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THE IMPACT OF INTELLECTUAL CAPITAL ON THE PROFITABILITY OF COMMERCIAL BANKS IN SERBIA

ABSTRACT: *The subject of the research in this paper is the impact of intellectual capital efficiency on the profitability of commercial banks in the Republic of Serbia. The efficiency of commercial banks' intellectual capital was measured by the created value added in the observed period, using the Value Added Intellectual Coefficient methodology (VAIC). Empirical analysis was carried out using econometric analysis of panel data for 27 banks that were operating in the banking sector of the Republic of Serbia in the period 2008–2016.*

The results of the analysis show that the significance of the impact of the efficient use of intellectual capital on the profitability of banks operating in Serbia depends on the

selected profitability measure. When ROA is chosen as an indicator of profitability the bank's level of indebtedness determines the sign of this influence, so at higher levels of indebtedness efficient use of intellectual capital negatively affects the profitability of the bank. On the other hand, in this case the size of the bank does not significantly affect the dependence of the bank's profitability on the efficient use of its intellectual capital. If ROE is a measure of the profitability of banks the efficient use of intellectual capital has no significant impact on banks' profitability.

KEY WORDS: *intellectual capital, profitability, commercial banks, Value Added Intellectual Coefficient (VAIC)*

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1. INTRODUCTION

In the knowledge economy, human intelligence in various forms of intellectual capital becomes a critical resource for economic development. Business entities create a competitive advantage through innovation and increased productivity, not by allocating traditional production factors (labour and capital), as was characteristic of agricultural and industrial economies. The use of non-material resources in businesses in the past is not unknown. However, major changes in the business environment in the mid-1980s put intellectual capital in a completely new context. These changes were manifested in a unique combination of two related economic factors: a high level of competition due to the globalization of world trade and deregulation of key sectors in the leading economies, and explosive advances in information and communication technologies in which the emergence and development of the Internet played a key role. The imperative of innovation has become a condition for the survival of businesses in the modern economy.

The early 1990s saw significant changes in the structure of business assets. In only ten years (1982–1992) the share of book value in market value of the companies that form the S&P500 index declined from 62% to 38% (Lev & Daum 2004). By 1999 the average ratio of market value to book value of net assets (P/B ratio) of companies in the S&P500 index had reached a value of seven (Lev 2001). The Tobin Q-ratio (average ratio of companies' market value to the cost of replacing their net assets) of companies in the S&P500 index tripled in the same period (<https://www.boerse.de/indizes/tobin-q/grafik>). These trends may point to the growing importance of unrecognized intangible assets in creating companies' market value.

As assets based on knowledge and innovation increasingly represented an important part of the total value of business entities, reporting on these assets grew in importance. However, changes in the knowledge economy business environment were not followed by adequate changes in industrial economies' accounting systems (Shortridge & Smith 2009). There is therefore a widespread opinion that accounting information has become less relevant (less useful in making business decisions) over the last three decades (Lev 1999). By contrast, there is another view that as long as the value generated by the use of intellectual resources is present in profitability flows and cash flows it cannot be concluded that accounting information is not useful in supporting business decisions (Penman 2009). Therefore, popular approaches have been developed to determine the absolute value of intellectual capital – such as the method of Calculated

Intangible Values (Stewart 1997) – and to calculate its efficient use – such as the Value Added Intellectual Coefficient (Pulić 2004), which we use in this paper.

Generally, in accounting literature, the notion of intangible assets is only used for intangible assets that fulfil the definition of assets and the criteria for recognising them defined in the Framework for the Preparation and Presentation of Financial Statements and the requirements presented in International Accounting Standard 38 – Intangible Assets. However, intellectual resources or intellectual capital has a broader meaning, as it encompasses elements that are not included in financial statements but which also contribute to value creation. In the literature a number of approaches to classifying intellectual resources have been proposed. The European Commission project, Measuring Intangibles to Understand and Improve Innovation Management (MERITUM), is most often used in guidelines on intellectual capital and in academic papers. According to this categorization, intellectual capital consists of three components: human, structural, and relational capital. Human capital is defined as the knowledge, skills, and know-how that employees take away after working hours and bring back in the morning. Structural capital refers to the human knowledge integrated in company processes and procedures that remains in the company when employees go home or when they leave to work in another company. Relational capital comprises resources based on a company's external relations with other entities in the business and social environment.

