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BANKS AND INSURANCE COMPANIES EFFICIENCY INDICATORS IN THE PERIOD OF FINANCIAL CRISIS: THE CASE OF THE REPUBLIC OF CROATIA*

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ABSTRACT

The main goal of the paper is to identify and to compare the efficiency measurement results of banks and insurance companies using Data Envelopment Analysis (DEA) and accounting indicators in the period before and after the onset of recent financial and economic crises in the Republic of Croatia. This research is important because it observes and compares the results of those two efficiency measurement methods which former researches did not encompass. The research includes the banking industry and the insurance sector in the Republic of Croatia due to their relatively high asset share of about 83% in total financial sector asset. The main difference in results between DEA approach and accounting approach was remarked in sense of accounting approach efficiency measurement scores lag in the crisis period. DEA efficiency scores had the lowest values in the year 2007 for insurance industry and for banks in 2008 but with visible lower values already in 2007. The lowest ROA and ROE accounting ratios in the year 2009 could be explained by the fact that although financial institutions operate more efficiently in the crisis period in sense of expense and income results, accounting ratios cannot achieve as good scores as in period of a boom, due to the deteriorated market conditions, and more reserved business policy.

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I. INTRODUCTION

Financial institutions operating efficiency measurement is based on data from financial statements and on market efficiency indicators. Financial statements are the main source of accounting information used in the financial institutions' operating efficiency measurement through the analysis of relations between specific values, commonly accepted as efficiency indicators. The most significant drivers of banks' profitability are earnings, efficiency, risk-taking and leverage. Financial ratios as indicators of banks' and insurance companies' efficiency are divided into four main groups: accounting indicators of relations in the balance sheet, accounting indicators of relations in the profit and loss account, accounting profitability indicators and market profitability indicators, i.e. investment indicators.[1] In that manner, the most significant ratios as accounting efficiency/profitability indicators calculated for banks and insurance companies are Return on Assets (ROA) and Return on Equity (ROE). Accounting ratios in general are easier to calculate due to the fact that they are calculated using the information from financial statements: net profit or profit before taxes, total or average asset, total or average equity, total income, total expenditure, etc. ROA and ROE as efficiency indicators have some disadvantages in the sense of operating efficiency measurement, but we find that those disadvantages can be removed by data envelopment analysis (DEA) efficiency measurement approach.

The Republic of Croatia, as well as all "emerging" Europe economies, before the onset of the global financial and economic crisis in 2008, was recording high growth rates, driven by aggressive banks lending activities (i.e. credit boom) because of easy access of foreign owned banks to financing from their parent banks. About 90% of Croatian banks are foreign owned. Due to the fact that Croatian financial institutions and market are still relatively "closed" in the sense of investments on foreign financial markets and in advanced financial instruments, recent global financial crises did not directly affect Croatian economy and financial sector. Although financial institutions in the Republic of Croatia did not have a direct exposure through their investments, the spill over effect of the crisis and slowing down of the banks' credit activity, which was remarkable especially in the year 2009, caused a deep recession and until today Croatian economy did not recover. Slowdown of banks' credit activity and negative trends on the capital market, affected negatively on the economic growth and financial institutions business' activity results as well as on efficiency/profitability indicators. Efficiency measurement results before and after the onset of the financial crisis could be difficult to evaluate and to compare due to several reasons. It can be subject to debate whether the financial institution business performance is more efficient in a boom or a recession period. It could be argued that bank efficiency could suffer during a credit boom, as temporarily high bank profitability relaxes incentives to save costs, but intense competition during a boom may increase bank efficiency.[2] The same could be concluded for the insurance companies.

DEA efficiency measurement approach has been extensively used to assess school efficiency (Norman and Stocker, 1991; Thanassoulis and Dunstan, 1994; Soteriou, Karahanna, Papanastasiou, and Diakourakis, 1998), hospitals efficiency (Jacobs, Smith and Street, 2006), public sector and not-for-profit settings (Sljepčević, 2009), efficiency of banks (Berger and Humphrey, 1997; Kraft, Tirtiroglu, 1998; Jemrić and Vujčić, 2002; Fries and Taci, 2005); insurance

[1]LajošŽager and others, Financial statements analysis (In Croatian) (Zagreb: Masmedia, 2009)
[2]GeorgeAnayiotos, Hovhannes Toroyan, and Athanasios Vamvakidis, "The efficiency of emerging Europe's banking sector before and after the recent economic crisis," Financial Theory and Practice 34, no. 3 (2010): 248.

companies efficiency (Cummins and Weiss, 1998; Mahlberg and Url, 2000; Davosir Pongrac, 2006), etc.

Anayiotos, Toroyan and Vamvakidis (2010) made a research using DEA approach for analysis of emerging Europe's banking sector efficiency (sample of 125 large banks from 14 emerging European countries), before and after the recent economic crisis. The results of their research suggest that DEA efficiency scores before crisis were strongly linked to the country's level of development, but also that banks efficiency suffered in the period before crisis when credit activity expanded, although efficiency scores increased. Foreign owned banks are more efficient than domestic banks, but less than their mother banks.[3]Poghosyan and Kumbhakar (2010) find that foreign ownership increase banks' efficiency only in less developed countries, and pointed direct correlation of the cost efficiency of banks in 20 emerging European countries during 1993-2004 with progress in economic reforms, economic stability, capital regulation and market structure in the banking sector.[4]

Fries and Taci (2004) find using DEA approach, on sample of 289 banks in 15 East European countries for the years 1994-2001, that banking sectors in which foreign owned banks have a larger share of total assets operate with lower expenses and that progress in banking reform has a non-linear association with cost efficiency. An average-sized bank in the sample operated at a point that is close to constant returns to scale, while smaller banks operated with significant unrealised economies of scale. They concluded that consolidation of smaller banks in the region would contribute to greater cost efficiency in banking, private banks are more cost efficient than state-owned banks, but privatised banks with majority foreign ownership are the most efficient and those with domestic ownership are the least.[5]In case of Croatian banking sector for the period 1995-2000, smaller banks are globally efficient, but large banks are locally efficient; foreign owned banks are on average the most efficient, and new banks are more efficient than the old ones.[6] The rehabilitation process in the large state-owned banks improved their efficiency but also contributed to a substantional decrease in interest rate spreads and thus a more competitive environment in the banking market.[7] Greater macroeconomic stability and competition in the banking sector from foreign banks' entry, as well as development of the supportive institutions, promote cost efficiency.

