the sample is too small to be used directly in econometric models. Secondly, by using DEA methodology the results in this study are comparable to the results provided by Jurčević and Mihelja Žaja (2013) that also focus on efficiency of Croatian insurance companies during the financial and economic crisis (2005-2010).

However, DEA methodology is not without its own limitations, such as not addressing statistical noise. Furthermore, a consensus in the existing literature is that the total number of input and output variables should not exceed 1/3 of the number of DMU's. Two most popular DEA models are the CCR model (named

after Charnes, Cooper, and Rhodes (1978)) that assumes constant returns to scale (CRS) and the BCC model (named after Banker, Charnes and Cooper (1984)) that assumes variable returns to scale (VRS). In this paper, the CCR and BCC input oriented models are used on two different combinations of input and output variables in the period from 2015 until 2020. The choice of input and output variables is crucial and can greatly affect efficiency results. Usually, for a common business that produces physical products, the choice of input and output variables is straightforward as the inputs in general would be capital and labor used in the production of the outputs i.e. the products that business offers on the market. This approach is similar to the Cobb-Douglas production function used in econometrics. However, the definition of input and output variables for businesses that offer services is more complex. Furthermore, banks and insurance companies offer financial services where the definition of inputs and outputs is even more blurred. For example, deposits from banks' clients are at the core of the banking business, but it is debatable whether deposits should be deemed as inputs or outputs of the banking process.

Similarly, defining the inputs and outputs of the insurance business is also challenging. On one hand, it is possible to define the inputs and outputs of the insurance companies in retrospect to its operations. On the other hand, it is possible to define the input and output variables of insurance companies traditionally as a combination of capital and other inputs in the production of financial services, with the focus on the intermediation aspect of insurance companies. Regarding the operating approach, it is possible to define the operating costs (include the cost of labor and other costs), investment costs and claims incurred as inputs, and earned premiums and investment income as outputs. It can be argued that the choice of operating costs is more accurate than using wages or the number of employees since the insurance industry's affinity to outsource some of its operations.

Furthermore, as discussed above, insurance companies are financial intermediaries since they invest the accumulated premiums from sold insurance policies and therefore are deemed institutional investors. Therefore, it is reasonable to deem investment costs as another input variable of the insurance business. Finally, the last input variable tied to the insurance business is claims incurred. Although the inclusion of this variable is debatable, it certainly is a part of the insurance business. On one hand, it is difficult to rationalize the use of this variable as an output (even though there are some studies that incorporate it as such, see Borges et al. (2008)) since insurance companies do not strive for the maximization of claims paid. The consequence of a drastic increase of claims (for example after an environmental catastrophe) will negatively affect the financial stability of insurance companies but if this variable is used as an output, its increase will result in increased efficiency, which in this situation should not be the case. Therefore, it is easier to rationalize claims incurred as an input variable since insurers tend to minimize claims paid. On the other hand, it can be argued that claims incurred are an unwanted byproduct of the insurance business, since the best scenario for an insurance company is that the event in which the claim is to be paid to the insurance

policyholder never occurs in the first place, while the insurer receives monthly or yearly premiums. Nonetheless, this argument solidifies the rationale that insurers minimize claims payments to policyholders, and can be used as inputs of the insurance business in the same sense as operational and investment costs are used.

Furthermore, regarding the intermediation approach, it is possible to use total capital as an input variable as well as total investments since they represent the majority of insurance companies' total assets, while the outputs would be the same for the operating approach – earned premiums (received from insurance policies) and investment income as a product of total investments. Finally, it is questionable whether technical reserves (the reserves needed for potential claims to insurance policyholders and other risks and losses) should be included as an input or output variable. Similar to the claims incurred variable, it is debatable whether technical reserves are an acceptable variable. Technical reserves are not maximized but minimized by the insurer. Therefore, the reserves most certainly should not be taken into account as an output variable. On the other hand, there is some rationale that the reserves should be taken into account as an input variable since they are required for the operation of insurance companies. Whether this argument is acceptable for the use of technical reserves as an input variable remains to be seen in future studies.