For this paper, empirical research was conducted in the banking sector. Although credit and deposit activity continues to be the core of banking, modern banks are constantly adapting to the dramatic changes in the business environment. Factors that are identified above as reducing the relevance of accounting information in the knowledge economy have also radically transformed banking operations: deregulation, technological innovation, and globalization are the main agents of change in modern banks' business activities and strategies (Goddard et al. 2007). In formulating research hypotheses in this paper the assumption is that modern banking is knowledge-intensive, so value is primarily created through the efficient use of intellectual resources. This is supported by the results of the relevant studies presented below.

2. LITERATURE REVIEW

The most important studies on the impact of the efficient use of intellectual capital on business performance (market or financial) can be classified into

three groups, depending on whether they are conducted in the banking sector in countries other than Serbia, in foreign business entities that operate in sectors other than banking, or in Serbian banks and other business entities.

One of the first relevant studies in the first group is by Mavridis (2004), who uses modified Value Added Intellectual Coefficient (VAIC) methodology on a sample of 141 Japanese banks, divided into five categories according to the scope and specificity of the business. The Japanese banks are ranked using the Best Practice Index (BPI), an indicator similar to VAIC, and the effect of efficient use of intellectual capital on performance is found to be statistically significant. The research also compares relevant indicators of Austrian and Greek banks and finds significant differences between these and Japanese banks.

The next survey in which banks are ranked according to the efficient use of intellectual capital was carried out in the Malaysian banking sector for the period 2001–2003 on a sample of 16 banks (Goh 2005). The research finds that efficient use of intellectual capital has a statistically significant impact on achieved performance and that the most important investment is in human capital. It also shows that despite the positive indicators of accounting performance in the sector, some large Malaysian banks use their intellectual resources less efficiently than foreign banks.

A survey conducted on a sample of 98 Indian banks for the period 2000–2004 (Kamath 2007) reaches similar conclusions. Based on the VAIC and its components, the Indian banks in this survey are ranked according to category (state and associated banks, nationalised banks, private sector domestic banks, and foreign banks). Regional rural banks are not included (the total market share of the over 200 banks in this category was about 3% in the observed period). The study concludes that there are significant differences between the different categories of bank in the Indian banking sector. Foreign banks have more efficient human capital, while public sector banks are burdened with an excessive and inefficient workforce.

A qualitative research study in the Portuguese banking sector is based on semi-structured interviews with directors/deputy directors of human resource departments in 9 of the 11 large banks that have more than 50 branches (Curado 2008). The research focuses on the management of knowledge and intellectual capital in the selected banks and the results show that the respondents were mostly familiar with the research subject but that there was still much to do regarding effective knowledge and intellectual capital management (there was

not a position devoted entirely to either area, no periodical or annual reports on these activities were being compiled, management strategies were not defined or the respondents were not familiar with them, etc.). The perception of the respondents was that about 55% of the bank value is created using intellectual capital, and that human capital is the most important component of intellectual capital, accounting for nearly half of the total value.

A survey was conducted in the Italian banking sector on data for 21 commercial banks quoted on the Milan Stock Exchange in the period 2005–2007 (Puntilo 2009). Unlike most other relevant research, this research conducts an econometric analysis of the panel data. The results do not find that the efficient use of intellectual capital components have a significant impact on commercial banks' profitability and market performance, but they do find that the efficient use of physical and financial capital has a significant impact on a bank's financial and market performance.