Numerous papers have also been written on the subject of the insurance companies' efficiency. The most cited authors in this field are Cummins and Weiss. In their papers they determine relative efficiency of insurance industry in Italy, Spain, but mostly in the USA. For output measurement they implement modified version of value added approach, and for input variables they use labour and capital which they take as factors of production for insurers. Cummins and Weiss (1998) and Cummins and Misas (2006) in their papers analyse the effect of single European market on the relative technical efficiency of insurance companies in Italy and

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[3]Anayiotos, Toroyan and Vamvakidis, "The efficiency of emerging Europe's banking sector before and after the recent economic crisis," 247-267.
TigranPoghosyan, and ArsenPoghosyan, "Foreign bank entry, bank efficiency and market power in Central and Eastern European Countries," Economics of Transition18, no. 3 (2010)
[4]Anayiotos, Toroyan and Vamvakidis, "The efficiency of emerging Europe's banking sector before and after the recent economic crisis," 248.
[5] Steven Fries and Anita Taci, "Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries," Journal of Banking and Finance 29, no. 1 (2005): 79.
[6] IgorJemrić and Boris Vujčić, Efficiency of Banks in Croatia: A DEA Approach,WP – 7 (Zagreb: CNB, 2002), 17.
[7]Ibid.

Spain. Besides them, Mahlberg and Url (1998, 2000) observed how a single market will affect the insurance industry in Austria and Germany by determining relative technical efficiency and the Malmquist index of total productivity.

In this paper, we utilize the mathematical programming technique of data envelopment analysis for the purpose of measuring relative operating efficiency of financial institutions: commercial banks and insurance companies, and we compare DEA scores with certain financial ratios that represent accounting efficiency indicators in the periods before and after recent financial and economic crises in the Republic of Croatia. The main goal of the paper is to identify the signs and the effects of crisis through efficiency indicators and to see if there are differences in the results of those two efficiency measurement approaches. The objective of this paper is to investigate the performance of financial institutions during the crisis. The research includes commercial banks and insurance companies as decision making units (DMUs) due to their relatively high asset share of about 83% in total Croatian financial sector asset.[8]

II. METHODOLOGY

There are a few common approaches on the financial institutions' efficiency measurement. The first approach on efficiency measurement is using ratio analysis among several financial institutions by using numerous accounting ratios, which can measure the overall financial soundness of the financial institutions and the operating efficiency of its management. Those ratios promise to provide valuable information about the financial institutions financial performance when compared to previous periods. The main weakness of ratio analysis is that there is a lack of agreement on the relative importance of various types of input and output. For example, a bank may appear to be performing well even if it is poorly managed on certain of these dimensions, as long as it compensates by performing particularly well on other dimensions.[9] Furthermore, the accounting ratios also fail to observe more outputs with more inputs and fail to consider the value of management actions and investment decisions that will affect future as opposed to current performance.[10] Accounting ratios are short-run measures and may be inappropriate for describing the actual efficiency of a bank in the long run.[11]

Accounting ratios ROA and ROE are the most important banks' and insurance companies' operating efficiency/profitability indicators. ROA as accounting indicator of bank's and insurance company's operating efficiency is calculated as the profit before taxes divided by total asset[12], and it is the most important single ratio in comparing the efficiency and operating performance of the observed financial institutions as it indicates the returns generated from the assets financed by them.[13] ROA can be observed also as a measure of bank's management quality. ROE is a bank's and insurance company's efficiency indicator calculated as the net profit after

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[8]Croatian Financial Services Supervisory Agency (CFSSA), *official data*(2010);
Croatian National Bank (CNB), *official data,* (2010)

[9]LukaNeralić, "About some uses of DEA in banking sector," (In Croatian), Ekonomija – Časopiszaekonomskuteoriju I politiku 3, no. 2 (1996): 493-515.;
DavidH. Sherman and Franklin Gold, "Bank Branch Operating Efficiency. Evaluation with Data Envelopment Analysis," Journal of Banking and Finance 9, no. 2 (1985): 297-315.

[10]Neralić, "About some uses of DEA in banking sector," 493-515.

[11]Muhittin Oral and RehaYolalan, "Empirical Study on Measuring Operating Efficiency and Profitability of Bank Branches," European Journal of Operational Research 46, no. 3 (1990): 282-294.

[12]Žager and others, Financial statements analysis, 305.

[13]KyriakiKosmidou and others, "A multivariate analysis of the financial characteristics of foreign and domestic banks in the UK," Omega 34, no. 2 (2006): 189-195.

taxes divided by the shareholder's equity. ROE measures the return on investment made by equity investors.[14] In other words, ROE measures how much profit (in %) is earned by the unit of shareholder's equity. ROA is a commonly used accounting ratio as a key measure of bank's operating efficiency, while Berger (1995) characterized both ROA and ROE, as standards in bank research. Commonly accepted efficiency frontier is a value of ROA at least 1% and ROE at least 15% in the period of a boom, while in the recession period each bank with value of ROE at least 10% is considered to be efficient. In consolidated statements for Croatian banking sector, ratios Return on Average Assets (ROAA) and Return on Average Equity (ROAE) are calculated and observed. They take into account the average values of assets/equity instead of the total values as in case of ROA and ROE calculation. In that sense, ROAA represents pre-tax profit as a percentage of average assets, while ROAE represents the after-tax profit as a percentage of average equity. The total income and expense ratio as total business efficiency (i.e. cost efficiency) indicator is the main in the group of accounting indicators of relations in the profit and loss accounts.[15] For the purpose of this research, in case of banking sector efficiency, ROAA and ROAE indicators are observed, as well as some other selected data and indicators calculated on the basis of information from financial statements, such as interest rate spread and cost to income ratio. The interest rate spread is calculated as the difference between interest income earned on average interest-bearing assets and interest expense incurred on average interest-bearing liabilities.[16] Cost to income ratio is calculated as a share of bank's operating expenses in net income. Operating expenses include general administrative expenses and amortization. Due to the fact that inputs and outputs in DEA approach efficiency measurement include expenses and income data, the latter two indicators, which also use expenses and income data in calculation, are valuable source of information for a more complete conclusion about banks performance efficiency.