The data used in input and output variables was acquired from the end-of-year financial statements of Croatian insurance companies. The first model (operating approach) follows the input/output combination from Jurčević and Mihelja Žaja (2013) that uses information available from insurance companies' income statements. The use of the same combination of input and output variables allows for a direct comparison of the attained results in this study to the results provided by Jurčević and Mihelja Žaja (2013) since in both cases the efficiency of Croatian insurance companies is estimated. On the other hand, the second model (intermediation approach) uses information from insurance companies' balance sheets for inputs, and income statements for outputs, that are the same as in the operating approach.

For the operating approach that, as already mentioned follows from Jurčević and Mihelja Žaja (2013) input variables are (denoted as x_{ij} for every input i=1,…, 3, and j=1,..., n; n=15 denotes each of 15 insurance companies):

- Input 1 (x_{ij}) - operating costs
- Input 2 (x_{ij}) - investment costs
- Input 3 (x_{ij}) - claims incurred

The output variables for the operating approach are (denoted as y_{ij} for every output i=1,…, 2 and j=1,..., n; n=15 denotes each of 15 insurance companies):

- Output 1 (y_{ij}) - earned premiums
- Output 2 (y_{ij}) - investment income

For the intermediation approach input variables are (denoted as x_{ij} for every input i=1,…, 2, and j=1,…, n; n=15 denotes each of 15 insurance companies):

- Input 1 (x_{ij}) - total equity
- Input 2 (x_{ij}) - total investments

The output variables for the intermediation approach are the same as for the operating approach (denoted as y_{ij} for every output i=1,…,2 and j=1,..., n; n=15 denotes each of 15 insurance companies):

- Output 1 (y_{ij}) - earned premiums
- Output 2 (y_{ij}) - investment income

The following table presents the summary statistics for the mentioned input and output variables of the sample in the observed period from 2015 until 2020.

Table 2

Summary statistics of the sample variables (2015 – 2020)

Intermediation approach	**Min**	**Max**	**Average**	**Standard deviation**	**Coefficient of variation**
Total capital	34,097,623	3,533,839,709	648,093,059	699,201,417	1.08
Total investments	43,951,258	8,519,379,020	2,174,801,540	1,932,527,756	0.89
Operating approach	**Min**	**Max**	**Average**	**Standard deviation**	**Coefficient of variation**
Operating expenses	5,087,618	916,367,430	211,252,349	212,918,258	1.01
Investment costs	0	1,229,460,040	42,849,978	134,488,845	3.14
Claims incurred	674,636	1,616,354,746	301,761,301	327,436,805	1.09
Common variables (outputs)	**Min**	**Max**	**Average**	**Standard deviation**	**Coefficient of variation**
Earned premiums	5,681,367	2,498,885,575	533,055,461	560,458,142	1.05
Investment income	1,397,799	594,031,433	108,058,359	111,944,360	1.04

Source: author's calculations, using financial statements data, all values in HKR

The DEA model is a non-parametric method used in efficiency estimation that takes the form of a programming problem. The efficiency results are obtained as the ratio of weighted outputs to weighted inputs for each DMU as shown in (1) to (4). It is necessary to obtain values for the input "weights" (v_i) where i = 1,…, m and the output "weights" (u_r) where r = 1,…, s.

$$\max_{u,v} \theta\,(u, v) = \frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \quad (1)$$

subject to

$$\frac{u_1 y_{1j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \text{ where } j = 1, \ldots, n \quad (2)$$

$$u_r \geq 0, \text{ r} = 1, \ldots, \text{s} \quad (3)$$

$$v_i \geq 0, \text{ i} = 1, \ldots, \text{m} \quad (4)$$

The fractional programming model from (1) to (4) has an infinite number of solutions. If some (u^*, v^*) is optimal, than for each positive scalar c, (cu^*, cv^*) is also optimal. Using the transformation in (5) it is possible to select a representative solution (u, v) for which we define the weighted sum of input variables equal to 1.