Another survey of the Indian banking sector is interesting in the context of this paper. Mondal and Ghosh examine the impact of intellectual capital on financial performance for a sample of the 65 largest commercial banks in India in the period 1999–2008 (Mondal & Ghosh 2012). The research uses a series of regressions individually for each year, which is a limitation, as it produces no single conclusion regarding the significance and intensity of the impact of individual regressors on the indicators of profitability and productivity as dependent variables in the models. Nevertheless, in most of the observed years it finds a significant positive influence of intellectual capital components, primarily on productivity but also on the profitability of the analysed banks, and the efficiency of human capital plays a major role in the results.

Regarding the second study category, research carried out in other sectors, the most frequently cited is by Firer and Williams (Firer & Williams 2003) on data on 75 companies listed on the Johannesburg stock exchange that operate in sectors that use intellectual resources intensively (banking, electronics, information technologies, and services). The empirical research examines the impact of the efficient use of intellectual capital components (human and structural capital) and physical and financial capital on the profitability, productivity, and market capitalization of the companies. It concludes that efficient intellectual capital components have no significant influence on the dependent variables (with the exception of the negative impact of human capital efficiency on productivity), and that the performance of companies in the analysed sectors in South Africa is still predominantly based on the efficient use of physical and financial capital.

One of the most comprehensive studies is on a sample of Taiwanese companies from 20 sectors in the period 1992–2002 and shows that the effective use of intellectual capital has a significant impact on the companies' market performance, profitability, and income growth (Chen et al. 2005). In addition to the number of observations (4,254) and the sector heterogeneity in the sample, the significance of this research is that it measures the impact of marketing and R&D costs on the dependent variables in one model and estimates all models with a time lag of regressors for one, two, and three years. The results also show that the conclusions for the sample as a whole are generally valid for most of the sectors from which the companies are sampled, although there are also sectors in which this is not the case. This fact could be important for economic policymaking in developing countries.

Also noteworthy is a study by the Finnish authors Kujansivu and Lönnqvist that examines the link between two methodological approaches to evaluating intellectual capital – Calculated Intangible Value (CIV) and VAIC (Kujansivu & Lönnqvist 2007). While applying CIV assigns the absolute value of the whole of the entity's intellectual resources, the application of VAIC generates coefficients of the efficient use of physical and financial capital and intellectual capital employed. Using correlation analysis on a sample of about 20,000 Finnish companies over a three-year period, a significant positive correlation of low intensity between the two measures is confirmed in most industries.

Zegal and Mauloul (2010) examine the impact of the efficient use of intellectual and invested (physical and financial) capital on economic, financial, and market performance for a sample of 300 British companies classified in three groups (high-tech, traditional industry, and service companies), using correlation and multiple linear regression analysis. The results find a significant positive impact of intellectual capital on economic and financial performance in all three groups of companies and in the sample as a whole, while a significant impact on market performance is confirmed only in the group of high-tech companies.

Similarly, a survey conducted on a sample of Australian companies in the period 2004–2008 (Clarke et al. 2011) confirms the relationship between the VAIC coefficient and performance indicators, but this relationship is based mainly on the impact of Capital Employed Efficiency (CEE) and, to a lesser extent, Human Capital Efficiency (HCE) on performance. The importance of this research is that it is one of the few that examines conditional effects, i.e., the way in which the efficient use of intellectual capital components (human and structural - HCE and SCE) shape the influence of the efficient use of capital employed (CEE) on

performance indicators (ROA, ROE, income growth, and employee productivity). Although the results suggest that HCE and SCE might have a modifying impact on the performance indicators' dependence on CEE, in this case no final conclusion could be reached because the choice of the dependent variable in the models determines this impact's significance.

Also worth mentioning is a survey conducted on a sample of Greek companies listed on the Athens Stock Exchange (96 companies from the four main sectors of the Greek economy) in the period 2006–2008 (Maditinos et al. 2011). This research confirms the impact of human capital efficiency on the return to equity (one of three measures of financial performance used), but does not confirm that the efficiency of capital (physical and financial) employed and structural capital significantly impact profitability and growth.