When supervising the operations of insurance companies the following indicators are used: claims ratio, expense ratio, combined ratio and return on investment. Claims ratio is the proportionate relationship of claims paid, changes in the provision for claims and changes of other technical provisions to net earned premiums expressed as a percentage. Expense ratio is the proportionate relationship of operating expenses (acquisition and administrative expenses) and other technical charges to gross written premium reduced by premiums assigned to reinsurance expressed as a percentage. The usual range of the value of the expense ratio for the insurance sector is 20-30%.Combined ratio is calculated by adding the claims ratio to expense ratio and indicates the profitability of operations before including income from investments. Return on investment is the proportionate relationship of the net income from investments to balance of investments expressed as a percentage. Security of funds invested is extremely important for the insurance sector because insurance companies acting as financial institutions accumulate substantial financial funds, and when calculating insurance premium, future investment result is taken into account, therefore allowing the premium needed for payment of insured event and coverage of expenses for conducting business activities to be reduced for that amount. Based on the information from balance sheets and profit and loss accounts, solvency (solvency margin) and profitability indicators are calculated as well. Solvency indicator (solvency margin) is used for expression of capital adequacy, i.e. valuation of the insurer's capital and guarantee capital with

[14]Žager and others, Financial statements, 305.;
Kosmidou and others, "A multivariate analysis of the financial characteristics of foreign and domestic banks in the UK," 189-195.
[15]Žager and others, Financial statements analysis, 303.
[16] Croatian National Bank (CNB), *official data*, 2010.

respect to the size of its business, and it depends on adequacy of technical provisions which must be sufficient for a full coverage of the liabilities of the insurance company under the insurance contracts in force. The definition of capital adequacy specifies that insurance company must maintain, at all times, the capital level adequate to both the volume and the lines of insurance written, as well as to the nature of risks to which it is exposed. The profitability indicators imply on the effects of asset and liability management on the business result and the most important indicators that were already explained in the previous section are ROA and ROE.[17]

The second approach in the efficiency measurement is the parametric programming approach which has generally been concerned with the production or expense function base. It is focused on estimating the characteristics of the function and measuring economies of scale assuming all DMUs were operating efficiently. Parametric efficiency measurement approaches include Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA), Distribution Free Approach (DFA).[18] The analysis in this paper does not include parametric programming approach in the efficiency measurement.

The third approach uses DMUs efficiency frontiers to construct measures of efficiency and can be labelled as a non-parametric programming approach. This approach considers how much total efficiency in the financial sector can be improved, and ranks the efficiency scores of DMUs. This efficiency measurement derives from analysing empirical observations obtained from DMUs to define productive units which are characterized by common multiple outputs and common designated inputs.[19] DEA is a linear programming non-parametric approach and enjoys a number of advantages over other traditional parametric efficiency measurement approaches. Also, disadvantages of the accounting approach efficiency measurement and improvement mentioned in the previous section can be removed by DEA approach. If we want to calculate the indicator of business performance that will represent the efficiency of organizational unit within a financial institution, then we have to use input and output ratio. Thus, if we want to calculate the efficiency measure that will take into account more inputs and outputs, it is necessary to make a selection of those that will be included in the calculation and assign them certain weight in order to determine unique efficiency measure. The methodology that enables this is data envelopment analysis. Unlike statistical methods that derive estimations on the basis of average production unit, DEA is an extreme point method in which each decision making unit is compared only with the best one. For the observed inputs and outputs of the DMUs, it is assumed that connection between them exists, but the shape of that connection is not defined, what is the case with statistical methods.

The foundation for the development of data envelopment analysis was given by Farrell in 1957 in the paper „The Measurement of Productive Efficiency". He introduced the concepts of technical, pricing and total efficiency, at the same time differentiating the measurement of input efficiency and output efficiency. Total efficiency implies how much costs achieved are higher than minimal and it encompasses two components: technical efficiency and alocative efficiency. Technical efficiency reflects the DMUs possibility to produce maximal output by using a given set of inputs. On the other hand, alocative efficiency reflects the DMUs possibility to use inputs in optimal proportion in respect to the input price. Given the Farrell's assumptions, the methods

[17] Croatian Financial Services Supervisory Agency (CFSSA), *official data*, 2006.

[18] Allen N.Berger and David B. Humphrey, "Efficiency of financial institutions: International survey and directions for future research," European Journal of Operational Research 98, no. 2 (1997): 184.

[19] AbrahamCharnes, William W. Cooper, and Edwardo Rhodes, "Measuring the Efficiency of Decision Making Units," European Journal of Operational Research 2, no. 6 (1978): 429-444.

for measuring efficiency were elaborated. One of them was Data envelopment analysis that measures relative efficiency of DMUs by constructing empirical efficiency margin or production possibilities frontier on the basis of data about used inputs and achieved output of all units.

The DEA approach, based on Farrell assumptions, first was described by Charnes, Cooper and Rhodes (1978) who applied a mathematical planning model (CCR model) to measure the efficiency frontier based on the concept of Pareto optimum. Originally, DEA was intended for use in public sector and not-for-profit settings where cost minimization or profit maximization may not apply. DEA is most useful in cases where accounting and financial ratios are of little value, multiple outputs are produced through the transformation of multiple inputs, and the input-output transformation relationships are not known.[20] The results of DEA can help DMUs to improve their business results. The disadvantage of using DEA as a tool of detecting the relative efficiency is sensitivity in sense of how much can we change the data of observed effective DMU to keep it effective. The main goal of sensitivity analysis is to identify the level of input and output data change to keep effective DMU still effective but only if changes are in default limits. The basic idea of DEA is to identify the most efficient DMU among all DMUs, where the set of best practice or frontier observations are those for which no other DMU or linear combination of units has as much or more of every output (given inputs) or as little or less of every input (given outputs) (.[21] The most efficient DMU is called a Pareto-optimal unit and is considered the standard for comparison for all other DMUs.

Isoquant (linear curve, efficiency line) combines efficiency points (extreme points of convex set, unit output) that are possible to achieve with unequal combination of inputs and demonstrates that in one point, in getting unit output, it is not possible to decrease neither of the inputs by the unit of outputs without increasing the other.