$$\sum_{i=1}^{m} v_i \, x_{i0} = 1 \tag{5}$$

The optimal solution from (5) simplifies the fractional programming problem from (1) to (4) into a linear programming problem for each DMU. The CCR model now can be written as:

$$\max_{u,v} z_0 = \mu_1 y_{1o} + \cdots + \mu_s y_{so} = \sum_{r=1}^{s} \mu_r y_{r0} \tag{6}$$

subject to

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i \, x_{ij} \leq 0, j = 1, \dots, n \tag{7}$$

$$\sum_{i=1}^{m} v_i \, x_{i0} = 1 \tag{8}$$

$$\mu_r \geq 0, \mathrm{r} = 1, \dots, \mathrm{s} \tag{9}$$

$$v_i \geq 0, \mathrm{i} = 1, \dots, \mathrm{m} \tag{10}$$

The dual of the linear programming problem (6) to (10) for each DMU can be written as:

$$\min_{\lambda} z_0 = \Theta_0 \tag{11}$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \tag{12}$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j \, x_{ij} \geq 0, i = 1, \dots, m \tag{13}$$

$$\lambda_j \geq 0, \mathrm{j} = 1, \dots, \mathrm{n} \tag{14}$$

where θ_0 is a scalar and its value denotes the efficiency score for the i-th DMU, and λ_j is a Nx1vector of constants.

On the other hand, Banker, Charnes, Cooper (1984) develop a model that allows variable returns to scale (VRS) by adding a convexity condition for λ_j in the model (11) to (14). The convexity condition is achieved by setting the sum of components of the vector λ_j to one. This gives us the following model:

$$\min_{\lambda} z_0 = \Theta_0 \tag{15}$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \tag{16}$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0, i = 1, \ldots, m \quad (17)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \quad (18)$$

$$\lambda_j \geq 0, \mathrm{j} = 1, \ldots, \mathrm{n} \quad (19)$$

The model (15) to (19) is now called the input oriented BCC model. Contrary to the CCR model, it provides information on pure technical efficiency since it allows for variable returns to scale (VRS). In this paper input orientated CCR and BCC models are used since in authors' opinion, output quantiles are in a sense fixed (insurers do not have control over them and cannot easily affect the demand). As stated by Barros et al. (2014, p. 492) the orientation should be selected according to the type of quantities (inputs or outputs) decision makers have most control over, and in author's opinion on the Croatian insurance market, insurers have more control over the inputs than they have over the outputs.

6. RESULTS AND DISCUSSION

Following the methodology explained in this study and the approaches used (combinations of input and output variables), which only differ in the combination of inputs, the efficiency of insurance companies is calculated. In addition to the financial indicators presented in Section 4 the efficiency results using DEA are calculated with the goal of comparison between financial indicators and efficiency estimates. The following tables present the efficiency results for the operating approach. Table 3 presents the efficiency results for the input oriented operating approach CCR model that assumes constant returns to scale. Similar to the results from Table 1 (financial indicators) the largest insurance company Croatia osiguranje d.d. is on the frontier, i.e. fully efficient, throughout the observed period (this can be observed in Table 3 where Croatia osiguranje d.d. achieves full efficiency (100%) meaning that with the given inputs and outputs there is no other insurer that achieves higher levels of productivity, therefore Croatia osiguranje d.d. is operating on the efficiency frontier throughout the observed period despite the change in the values of the input and output variables). However, other large insurance companies show mixed results. Second largest insurer Allianz Hrvatska d.d. showed above average efficiency and steady improvements in the observed period, being fully efficient in 2019. The same can be said for Grawe Hrvatska d.d. the fourth largest insurance company in Croatia. Additionally, small insurers (Hrvatsko kreditno osiguranje d.d., Wüstenrot životno osiguranje d.d.) and some medium insurers (Agram life osiguranje d.d. and Merkur osiguranje d.d.) are also efficient. Comparing efficiency results by type of insurance, life insurers in general achieve near full efficiency (only OTP

Osiguranje d.d. achieves below average efficiency), non-life insurers in general achieve below average efficiency, while there are mixed results for composite insurers.

Table 3

Efficiency of Croatian insurance companies from 2015 until 2020 – operating approach (CCR model)