Table 1: Relevant Research on Serbia

No.	Authors	Year	Sample description	Sample size	Unequivocally proven impact
1.	Janošević, Dženopoljac	2011	Companies with highest profit in 2010 – real sector	100	No
2.	Janošević et al.	2012	Manufacturing companies with highest profit in 2011	100	No
3.	Janošević, Dženopoljac	2012	Largest Serbian export companies in 2011	300	No
4.	Janošević, Dženopoljac	2012	Companies participating in BELEX15 index (2007–2010)	15	No
5.	Dženopoljac	2013	Companies participating in BELEX line index (2010–2012)	54	Yes for some performance indicators
6.	Bontis et al.	2013	Serbian banking sector (2008– 2011)	33	No

Source: Adapted from Dženopoljac (2014), p.181

Most of the relevant research in the third category, the impact of the efficient use of intellectual capital in Serbian banks and other business entities, has been conducted using multiple linear regression analysis. It does not substantially confirm the impact of efficient intellectual capital on financial and market

performance, as can be seen in Table 1. This could lead to the conclusion that Serbian companies continue to base their results mainly on investments in physical and financial capital and that intellectual capital is still relatively unimportant. However, it is possible that these results are due to the chosen method of estimation, company sample, and observed period.

3. EMPIRICAL ANALYSIS OF THE IMPACT OF INTELLECTUAL CAPITAL ON PROFITABILITY – THE CASE OF COMMERCIAL BANKS IN SERBIA

3.1 Data and methodology

At the end of 2016 there were 31 banks in the Serbian banking sector. One was established in 2015 and a second in 2016. The initial survey was conducted on sampled panel data for the remaining 29 commercial banks in the period 2008–2016. The data source was commercial banks' audited annual financial reports published on the National Bank of Serbia website. The observed period starts in 2008 because previously wage costs were not presented as a separate position in official income statements, and they are important determinants for the calculation of certain indicators used in the model.

The starting point in empirical research is the methodology of the Value Added Intellectual Coefficient, VAIC (Pulić 2004)¹. Pulić is of the opinion that all of a company's resources can be grouped into two major categories: capital employed (CE) and intellectual capital (IC). Capital employed includes physical and financial capital, while intellectual capital is comprised of human and structural capital, including relational capital (as in Edvinsson & Malone 1997). Value added can be most easily presented as the difference between the company's output and input, as in equation (1). Sales revenue is a measure of output and the value invested in the business process in various forms represents input in the calculation of value added.

$$VA = OUT - IN \quad (1)$$

The main assumption on which the VAIC method is based is that expenditure on employees (wages) is a company asset, contrary to the traditional accounting

¹ Ante Pulić, Professor at the Universities of Zagreb and Graz, authored this methodology. He became known in academia after he applied VAIC methodology to measure the efficiency of regions in Croatia. However, VAIC is primarily designed as an instrument for measuring the efficient use of resources in companies.

concept that treats it as a cost. This means that when calculating VAIC it is necessary to include expenditure on employees in the value added, so the value added is calculated as the difference between sales revenue and the related cost of materials, components, and services used in the production of sold products (Pulic 2004). This can be presented in the following way:

$$VA = OP + EC + D + A \quad (2)$$

where the symbols used in equation (2) have the following meaning:

VA – value added

OP – operating profit

EC – employee costs

D – depreciation of tangible fixed assets

A – amortization of intangible assets.

In this approach the value of human capital (HC) equals the amount of total expenditure on employees in the observed period:

$$HC = EC \quad (3)$$

Structural capital (SC) is calculated as the difference between intellectual capital and human capital. Since value added is an indicator of the value of intellectual capital, structural capital can be expressed as:

$$SC = VA - HC \quad (4)$$

Finally, the value of the capital employed (CE) (i.e., the value of invested physical and financial capital) is represented by the book value of the company's net assets.