Points that are outside the efficiency line signify that there is an inefficient usage of resources for getting the unit output. Point that is on the efficiency line does not ensure efficiency in the DEA sense because that is necessary but not sufficient condition of efficiency since some input can be decreased without of increasing other input and hence objectify unit output (Neralić, 1996, 493-496).[22]

Different DEA models as a result give different types of relative efficiency. CCR model, that assumes constant returns to scale, as a result gives global technical efficiency. BCC model assumes variable returns to scale and as a result gives pure local technical efficiency. The proportion of given results determines efficiency in respect to the returns to scale. If the DMU is perfectly efficient by both models, then its efficiency in respect to the returns to scale is the highest.

[20]Ibid.

[21] Berger and Humphrey, "Efficiency of financial institutions: International survey and directions for future research," 177.

[22]Neralić, "About some uses of DEA in banking sector," 493-496.

A. Charnes-Cooper-Rhodes model (CCR model) - input oriented

The assessment of relative efficiency of the observed decision making unit can be acquired by solving following problem of fractional linear programming:[23]

$$max\ \theta = \frac{u_1 y_{10} + u_2 y_{20} + \cdots + u_s y_{s0}}{v_1 x_{10} + v_2 x_{20} + \cdots + v_m x_{m0}} \tag{1}$$

with restrictions:

$$\frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} \leq 1, \quad (j = 1,2, \ldots, n)$$

$$v_1, v_2, \ldots, v_m \geq 0$$
$$u_1, u_2, \ldots, u_s \geq 0 \tag{2}$$

Equivalent linear model is:

$$max\ \theta = \mu_1 y_{10} + \cdots + \mu_s y_{s0} \tag{3}$$

with restrictions:

$$v_1 x_{10} + \cdots + v_m x_{m0} = 1$$
$$\mu_1 y_{1j} + \cdots + \mu_s y_{sj} \leq v_1 x_{1j} + \cdots + v_m x_{mj}\ (j = 1, \ldots, n)$$
$$v_1, v_2, \ldots, v_m \geq 0$$
$$\mu_1, \mu_2, \ldots, \mu_s \geq 0 \tag{4}$$

where x represents inputs and y represents outputs.

An optimal solution to this linear problem is (θ^*, v*, u*), where v and u represent input and output weight vectors.

The definition of CCR-efficiency is:[24]

1. DMU0 is CCR-efficient if $\theta^*=1$ and there exist at least one optimal (v*, u*) with v*>0 and u* >0.
2. Otherwise DMU0 is CCR – inefficient.

The dual problem of linear programming problem is expressed with a real variable θ as follows:[25]

$$min\theta \tag{5}$$

[23] William W. Cooper, Lawrence M. Seiford and Kaoru Tone, Data Envelopment Analysis, A Comprehensive Text with Models, Applications, References and DEA-Solver Software (Boston: Kluwer Academic Publishers, 2000), 23.

[24] Ibid., 24.
[25] Ibid., 43.

subject to:

$$\begin{aligned} \theta x_0 - X\lambda &\geq 0 \\ Y\lambda &\geq y_0 \\ \lambda &\geq 0 \end{aligned} \qquad (6)$$

Dual linear problem has a feasible solution θ=1, λ0=1, λj=0 (j≠0). Hence the optimal θ, denoted θ*, is not greater than 1. On the other hand, due to the nonzero assumption for the data, the constraint forces λ (optimal values of variables of dual model) to be nonzero. Putting this all together, we have u<θ≤1.[26] DMUs for which the θ*<1 are relatively inefficient and those for which θ*=1 are relatively efficient having their virtual input-output combination points lying on the frontier.

When θ*<1 it can be said that (X λ, Y λ) outperforms (θx0, y0) and with regard to this property we must define input excess $s^- \in \mathbb{R}^m$ and output shortfalls $s^+ \in \mathbb{R}^s$ and identify them as „slack" vectors by:[27]

$$s^- = \theta x_0 - X\lambda, \quad s^+ = Y\lambda - y_0 \qquad (7)$$

in order to find possible input excesses and output shortfalls, we solve the two phase linear programming problem.

In the first phase θ is minimized and in the second phase the sum of input excesses and output shortfalls is maximized by using optimal value θ* of the goal function from the first phase that represents CCR efficiency. The main goal of the second phase is to find the solution that maximizes the sum of input excesses and output shortfalls while keeping θ=θ*. In the second phase the following problem of linear programming is solved:[28]

$$max\varpi = es^- + es^+ \qquad (8)$$

$$s^- = \theta^* x_0 - X\lambda \qquad (9)$$

$$s^+ = Y\lambda - y_0 \qquad (10)$$

$$\lambda \geq 0, \quad s^- \geq 0, \quad s^+ \geq 0$$

where e = (1,1,...,1) a vector of ones so that $es^- \sum_{i=1}^{m} s_i^-$ and $es^+ \sum_{r=1}^{s} s_r^+$.

An optimal solution (λ*, s-*, s+*) of the second phase is called the max-slack solution and if it satisfies s-* = 0 and s+* = 0, then it is called zero-slack.

[26] Ibid.
[27] Ibid., 44.
[28] Ibid.

If an optimal solution (θ^*,λ^*, s^{-*}, s^{+*}) of the two linear programming problems, explained above, satisfies $\theta^*=1$ and is zero-slack ($s^{-*} = 0$ i $s^{+*} = 0$), then DMU is called CCR-efficient. Otherwise, the DMU is called CCR-inefficient, because the conditions that $\theta^*=1$ and all slacks are zero, must both be satisfied if full efficiency is to be attained.[29]

B. Charnes-Cooper-Rhodes model (CCR model) - output oriented

CCR model output oriented is defined as follows:

$$max\eta \tag{11}$$

with restrictions:

$$\begin{aligned} x_0 - X\mu &\geq 0 \\ \eta y_0 - Y\mu &\leq 0 \\ \mu &\geq 0 \end{aligned} \tag{12}$$

Optimal solution to the output oriented model can be acquired directly from the optimal solution to the input oriented model in the following manner:

$$\lambda^* = \mu^*/\eta^* \qquad\qquad \theta^* = 1/\eta^*$$

From the above follows that DMU is efficient according to CCR input oriented model, if and only if it is efficient pursuant to CCR output oriented model. By solving CCR output oriented model that assumes constant returns to scale, we get global technical efficiency.