Insurance company	2015	2016	2017	2018	2019	2020	Period average
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	46.03%	58.58%	48.69%	78.42%	75.36%	88.45%	65.92%
AGRAM LIFE OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
ALLIANZ HRVATSKA D.D.*	61.74%	78.64%	73.87%	89.26%	100.00%	91.34%	82.48%
CROATIA OSIGURANJE D.D.*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
EUROHERC OSIGURANJE D.D.*	47.09%	63.69%	47.57%	82.01%	77.91%	87.45%	67.62%
GENERALI OSIGURANJE D.D.	59.89%	77.40%	62.94%	100.00%	86.41%	73.93%	76.76%
GRAWE HRVATSKA D.D.*	80.70%	100.00%	94.96%	83.98%	93.07%	80.91%	88.94%
HOK - OSIGURANJE D.D.	80.65%	76.21%	80.31%	84.13%	90.08%	85.95%	82.89%
HRVATSKO KREDITNO OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
MERKUR OSIGURANJE D.D.	100.00%	100.00%	85.41%	100.00%	100.00%	100.00%	97.57%
OTP OSIGURANJE D.D.	85.86%	74.19%	78.55%	90.35%	93.40%	68.19%	81.76%
TRIGLAV OSIGURANJE D. D.	44.41%	54.88%	52.16%	66.40%	78.61%	84.51%	63.50%
UNIQA OSIGURANJE D.D.*	61.70%	57.79%	47.54%	53.83%	61.79%	59.60%	57.04%
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.*	60.73%	83.53%	100.00%	77.77%	87.95%	85.29%	82.55%
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	100.00%	100.00%	98.72%	100.00%	100.00%	100,00%	99.79%
Average	75.25%	81.66%	78.05%	87.08%	89.64%	87.04%	83.12%
Standard deviation	21.05%	16.89%	20.56%	13.55%	11.32%	12.08%	14.19%

*Source: author's calculations using financial statements data; * denotes 6 largest insurance companies by total assets*

Table 4 presents the efficiency results for the input oriented operating approach BCC model that assumes variable returns to scale (VRS). The results are by nature of the model, higher in contrast to the CCR model but the conclusions are quite similar. Croatia osiguranje d.d. is fully efficient in the observed period. Furthermore, other larger insurance companies improved to full efficiency in 2019 or in 2020 (Allianz Hrvatska d.d., Euroherc osiguranje d.d., Grawe Hrvatska d.d., Weiner osiguranje Vienna Insurance Group d.d.) with one exception of Uniqa osiguranje d.d. Identically to the CCR model, some small insurers (Hrvatsko kreditno osiguranje d.d. and Wüstenrot životno osiguranje d.d.) and some medium insurers (Agram life osiguranje d.d. and Merkur osiguranje d.d.) are fully efficient in the observed period. Observing insurers by type, the same conclusions can be drawn as for the CCR model. Life insurers tend to be fully efficient (except to OTP

Osiguranje d.d.), non-life insurers are in general inefficient (below average efficiency), and composite insurers have mixed results.

Table 4

Efficiency of Croatian insurance companies from 2015 until 2020 – operating approach (BCC model)

Insurance company	2015	2016	2017	2018	2019	2020	Period average
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	46.56%	93.72%	61.99%	79.66%	94.74%	100.00%	79.45%
AGRAM LIFE OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
ALLIANZ HRVATSKA D.D.*	61.83%	100.00%	100.00%	100.00%	100.00%	93.90%	92.62%
CROATIA OSIGURANJE D.D.*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
EUROHERC OSIGURANJE D.D.*	47.37%	99.06%	87.73%	95.02%	92.61%	100.00%	86.97%
GENERALI OSIGURANJE D.D.	60.77%	100.00%	69.63%	100.00%	100.00%	82.70%	85.52%
GRAWE HRVATSKA D.D.*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
HOK - OSIGURANJE D.D.	81.14%	79.26%	82.00%	86.37%	90.69%	90.25%	84.95%
HRVATSKO KREDITNO OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
MERKUR OSIGURANJE D.D.	100.00%	100.00%	86.68%	100.00%	100.00%	100.00%	97.78%
OTP OSIGURANJE D.D.	87.27%	74.36%	79.09%	92.43%	97.19%	70.68%	83.50%
TRIGLAV OSIGURANJE D. D.	45.44%	71.00%	52.56%	67.07%	81.81%	90.19%	68.01%
UNIQA OSIGURANJE D.D.*	72.98%	62.96%	47.65%	63.48%	67.00%	59.88%	62.33%
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.*	75.30%	91.28%	100.00%	89.61%	93.28%	96.37%	90.97%
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	78.58%	91.44%	84.49%	91.58%	94.49%	92.26%	88.81%
Standard deviation	20.93%	12.43%	17.96%	11.95%	8.89%	11.87%	11.56%