In the next step the efficiency ratios for the company's human, structural, and capital employed (HCE, SCE, CEE) are calculated in the following way:

$$HCE = VA/HC \quad (5)$$

$$SCE = SC/VA \quad (6)$$

$$CEE = VA/CE \quad (7)$$

Because the author views human and structural capital as reciprocal, the calculation of the second of the three ratios (6) differs from the first (5) and the third (7). We arrive at VAIC as a comprehensive measure of the efficient use of the company's total resources in generating value by adding the three individual efficiency ratios:

$$\text{VAIC} = \text{HCE} + \text{SCE} + \text{CEE} \quad (8)$$

and finally

$$\text{VAIC} = \text{ICE} + \text{CEE} \quad (9)$$

where ICE = Intellectual Capital Efficiency, and bearing in mind that $\text{ICE} = \text{HCE} + \text{SCE}$.

The VAIC method has grown in importance, since its implementation is simple and it uses publicly available reliable data from audited financial statements. Academics and professionals consider that it “is becoming more and more accepted by researchers as a good indicator of the efficient use of intellectual capital by companies” (Janošević & Dženopoljac 2011, p.357). However, a major criticism is that the assumptions on which it is based “can explain the disappointing results of using VAIC as an indicator that explains the performance of companies” (Andriessen 2011, p.367). The most important criticisms of the VAIC methodology are summarized below (see Andriessen 2011; Ståhle et al. 2011; Starovic & Marr 2002):

- The method does not properly separate assets and costs; for example, in the case of expenditure on employees. Related benefits can rarely be expected after the end of the observed period, which means that this expenditure should be treated as a cost rather than an asset.
- The method creates considerable confusion between the value of stocks and value of flows. For example, periodic expenditure on employees is treated as a stock value, although it is actually a flow value. Only the accumulated amount of all previous periodic expenditure on employees can be a value of the stock of human capital, not the amount from one observed period.
- It is disputable whether the assumption of reciprocity of the effect of human capital and structural capital is rationally grounded. Because of this assumption the application of the VAIC method often results in unexpected outcomes.

- The approach ignores the fact that the added value does not only result from the use of human and structural capital employed on an individual basis, but also from synergies between different types of resources in the business process.
- The use of value added in the calculation of VAIC is problematic since the amount of write-offs of tangible and intangible assets is determined by the capital intensity of the sector in which the business entity operates as well as by adopted accounting policies (specifically, the policy concerning the entity's asset depreciation and amortisation), resulting in VAIC values being incomparable between entities from different sectors.
- In calculating VAIC it is possible to compensate for inefficient use of one type of resource by more efficient use of another type of resource that will result in roughly equal VAIC values.
- In periods when companies are considered to have negative results, the value added and the individual efficiency indicators (HCE, SCE, and CEE) are likely to be negative, which will raise doubts about the conclusions of analysis based on this approach.

Although in recent years various authors have rejected or challenged the above criticisms, it is undisputed that the VAIC methodology has been applied in much research on the influence of intellectual capital on entities' financial and market performance. Thus, the main argument for using VAIC methodology in this paper is the possibility of comparing the results with similar research.

3.2 Defining the research hypothesis and model

In this paper's quantitative research, descriptive statistical analysis and econometric analysis of panel data is carried out in order to examine the statistical significance and intensity of the impact of the efficient use of intellectual resources on the indicators of profitability as dependent variables. The regressors in the multiple linear regression models will be ICE and CEE as VAIC components. ICE is a key regressor when considering the impact of intellectual capital on banks' profitability, while CEE is included as the control variable in the defined models. In addition, the specification includes the regressors 'Size' (measured by the natural logarithm of the book value of the bank's total assets) and 'Leverage' (measured by the share of total liabilities in the bank's total assets), and the interactions of the regressor ICE with the regressors Size and Leverage.