C. Banker-Charnes-Cooper model (BCC model) - input oriented

BCC input oriented model evaluates DMUs efficiency by solving the following linear envelope problem:

$$min\theta_B \tag{13}$$

with restrictions:

$$\begin{aligned} &\theta_B x_0 - X\lambda \geq 0 \\ &Y\lambda \geq y_0 \\ &\textstyle\sum \lambda_j = 1 \\ &\lambda_j \geq 0 \end{aligned} \tag{14}$$

where θ_B is scalar.

[29] Ibid., 45.

BCC input oriented model differs from CCR model of the same orientation only in additional restriction $\sum \lambda_j = 1$. Since there is a restriction that λj ≥ 0 for all j, the condition of convexity is imposed on the allowable ways that n of DMU can be combined. Also, since every inefficient DMU is closer to its BCC projection than to its CCR projection, BCC-efficiency can be achieved easier, and the number of efficient DMUs with BCC model is never lower than those with CCR model regardless of the orientation.

Cooper, Seiford and Tone (2006) define BCC efficiency in the following manner: if the optimal solution (θ_B^*, λ^*, s^{-*}, s^{+*}) to BCC model attained with the two phase algorithm satisfies $\theta_B^* = 1$ and there are no additional variables ($s^* = 0$, $s^{+*} = 0$), then DMU_0 is called BCC-efficient, otherwise it is BCC-inefficient.[30]

D. Banker-Charnes-Cooper model (BCC model)- output oriented

Output oriented BCC model is defined:

$$max\eta_B \tag{15}$$

with restrictions:

$$\begin{aligned} X\lambda &\leq x_0 \\ \eta_B y_0 - Y\lambda &\leq 0 \\ \sum \lambda &= 1 \\ \lambda &\geq 0 \end{aligned} \tag{16}$$

Relative efficiency that is obtained as a result of solving BCC model that assumes variable returns to scale is local pure technical efficiency.

III. DATA AND EMPIRICAL APPROACH

Data Envelopment Analysis approach in this paper is used to measure the relative efficiency of the banks and insurance companies operating in the Croatian financial market in the period before and after the onset of the financial crisis. The sample involves 30 banks and 19 insurance companies operating in the Republic of Croatia over the period 2005-2010, separately observed and analysed due to specific business activity they conduct and it is not appropriate to compare their efficiency measurement scores. Few banks and insurance companies were excluded from the sample used for DEA approach due to changes in both sectors and no availability of data. As it was pointed out in the introduction, the research includes the banking industry and the insurance sector in the Republic of Croatia due to their relatively high asset share of about 83% in total Croatian financial sector asset. As a statistical basis for input and output data as well as for accounting indicators data, financial statements of the commercial banks and insurance companies, official data of the Croatian National Bank (CNB), the Financial Agency (FA) and the Croatian Financial Services Supervisory Agency (CFSSA) were used.

[30]Ibid., 88.

About 90% of Croatian banks are foreign owned, measured as a share of total banking sector asset. 15 banks in total are foreign owned, 17 privately held domestic banks and 2 state owned banks. Concentration level in Croatian banking sector is extremely high, asset share of the four (two) largest banks was about 65% (42) of total banking sector asset which amounted 391.6 billion HRK at the end of 2010.[31]

In 2010 on Croatian financial market operated 28 insurance and reinsurance companies that provided life and non-life services, and 18 of them were foreign owned. Total written premium in the same year was around 9 billion HRK and more than 50% of that amount was written by three insurance companies. 73% of that premium refers to non-life insurance since the largest part of it consists of automobile liability insurance that is obligatory.[32]

The characteristics of the data and knowing the type of yield for the analysed process are crucial when selecting which type of DEA model to use. Due to the fact that this paper includes financial institutions, i.e., banks and insurance companies, and that we could not determine with certainty is the yield constant or variable, the DEA analysis will include both CCR and BCC output oriented models.

For the purpose of DEA commercial banks relative efficiency estimation, all data were taken from banks' financial statements. For each j-th DMU (i.e. for each bank) the input data (x_{ij}) were:

Input 1, (x_{1j}) → interest expenses

Input 2, (x_{2j}) → non - interest expenses

Input 3, (x_{3j}) → other expenses (labour-related and capital-related administrative expenses and other expenses from bank's business activity)

Output data (y_{ij}):

Output 1, (y_{1j}) → interest incomes

Output 2, (y_{2j}) → non-interest incomes

Output 3, (y_{3j}) → other incomes from business activity

The main business activity of banks assumes collection of deposits, lending transactions and payment operations. From those activities main groups of incomes and expenses arise. Interest income category assumes income from interests earned in bank's lending activities and related revenues, non-interest income include incomes from fees and commissions and other related revenues, and the last category are other incomes from business activity. On the other side, expenses from bank's business activity include: interest expenses that arise from deposits collection activity and related expenses, non–interest expenses that include expenses on fees and commissions and other related expenses, and the category other expenses which includes: labour-related administrative expenses (costs of employees), capital-related administrative expenses (amortization, office supplies, etc.) and other expenses from banks business activity.

The role of insurance companies on the financial market is complex. On the one side they underwrite and collect premiums for risks undertaken what is followed by claim payout or

[31] Croatian National Bank (CNB), *official data*, 2010.

[32] Croatian Financial Services Supervisory Agency (CFSSA), *official data*, 2010.

payoff of sum insured, and on the other side they invest available reserves and mathematical provision from which they collect profit. That is why for inputs and outputs were selected items from the profit and loss accounts which, as flow variables, express the changes of certain variables and are expressed as a value and not quantity.