*Source: author's calculations using financial statements data; * denotes 6 largest insurance companies by total assets*

From Tables 3 and 4 it is possible to arrive to the following conclusions. Firstly, in general, the efficiency of insurance companies improved in the observed period. Secondly, larger insurance companies in general tend to have above average efficiency. Comparing the efficiency results from Tables 3 and 4 to Table 1 (financial indicators); it is possible to conclude that in general, larger insurance companies achieve above average or full efficiency, and higher profitability indicators and lower claims, expense and debt ratios. Additionally, it is possible to conclude that size matters in efficiency of insurance companies (supposedly due to the benefits of scale) since the largest insurance company is efficient throughout the observed period.

One exception among large insurers is Uniqa osiguranje d.d. whose efficiency did not improve in the observed period. One explanation is that Uniqa

osiguranje d.d. is closer to a medium insurance company than to the largest insurance company (the difference in total assets is over HRK 7.5 billion). The difference in assets between the largest insurer (Croatia osiguiranje d.d.) and the second largest insurer (Allianz Hrvatska d.d.) is over HRK 5 billion (Croatia osiguranje d.d. is by assets two times larger than Allianz Hrvatska d.d.). Therefore, the results indicate that through the process of M&A (i.e. financial consolidation of the Croatian insurance market) some efficiency gains could be achieved for medium and large insurers that are currently inefficient. Finally, it is concluded that extremely large and extremely small insurance companies are efficient using the proposed operating approach, regardless of the constant or variable returns to scale, while medium insurance companies have mixed results (similar conclusions are brought up by Jermic and Vujčić (2002) in banking).

Furthermore, to address whether a different combination of input variables (in this case from balance sheet data) can affect efficiency results the intermediation approach is calculated. Tables 5 and 6 present the results for the CCR and BBC model using the intermediation approach that uses total equity and total investments as inputs to the insurance process, while the output variables remain the same as for the operating approach. The results from the CCR model are presented in the following Table 5. It is visible in Table 5 that the intermediation approach produces lower efficiency scores in comparison to the operating approach. Furthermore, it seems that this approach discriminates against larger, and in some cases smaller insurance companies, since the attained results show the below average efficiency. The largest insurance company is efficient only in 2017 and 2018 while the rest of the observed period attains below average efficiency.

Table 5

Efficiency of Croatian insurance companies from 2015 until 2020 – intermediation approach (CCR model)

Insurance company	2015	2016	2017	2018	2019	2020	Period average
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	48.71%	63.39%	57.22%	65.49%	52.37%	67.03%	59.04%
AGRAM LIFE OSIGURANJE D.D.	68.86%	59.95%	59.75%	94.48%	68.20%	91.83%	73.85%
ALLIANZ HRVATSKA D.D.*	76.72%	73.32%	71.10%	85.35%	68.52%	74.34%	74.89%
CROATIA OSIGURANJE D.D.*	69.99%	81.21%	100.00%	100.00%	62.41%	77.24%	81.81%
EUROHERC OSIGURANJE D.D.*	51.73%	67.53%	57.98%	74.75%	59.79%	71.70%	63.91%
GENERALI OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	66.41%	85.26%	91.95%
GRAWE HRVATSKA D.D.*	100.00%	94.83%	89.56%	84.95%	63.57%	87.50%	86.74%
HOK - OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
HRVATSKO KREDITNO OSIGURANJE D.D.	49.02%	63.56%	46.83%	49.40%	40.55%	75.38%	54.12%
MERKUR OSIGURANJE D.D.	74.19%	86.08%	77.32%	100.00%	68.36%	95.66%	83.60%
OTP OSIGURANJE D.D.	62.39%	74.89%	64.39%	61.99%	46.80%	55.82%	61.05%
TRIGLAV OSIGURANJE D. D.	100.00%	94.66%	100.00%	84.12%	100.00%	99.03%	96.30%
UNIQA OSIGURANJE D.D.*	95.74%	87.24%	83.44%	100.00%	80.42%	84.09%	88.49%
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.*	98.39%	100.00%	100.00%	99.98%	70.35%	100.00%	94.79%
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	56.37%	73.83%	70.10%	79.07%	65.06%	87.81%	72.04%
Average	76.81%	81.37%	78.51%	85.31%	67.52%	83.51%	78.84%
Standard deviation	19.85%	13.93%	18.28%	15.82%	15.88%	12.67%	14.13%