Interactions are conditional effects, which means that the effect of ICE on profitability indicators depends on the regressors Size and Leverage (on the interpretation of interaction of regressors in models see, for example, Brambor et

al. 2006). In this way, the impact of the efficient use of a bank’s intellectual resources on its profitability will be examined depending on the size and indebtedness of the bank. Since both the interactions and the regressors that constitute these interactions are included in the model, the question of treating the increased multicollinearity in such a specification logically arises. It should be borne in mind that including in the model interactions together with the regressors that constitute these interactions changes the estimated values of the coefficients and their interpretation in relation to the specification without interactions, so the problem of multicollinearity in a model with interactions is overstated (Friedrich 1982). Although it is true that omitting regressors that constitute interactions from the specification would reduce multicollinearity, only in rare circumstances of perfect multicollinearity would it really be necessary to do so (Brambor et al. 2006).

The most commonly used indicator of size (e.g., in Zeghal & Maaloul 2010) is the size of the commercial bank, measured by the natural logarithm of the value of total assets in the observed banks, and a natural logarithm of market capitalization (e.g., in Firer & Williams 2003). Leverage, measured by the share of total liabilities in the book value of total assets, is also used as a control variable in similar research (Firer & Williams 2003; Zeghal & Maaloul 2010).

That the positive impact of the efficient use of intellectual capital and its components on the profitability of entities has been confirmed in similar research (Chen et al. 2005; Ting & Lean 2009; Zeghal & Maaloul 2010, etc.) is a rational basis for setting up the following research hypothesis:

H₁: Efficient use of intellectual capital positively affects the profitability of commercial banks

In the two regression models the dependent variables ‘return on assets’ (ROA) and ‘return on equity’ (ROE) are indicators of profitability. To empirically check this dependence the initial models with fixed individual and time effects are defined, represented as follows:

$$\begin{aligned}
 ROA_{it} &= \beta_{1it} + \beta_2 * ICE_{it} + \beta_3 * CEE_{it} + \beta_4 * Size_{it} + \beta_5 * Leverage_{it} + \beta_6 * ICE_{it} * Size_{it} \\
 &+ \beta_7 * ICE_{it} * Leverage_{it} + u_{it} = \\
 &= (\beta_1 + \mu_i + \lambda_t) + \beta_2 * ICE_{it} + \beta_3 * CEE_{it} + \beta_4 * Size_{it} + \beta_5 * Leverage_{it} \\
 &+ \beta_6 * ICE_{it} * Size_{it} + \beta_7 * ICE_{it} * Leverage_{it} + u_{it},
 \end{aligned}
 \tag{10}$$

$$\begin{aligned}
 ROE_{it} &= \beta_{1it} + \beta_2 * ICE_{it} + \beta_3 * CEE_{it} + \beta_4 * Size_{it} + \beta_5 * Leverage_{it} + \beta_6 * ICE_{it} * Size_{it} \\
 &+ \beta_7 * ICE_{it} * Leverage_{it} + u_{it} = \\
 &= (\beta_1 + \mu_i + \lambda_t) + \beta_2 * ICE_{it} + \beta_3 * CEE_{it} + \beta_4 * Size_{it} + \beta_5 * Leverage_{it} + \\
 &\beta_6 * ICE_{it} * Size_{it} + \beta_7 * ICE_{it} * Leverage_{it} + u_{it}
 \end{aligned}
 \tag{11}$$

where the symbols have the following meaning:

- ROA_{it} – return on assets of bank *i* in year *t*
- ROE_{it} – return on equity of bank *i* in year *t*
- ICE_{it} – coefficient of intellectual capital efficiency of bank *i* in year *t*
- CEE_{it} – coefficient of capital employed efficiency of bank *i* in year *t*
- Size_{it} – size of total assets of bank *i* in year *t* measured by natural logarithm
- Leverage_{it} – level of indebtedness of bank *i* in year *t*, measured by share of total liabilities in book value of total assets
- ICE_{it} * Size_{it} – product of regressors ICE and Size of bank *i* in year *t*
- ICE_{it} * Leverage_{it} – product of regressors ICE and Leverage of bank *i* in year *t*
- β_{1it} – intercept of bank *i* in year *t*
- β₂ - β₇ – regression parameters
- μ_i λ_t – individual and time fixed effects
- u_{it} – random error in model.