For the purpose of DEA insurance companies' relative efficiency estimation, all data were taken from insurance companies' financial statements. For each j-th DMU (i.e. for insurance company) the input data (x_{ij}) were:

Input 1, (x_{1j}) → net operating expenses

Input 2, (x_{2j}) → investment costs

Input 3, (x_{3j}) → claims incurred

Output data (y_{ij}):

Output 1, (y_{1j}) → earned premiums

Output 2, (y_{2j}) → investment income

The DEA efficiency scores for banking sector and insurance industry were primarily compared with ROA and ROE efficiency indicators. For the banks, ROAA (Return on Average Assets) and ROAE (Return on Average Equity) are being rather observed as commonly accepted accounting efficiency/profitability indicators, shown in the official statements. For the purpose of this research, banks' accounting efficiency indicators: interest rate spread and cost to income ratio, were also observed and compared with DEA scores. As it was explained in the second part of this paper, insurance companies have some specific accounting indicators that are characterized with their specific activity. Their basic incomes are premiums but also large part of their income comes from investment activities. Indicators that depict these relations are called combined ratio which is composed of claims ratio and expense ratio and return on investment.

Accounting ratios for banks were calculated on the basis of information from banks' financial statements and the Financial Agency (FA) official statements or data were taken from the CNB official statements. Accounting ratios for insurance companies' are calculated on the basis of information from insurance companies' financial statements and the FA official statements or data were taken from the CFSSA official statements.

IV. THE RESULTS OF BANKS' AND INSURANCE COMPANIES' EFFICIENCY IN THE REPUBLIC OF CROATIA IN THE PERIOD 2005 – 2010

The results of DEA efficiency analysis that are acquired from CCR and BCC output oriented models by using software package DEA-Solver-Pro are shown in the next few tables, as well as accounting approach efficiency indicators, i.e. accounting ratios and selected data from financial statements.

TABLE 1 - CROATIAN COMMERCIAL BANKS EFFICIENCY MEASUREMENT SUMMARY RESULTS

	2005	2006	2007	2008	2009	2010
Accounting approach						
Total no. of banks	34	33	33	34	34	33
ROAA (%)	1.65	1.50	1.57	1.60	1.13	1.19
ROAE (%))	15.06	12.41	10.93	9.91	6.40	7.22
Interest rate spread (%)	3.00	2.80	2.60	2.60	2.20	2.70
CIR (%)	54.40	54.90	52.10	52.40	49.50	48.00
Total asset, millions HRK	260,300	304,600	345,100	370,100	378,400	391,600
Profit before taxes, millions HRK	4,030	4,236	5,105	5,805	4,216	4,530
Net Profit, millions HRK	3,248	3,395	4,067	4,612	3,278	3,766
Net income, millions HRK	9,985	10,913	12,677	14,370	15,295	15,685
Net interest income, millions HRK	7,005	7,691	8,554	9,958	9,551	10,908
Net non-interest income, millions HRK	2,980	3,222	4,129	4,412	5,744	4,777
DEA approach						
CCR – model						
No. of DMUs	30	30	30	30	30	30
No. of efficient DMUs	14	12	12	10	15	12
Average relative efficiency	0.945	0.943	0.916	0.908	0.924	0.903
Standard Deviation	0.079	0.074	0.092	0.106	0.103	0.112
No. of DMUs with efficiency lower than average	11	10	13	13	12	14
BCC – model						
No. of DMUs	30	30	30	30	30	30
No. of efficient DMUs	22	23	18	18	17	17
Average relative efficiency	0.965	0.983	0.947	0.957	0.958	0.936
Standard Deviation	0.073	0.049	0.079	0.065	0.057	0.094
No. of DMUs with efficiency lower than average	7	4	9	10	12	12

Source: Authors' calculation and CNB, official data

TABLE 2 - CROATIAN INSURANCE SECTOR EFFICIENCY MEASUREMENT SUMMARY RESULTS

	2005	2006	2007	2008	2009	2010
Accounting approach						
Total no. of insurance comp.	25	22	25	29	30	28
Claims ratio (%)	70.50	70.83	73.93	68.42	69.77	67.59
Expense ratio (%)	37.75	39.44	40.21	39.38	44.50	44.27
Combined ratio (%)	108.25	110.28	114.10	107.80	114.27	111.86
Return on investment (%)	3.88	4.49	5.65	1.88	4.83	4.57
Debt ratio	0.84	0.80	0.79	0.82	0.81	0.81
ROE (%)	9.94	8.71	7.63	0.22	0.12	5.30
ROA (%)	1.44	1.58	1.48	0.04	0.02	0.94
DEA approach						
CCR – model						
No. of DMUs	18	19	19	19	19	17
No. of efficient DMUs	7	9	9	5	11	9
Average relative efficiency	0.741	0.795	0.747	0.926	0.953	0.896
Standard Deviation	0.227	0.245	0.247	0.066	0.086	0.124
No. of DMUs with efficiency lower than average	10	7	10	9	4	7
BCC – model						
No. of DMUs	18	19	19	19	19	17
No. of efficient DMUs	12	13	13	11	15	15
Average relative efficiency	0.922	0.911	0.906	0.961	0.972	0.984
Standard Deviation	0.120	0.154	0.153	0.055	0.071	0.063
No. of DMUs with efficiency lower than average	5	5	5	7	3	1

Source: Authors' calculation and CNB, official data

The results of DEA approach in the table 1 and shown in the graph 1 (for the CCR model), point to a decrease in average efficiency of banks already in the year 2007, and a further decline accompanied during the year 2008 when the lowest efficiency score was accomplished, but in the year 2009 the increase in average relative efficiency was lesser. Same results were accomplished when observing the number of efficient DMUs, whit only 10 efficient DMUs in 2008. Results in

the number of efficient DMUs and average relative efficiency scores for the BCC model are better due to the fact that BCC model is based on variable returns to scale (VRS). CCR model based on constant returns to scale (CRS) is better when observing efficiency of financial institutions because under VRS most large banks, for example, might appear fully efficient, possibly because of the lack of truly comparable efficient banks (Berg, Hjalmarsson and Suominen, 1993; Anayiotos, Toroyan and Vamvakidis, 2010).[33] Lower DEA efficiency results were again accomplished in 2010 as a result of deteriorated financial market conditions.