*Source: author's calculations using financial statements data; * denotes 6 largest insurance companies by total assets*

On the other hand, it seems that the intermediation approach (or this combination of variables) favors medium (Generali osiguranje d.d.) and small (HKO osiguranje d.d.) insurance companies. One possible rationale for the obtained results is that larger insurance companies will amass substantial investments and equity, which in the intermediation approach are the input variables and are minimized. Therefore, the results indicate that the medium insurance companies (and some small) attain an optimal amount of total investments and equity. Finally, it can be observed that the volatility of the attained results is much greater than in the case of the operating approach. Table 6 presents the efficiency results for the BCC model that assumes variable returns to scale for the intermediation approach.

Table 6

Efficiency of Croatian insurance companies from 2015 until 2020 – intermediation approach (BCC model)

Insurance company	2015	2016	2017	2018	2019	2020	Period average
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	69.59%	74.21%	77.34%	73.62%	79.12%	89.40%	77.21%
AGRAM LIFE OSIGURANJE D.D.	70.48%	60.82%	61.45%	94.73%	83.47%	92.46%	77.24%
ALLIANZ HRVATSKA D.D.*	99.54%	88.26%	90.88%	86.34%	100.00%	90.90%	92.65%
CROATIA OSIGURANJE D.D.*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
EUROHERC OSIGURANJE D.D.*	77.00%	82.41%	86.89%	84.99%	100.00%	100.00%	88.55%
GENERALI OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	86.36%	85.28%	95.27%
GRAWE HRVATSKA D.D.*	100.00%	100.00%	89.81%	85.77%	85.07%	87.64%	91.38%
HOK - OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
HRVATSKO KREDITNO OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
MERKUR OSIGURANJE D.D.	75.01%	87.89%	78.87%	100.00%	76.22%	96.45%	85.74%
OTP OSIGURANJE D.D.	97.65%	100.00%	87.29%	76.02%	77.47%	78.72%	86.19%
TRIGLAV OSIGURANJE D. D.	100.00%	100.00%	100.00%	97.49%	100.00%	100.00%	99.58%
UNIQA OSIGURANJE D.D.*	100.00%	87.40%	83.65%	100.00%	100.00%	84.74%	92.63%
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.*	99.19%	100.00%	100.00%	100.00%	96.29%	100.00%	99.25%
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	92.56%	92.07%	90.41%	93.26%	92.27%	93.71%	92.38%
Standard deviation	11.91%	11.57%	11.12%	9.09%	9.34%	6.95%	7.73%

*Source: author's calculations using financial statements data; * denotes 6 largest insurance companies by total assets*

The attained results depict a different story in retrospect to the intermediation CCR model. By allowing variable returns to scale, large insurance companies (that certainly have scale benefits) achieve above average efficiency scores. The conclusion is similar to the conclusions for the operating approach. In general, large insurance companies are fully efficient or achieve above average efficiency in the observed period. Furthermore, the same conclusions can be made for small insurers, while medium insurers in general achieve the below average efficiency results. The comparison of the efficiency results by type for the intermediation approach shows that life insurers are in general below the average efficient, the same can be said for non-life insurers, while composite insurers are leaning to be above the average efficient.

Furthermore, three life insurance companies are excluded from the sample (Agram Life osiguranje d.d., OTP osiguranje d.d., and Wüstenrot životno osiguranje d.d.) and efficiency was estimated for the remaining 12 insurers (both non-life and composite) using both the operating and intermediation approaches as

well as the CCR and BCC models. For brevity sake, the results are not presented in this paper and are available upon request. Efficiency results excluding life insurance companies give similar conclusions as before, larger insurers (especially the three largest: Croatia osiguranje d.d. Allianz Hrvatska d.d., and Wiener osiguranje Vienna Insurance Group d.d.) tend to achieve the above average or full efficiency, the same can be said for small insurance companies (HOK osiguranje d.d. and Hrvatsko kreditno osiguranje d.d.) while medium insurers achieve mixed results.