3.3 Results and discussion

When presenting characteristic values in the descriptive statistical analysis, the starting point is the data for all 29 banks operating in Serbia in the period 2008–2016. Table 2 presents the results of descriptive analysis of the two dependent variables for the sample as a whole and within and between the observed banks.

Table 2: Results of descriptive statistical analysis of dependent variables (29 banks, 9 years)

Dependent variable	Mean	Stand. Deviation	Min	Max
ROA				
overall	-0.016307	0.130633	-1.421500	0.209500
between		0.053322	-0.224511	0.031711
within		0.119622	-1.286429	0.211704
ROE				
overall	-0.080802	0.587483	-8.333000	0.297400
between		0.225645	-0.905245	0.137733
within		0.543863	-7.508558	1.031442

Source: Results of analysis conducted by the author in STATA software

The analysis of the data based on graphs of changes in the values of the dependent variables in the observed period shows extreme values for two observations, *Srpska banka* in 2014 and *Telenor banka* in 2013. If the data for these two banks is excluded from the sample, the characteristic values of the descriptive statistics of dependent variables are as presented in Table 3.

Table 3: Results of descriptive statistical analysis of dependent variables (27 banks, 9 years)

Dependent variable	Mean	Stand. Deviation	Min	Max
ROA				
overall	-0.003593	0.040132	-0.252600	0.209500
between		0.022915	-0.048689	0.031711
within		0.033208	-0.207505	0.193840
ROE				
overall	-0.028298	0.187573	-1.617200	0.297400
between		0.110879	-0.291122	0.137733
within		0.152630	-1.354376	0.324613

Source: Results of analysis conducted by the author in STATA software

The differences between the values of Table 2 and Table 3 indicate the impact that the extreme values of the dependent variables have on the mean and standard deviations of ROA and ROE. To avoid this it is possible to exclude the two observations where *Srpska banka* and *Telenor banka* achieve extreme values. However, this would result in an unbalanced panel and make it impossible to apply some of the econometric tests below. Considering that *Srpska banka* and *Telenor banka* do not comprise a significant share in the total assets and income of the Serbian banking sector, the data relating to them will be exempt from further consideration. Therefore, the sample contains a total of 243 observations (i.e., data for 27 banks over a period of 9 years). Based on this sample, the characteristic values of the descriptive statistical analysis of the regressors in the defined models (except the regressors representing interactions) are shown in Table 4.

Table 4: Results of descriptive statistical analysis of regressors
(27 banks, 9 years)

Regressor	Mean	Stand. Deviation	Min	Max
ICE				
overall	1.131742	10.587420	-143.603100	48.658500
between		3.833792	-13.984340	7.806544
within		9.893497	-128.487000	44.001540
CEE				
overall	0.100340	0.174823	-1.451600	0.447000
between		0.095793	-0.124822	0.342278
within		0.147276	-1.226437	0.543529
Size				
overall	24.570190	1.399541	20.073560	27.035760
between		1.366884	21.820850	26.706700
within		0.390012	22.697480	25.656560
Leverage				
overall	0.765712	0.124013	0.146200	0.925100
between		0.089219	0.502444	0.861222
within		0.087649	0.409468	1.163868

Source: Results of analysis conducted by the author in STATA software

In both models defined to test the validity of hypothesis H_{-1} the assumptions of random error have been violated (the homoscedasticity of the random error, the independence of the random error between different observation units in the same time periods, and the absence of autocorrelation of a random error for the same unit of observation between different time periods). Individual effects are significant in both models, contrary to the time effects, which have no statistical significance in either model. The results of the tests of fulfilment of random error assumptions and significance of individual and time effects are given in Table 5 (the two initial specifications in the first two rows and the specifications which will be further considered in the latter rows). In both cases, due to the violation of the assumptions of random error in the model, linear regressions with panel-corrected standard errors were conducted using the Ordinary Least Squares (OLS) method and Prais-Winsten estimation. The results are given in Table 6.