On the other side, ROAA and ROAE accounting profitability ratios, shown in the table 1 and graph 2, for the banks were the lowest in the year 2009: after decrease in 2006, ROAA had grew until 2009, decline accompanied the year 2009 and slow recovery was accomplished in the year 2010. Significant ROAA indicator decrease by 0.5 percentage points at the end of 2009 compared to the end of 2008 is explained by stronger fall in pre-tax profit by 26.5%. The same could be concluded for ROAE indicator, a stronger fall in after –tax profit of 28.9% caused a decrease by 3.5 percentage points. Interest rate spread efficiency indicator was as well the lowest in 2009, while net interest income recorded small decrease in 2009 (increase in all other years). Cost to income ratio recorded decrease in all observed years when compared to the previous year. On the other side, the net non-interest income had the highest value in 2010. That can be explained by the fact that banks during the crisis and recession are trying to compensate losses in interest income when slowing credit activity with higher earnings on fees and commissions, i.e. non-interest income. The decrease in net income of banks resulted in bank efforts to slow down the growth of their costs, which caused the decrease of cost to income ratio in 2009. The interest rate spread was the lowest in 2009 what can be explained by the fact that average interest expenses had the growth dynamics almost similar to that from previous five years, while average interest income by the unit of interest-bearing assets remained almost at the same level as at the end of 2008. This indicates that the average interest income earned by the unit of interest-bearing assets has remained at the high levels observed in the previous five years.[34]

The average efficiency of insurance companies achieved in the observed period was 0.833 according to CCR model, and 0.934 according to BCC model as it is shown in table 2 and graph 1. This means that if average insurance company wants to be on the efficiency frontier it has to use 83.25%, that is 93.43%, of inputs that it currently uses and it will produce the same amount of output. According to the CCR model, shown in table 2, the lowest average efficiency was achieved in the year 2005 while in the year 2007 it was at the approximately at the same level. In these years more than 50% DMUs were inefficient, while 10 insurance companies had relative efficiency lower than average. The best result of relative efficiency was achieved in the year 2009 and was 0.953. The same year 11, of observed 19, insurers were efficient. The similar results were obtained with BCC model where the lowest average efficiency was in the year 2007 and was 0.906, what is higher than with CCR. In that year 11 insurance companies were relatively efficient while 7 of inefficient had relative efficiency lower than average. As was the case with CCR model, the best result of relative efficiency was achieved in the year 2009 when 18 insurance companies were efficient. The data for the last observed year, 2010, indicate lower scores using DEA.

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[33]Sanford V.Berg, and others, "Banking Efficiency in the Nordic Countries," Journal of Banking and Finance 17, no. 2-3 (1993): 371-388.;
Anayiotos, Toroyan and Vamvakidis, "The efficiency of emerging Europe's banking sector before and after the recent economic crisis," 247-267.

[34] Croatian National Bank (CNB), *official data*, 2010.

When we look at the accounting ratios we can see that claims ratio was outside the boundaries in the year 2007, i.e. the year of the crises (table 2 and graph 2). After that it started to return to the level that is normal for the insurance industry, which is 50-70%. The expense ratio had upward trend in the first three observed years what can be explained by the fact that in the same period business expenditures grew faster than calculated premium. After they declined negligibly in the 2008, in the year 2009 again was registered relatively high value of expense ratio since the framework for this ratio is 20-30% for insurance business. The highest value of the return on investment was registered in the 2007 at the level of 5.65% what is consequence of the growth in the value of investments on the financial market. The impact of the crises can be seen in the following year when this ratio dropped significantly to the 1.88%. ROA was the highest in the period before crises, in the year 2006, when it started to decline and then reached the value of 0.02% in the year 2009. ROE had the highest point in the year 2005 after which it started to decline to the lowest point in the year 2009. Contrary to the result of DEA, accounting ratios ROA and ROE indicate significant improvement in 2010.

By comparing the results of DEA and accounting approach for banks and insurance companies it can be concluded that they exhibit similar trend (graph 3). DEA approach shows the signs of crises earlier than accounting approach for both branches of financial business.

V. CONCLUSION AND FURTHER RESEARCH

We used Data Envelopment Analysis approach to measure the relative efficiency of the banks and insurance companies in the Croatian financial market in the period before and after the financial crisis (2005-2010), for DMUs for which relatively reliable financial statements are available. The sample in this study involves 30 banks and 19 insurance companies operating in the Republic of Croatia during the period 2005-2010. We compared the results of DEA approach to accounting ratios to identify the signs and the effects of crises and to see if there are differences in the results of those two efficiency measurement approaches.

We can conclude that better DEA approach efficiency results as well as accounting ratios before the recent crisis were influenced by boom period in Croatian financial sector. The main difference in results between those two approaches was remarked in sense of accounting approach efficiency measurement scores lag after 2008, i.e. after the onset of the financial crisis. DEA efficiency scores had the lowest values in the year 2007 for insurance industry and for banks in 2008 but with visible lower values already in 2007 when comparing to previous years. On the other hand, accounting ratios had the lowest values in 2009. DEA scores in 2008 and 2009 indicated that there should be improvement in accounting ratios, and as can be seen, this occurred in 2010. According to this results we can conclude that DEA approach indicate the signs of crises earlier than accounting approach. The results suggest that intense competition during a boom may increase bank efficiency according to DEA scores and decrease in early stages of crisis but also remarkable recovery already in the next period due to incentive to save or to cut expenses as much as it is possible to prevent loses during the crisis or to achieve at least the same or better profitability results in post crisis period. The lowest ROA and ROE accounting ratios in the year 2009 could be explained by the fact that although financial institutions operate more efficiently in the crisis period in sense of expense and income results, accounting ratios cannot achieve as good scores as in period of a boom, due to the deteriorated market conditions, and more reserved business policy.

The solutions to relative efficiency that can be obtained with DEA approach are very useful to researchers, executives and managers due to the specific characteristics of this method. First of all, every DMU is characterized with one result of relative efficiency. It is possible to

process more inputs and outputs at the same time whereat every input and output can be expressed in different measurement unit. The model itself suggests improvements to inefficient units that are based on accomplished results of the units which operate efficiently. And the last, but not the least important, the advantage of DEA method versus statistical methods is the fact that we do not have to know explicit relation between inputs and outputs.