These findings are in line with several studies mentioned earlier. For example, Borges et al (2008) and Diacon (2001), Wanke and Barros (2016), Diacon et al (2002) conclude that larger insurance companies tend to be more efficient. Furthermore, Cummins and Rubio-Misas (2006), Eling and Schaper (2017) report improvement in efficiency in the observed period. In comparison to the study provided by Jurčević and Mihelja Žaja (2013) the attained results also show high average efficiency levels regardless of the approach and to the returns to scale. Jurčević and Mihelja Žaja (2013) report average efficiency of insurance companies in the observed period (2005-2010) of 83.3% for the CCR model, and 93.4% for the BBC model, while our results are at 83.12% (CCR) and 88.81% (BCC) in the observed period (2015-2020). On the other hand, financial indicators in comparison to Jurčević and Mihelja Žaja (2013) improved, most probably due to economic recovery after the economic crisis in the observed period in this study.

7. CONCLUSION

Efficiency estimation of financial institutions such as banks and insurance companies is complex since difficulties arise in the categorization of input and output variables of the banking and insurance business. However, efficiency estimation of financial institutions is necessary because of the role they have in modern economy. Even though banks are by far the most important financial institutions that through financial intermediation affect the economic growth and development of a country, insurance companies also have an important role in the financial market that take form of the activities of risk polling and risk diversification. Furthermore, as institutional investors, insurers similarly to banks, participate in intermediary activities on the financial market. Therefore, it is necessary that insurance companies operate efficiently.

The main goal of this article was the estimation of efficiency in Croatian insurance companies. Efficiency was estimated using a number of financial indicators and non-parametric DEA methodology on a sample of 15 insurance companies in the period from 2015 until 2020. Throughout the observed period, a consolidation process of the Croatian insurance industry took place, reducing the number of insurers from 24 to 15. Our findings show that large insurers on the Croatian insurance market achieve above average or full efficiency using the operating approach DEA CCR or BCC models. However, using the intermediation approach proposed in this paper, while implementing constant returns to scale (CCR model) the results show that medium sized insurance companies are more

efficient. Finally, a comparison of the efficiency estimates to the financial indicators (ROI, ROE, ROA and claims, expense and debt ratios) shows that larger insurers achieve higher efficiency levels as well as higher ROI, ROE, ROA indicators, and below average claims, expense and debt ratios. Therefore, it can be concluded that larger insurance companies (and some small) are more efficient than the medium insurance companies.

Furthermore, it is necessary to address some empirical limitations of this study. The study was conducted on a sample of just 15 insurance companies that represent the Croatian insurance market on a relatively short period (2015-2020). Addressing the methodological limitations, DEA methodology enables efficiency estimation on smaller samples (bounded that the number of DMU's is at least twice or optimally three times greater to the sum of input and output variables used) than traditional statistical methods, and does not require a defined production function and the relationship between inputs and outputs. However, DEA methodology, being a nonparametric linear programming method, does not address statistical noise (it does not incorporate a random variable to account for errors in financial data), and consequently is highly sensitive to inaccurate information. Therefore, the use of audited financial statements that are deemed trustworthy is advised while implementing this method.

This paper provides some insight in the efficiency of insurance companies in Croatia. Future studies should address the differences in efficiency between the Croatian insurance companies and the EU insurance companies. Furthermore, future studies can also expand in the choice of input and output variables while implementing DEA methodology, and in the use of econometric models in efficiency estimation, keeping in mind the sample limitations of the Croatian insurance market.

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APPENDIX

Table A

Insurance companies by total assets in the period from 2015 until 2016 ranked by size (in HRK)

Insurance company total assets	2015	2016	2017	2018	2019	2020	Average
CROATIA OSIGURANJE D.D.	8,480,992,388	8,764,480,126	9,745,131,585	10,208,810,142	11,145,402,441	11,600,237,352	9,990,842,339
ALLIANZ HRVATSKA D.D.	4,640,992,956	4,936,010,530	5,122,886,057	5,153,666,416	5,725,299,751	5,886,665,378	5,244,253,515
WIENER OSIGURANJE VIENNA INSURANCE GROUP D.D.	3,459,935,547	3,579,284,989	3,363,353,884	4,397,890,653	4,772,365,010	4,803,426,588	4,062,709,445
UNIQA OSIGURANJE D.D.	4,028,455,475	3,886,771,632	3,690,407,876	3,503,505,028	3,560,172,563	3,557,992,960	3,704,550,922
GRAWE HRVATSKA D.D.	3,277,415,581	3,560,794,436	3,644,475,129	3,664,928,277	3,980,633,119	3,925,795,446	3,675,673,665
EUROHERC OSIGURANJE D.D.	2,926,577,474	2,964,487,652	3,146,834,969	3,553,683,383	3,718,654,475	3,960,776,188	3,378,502,357
MERKUR OSIGURANJE D.D.	2,515,531,561	2,594,025,414	2,676,256,719	2,646,573,305	2,833,360,714	3,010,076,322	2,712,637,339
GENERALI OSIGURANJE D.D.	1,431,437,169	1,648,850,150	1,924,986,783	2,225,440,842	2,906,417,492	3,402,525,652	2,256,609,681
AGRAM LIFE OSIGURANJE D.D.	1,954,033,947	2,137,696,334	2,249,561,147	2,241,523,585	2,381,363,500	2,466,452,926	2,238,438,573
ADRIATIC (JADRANSKO) OSIGURANJE D.D.	1,849,144,000	1,909,038,582	1,960,806,731	2,081,414,729	2,240,250,549	2,544,324,692	2,097,496,547
TRIGLAV OSIGURANJE D. D.	1,025,601,462	1,078,131,627	1,135,492,495	1,110,326,595	1,246,499,062	1,404,022,220	1,166,678,910
HOK - OSIGURANJE D.D.	379,115,916	392,693,278	415,496,473	432,943,712	472,422,747	507,436,332	433,351,410
OTP OSIGURANJE D.D.	139,237,064	151,603,648	161,694,903	166,879,609	179,968,767	178,198,826	162,930,470
WÜSTENROT ŽIVOTNO OSIGURANJE D.D.	85,284,114	111,825,121	127,549,045	140,759,376	167,171,923	189,960,986	137,091,761
HRVATSKO KREDITNO OSIGURANJE D.D.	56,199,105	58,086,241	68,048,647	64,107,613	67,152,962	70,221,990	63,969,426

Source: author's calculations using financial statements data

Classification criteria:
Large insurance companies – insurance companies with total assets on average exceeding HRK 3 billion kuna in the observed period.
Medium insurance companies – insurance companies with total assets on average between HRK 1 billion and 3 billion kuna in the observed period.
Small insurance companies – insurance companies with total assets on average below HRK 1 billion kuna in the observed period.

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UČINKOVITOST OSIGURAVAJUĆIH DRUŠTAVA U HRVATSKOJ

Sažetak

Osiguravajuća društva imaju značajnu ulogu u očuvanju stabilnosti i rastu financijskog tržišta i gospodarstva u cjelini. Stoga je ključno da osiguravajuća društva posluju učinkovito. Zbog financijske konsolidacije koja je zahvatila hrvatsko financijsko tržište, broj osiguravajućih društava smanjio se s 24 u 2015. godini, koliko je iznosio na početku promatranog razdoblja, na 15 osiguravajućih društava u 2020. godini. Nakon financijske konsolidacije, formiran je niz velikih osiguravajućih društava koja dominiraju hrvatskim tržištem osiguranja. Glavni cilj ovog rada je procijeniti i usporediti učinkovitost hrvatskih osiguravajućih društava korištenjem tradicionalnih financijskih pokazatelja i neparametarske DEA metodologije za razdoblje od 2015. do 2020. godine. Nadalje, cilj rada je utvrditi i jesu li veliki osiguravatelji učinkovitiji od srednjih i malih osiguravatelja. Rezultati pokazuju da veliki osiguravatelji općenito postižu iznadprosječne vrijednosti ROI, ROE i ROA, te ispodprosječne omjere šteta, troškova i duga, kao i iznadprosječnu ili punu učinkovitost prema DEA metodologiji. Osim toga, pojedina mala osiguravajuća društva imaju tendenciju biti učinkovita, dok su za srednja osiguravajuća društva rezultati kompleksniji. Konačno, prosječna učinkovitost osiguravajućih društava je poboljšana u promatranom razdoblju, dok se jaz između velikih, srednjih i malih osiguravatelja stalno povećava.

Ključne riječi: osiguravajuća društva, DEA metodologija, hrvatsko tržište osiguranja, osiguranje i rizik.

JEL klasifikacija: G22, C61, C67.