Further research could classify banks and insurance companies into more groups depending on if they are "large", "medium" or "small" in terms of asset size of DMUs as a percentage in total assets of all banks or insurance industry asset, and compare the efficiency scores of each one of these groups with the results of other groups, and with total average efficiency scores. The result of this multigroup classification in addition to more variables and more advanced methods could be an even more powerful analytical tool for the determination of the key factors of the efficiency of banks and insurance companies operating in the Republic of Croatia, comparing to accounting efficiency indicators. The multigroup classification approach, including approach used in this study, could be applied also in other countries, as well as classification of banks and insurance companies into groups depending on ownership, and comparison the gained scores with accounting ratio analysis results.

VI. APPENDIX

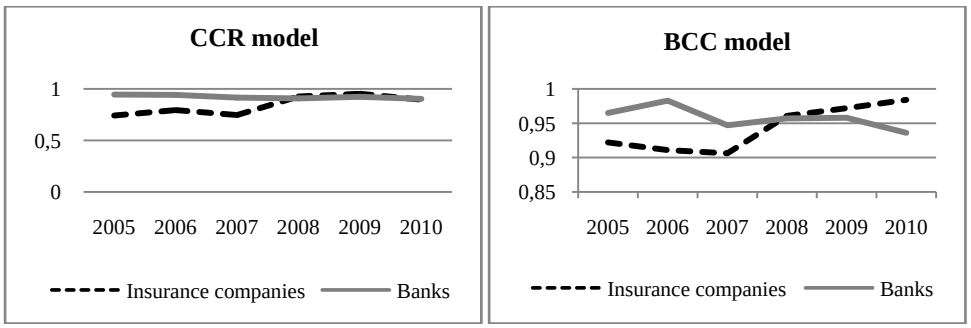

FIGURE 1. DEA EFFICIENCY SCORES

Source: Author's calculation

Graph 2.

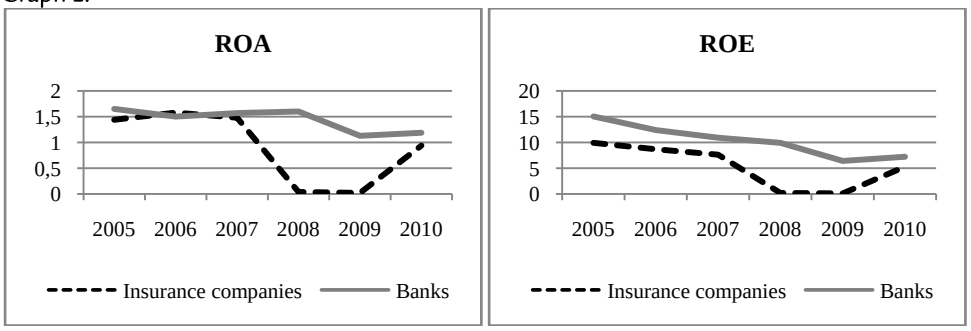

FIGURE 2. ACCOUNTING EFFICIENCY INDICATORS

Source: Author's calculation

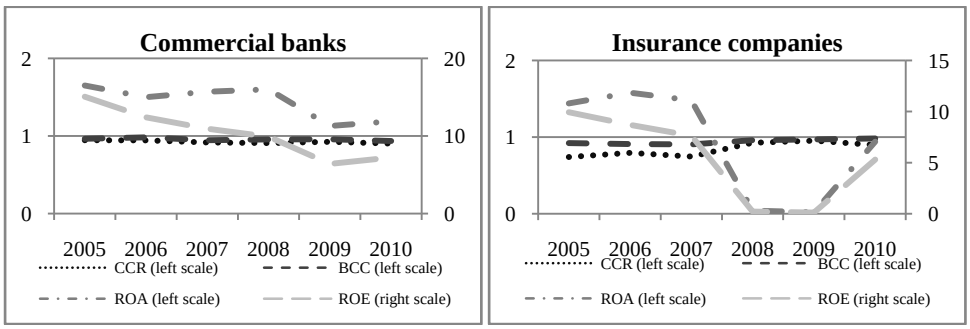

FIGURE 3. DEA APPROACH VS. ACCOUNTING APPROACH EFFICIENCY SCORES

Source: Author's calculation

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POKAZATELJI EFIKASNOSTI BANAKA I OSIGURAVAJUĆIH DRUŠTAVA U RAZDOBLJU FINANCIJSKE KRIZE: SLUČAJ REPUBLIKE HRVATSKE

Sažetak: Glavni cilj rada je identifikacija i usporedba rezultata mjerenja efikasnosti banaka i osiguravajućih društava primjenom matematičke analize omeđivanja podataka (AOMP) i računovodstvenih pokazatelja u razdoblju prije i nakon izbijanja financijske i ekonomske krize u Republici Hrvatskoj. Ovakav pristup u istraživanju je od iznimne važnosti jer omogućava praćenje i usporedbu rezultata navedenih metoda mjerenja efikasnosti na način koji prijašnja istraživanja nisu obuhvatila. Istraživanje obuhvaća bankovnu i osigurateljnu industriju u Republici Hrvatskoj zbog relativno visokog udjela njihove aktive od 83% u aktivi ukupnog financijskog sektora. Računovodstveni pristup daje rezultate koji su pokazali određeni vremenski odmak u odnosu na rezultate dobivene metodom AOPM u promatranom razdoblju. Rezultati mjerenja efikasnosti dobiveni metodom AOMP pokazali su najniže vrijednosti za 2007. godinu kod osigurateljne industrije i za 2008. godinu kod banaka iako su i za banke značajno niže vrijednosti vidljive već u 2007. godini. S druge strane računovodstveni pokazatelji efikasnosti, ROA i ROE, najniže vrijednosti pokazuju s određenim odmakom, tek u 2009. godini. Trend kašnjenja je zamjetan i u ostalim promatranim godinama. Takav trend je moguće objasniti nastojanjem financijskih institucija da posluju efikasnije u razdoblju krize promatrano kroz troškove i prihode, dok računovodstveni pokazatelji ne mogu postići tako dobre rezultate u razdoblju krize kao u razdoblju ekspanzije zbog nepovoljnijih uvjeta na tržištu i restriktivnije poslovne politike.

Ključne riječi: banke, osiguravajuća društva, efikasnost, analiza omeđivanja podataka, računovodstvenipokazatelji


SVEUČILIŠTE JURJA DOBRILE U PULI
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UTEMELJEN 1998.