Table 5: Results of the tests of fulfillment of random error assumptions and significance of individual and time fixed effects

Specification	Heteroscedasticity (modified Wald test)	Autocorrelation (Wooldridge test)	Cross-Sectional Dependence (Frees test)	Individual FE (F test)	Time FE (F test)
ROA model with interactions ICE*Size and ICE*Leverage	20,018.10 (0.0000)	7.167 (0.0127)	1.333	2.49 (0.0002)	0.98 (0.4554)
ROE model with interactions ICE*Size and ICE*Leverage	18,232.97 (0.0000)	7.004 (0.0136)	3.337	13.46 (0.0000)	1.40 (0.1972)
ROA model with interaction ICE*Leverage and regressor Size	29,818.33 (0.0000)	7.321 (0.0119)	1.775	2.41 (0.0003)	0.90 (0.5184)
ROE model with interaction ICE*Leverage and regressor Size	18,486.28 (0.0000)	4.895 (0.0359)	3.351	13.54 (0.0000)	1.41 (0.1958)
ROA model with interaction ICE*Leverage, without regressor Size	38,933.16 (0.0000)	6.557 (0.0166)	1.418	5.65 (0.0000)	0.79 (0.6151)
ROE model with interaction ICE*Leverage, without regressor Size	21,523.62 (0.0000)	5.368 (0.0286)	3.187	24.76 (0.0000)	1.43 (0.1837)

Notes: P-values are presented in brackets. In Frees’ test the critical value for 1% level of significance is 0.5811.

Source: Results of the analysis conducted by the author in STATA software

Table 6: Results of estimation of linear regression with panel-corrected standard errors (initial models with all regressors)

Linear regression with panel-corrected standard errors		
Regressor	Dependent variable	
	ROA - Return on Assets	ROE - Return on Equity
	Estimated coefficient	Estimated coefficient
ICE	0.006205	0.004215
CEE	0.191514***	1.004253***
Size	0.004381	0.020386
Leverage	-0.027839	-0.168949***
ICE*Size	0.000230	-0.000412
ICE*Leverage	-0.015101***	0.007521
Values		
R ²	0.8862	0.9748
Individual FE test (χ^2)	59,284.19***	120,000.00***
Significance of model (Wald χ^2)	98,536.03***	176,128.61***

Notes: The asterisks ***, ** and * indicate 1%, 5% and 10% levels of significance respectively.

Source: Results of the analysis conducted by the author in STATA software

From the presented results of the model in which ROA is a dependent variable it could be concluded that the estimated parameter of the regressor ICE is not significant (p-value = 0.109). However, since interactions of regressor ICE with regressors Size and Leverage are present in the model, the estimated parameter

of regressor ICE would represent a change in the dependent variable ROA for the unit change in the regressor ICE only if regressors Size and Leverage were equal to zero, which is not possible (the minimum values of these regressors are significantly greater than zero in the sample: see Table 4). Therefore, the estimated values and significance of the parameters of the interactions of regressor ICE with regressors Size and Leverage also have to be taken into account. From Table 6 it can be seen that the interaction of regressors ICE and Leverage is significant at the 1% level and has a negative sign, which means that the positive impact of intellectual capital efficiency on profitability measured by ROA is reduced with an increase in indebtedness, and at a certain level of indebtedness it becomes negative. In addition, the estimated coefficient of the interaction of regressors ICE and Size is not significant, which at first glance indicates that the ICE's influence on ROA does not depend on the size of the bank. However, this does not mean that for certain levels of size a significant conditional effect of ICE on ROA is not possible (Brambor et al. 2006). Therefore, an additional test of linear constraints should be carried out (test of the linear hypotheses that both estimated parameters of ICE and the interaction of ICE with regressors Size or Leverage are equal to zero). Based on the results of this test it will be possible to draw a conclusion about the significance of the impact of ICE on ROA. Realized values of the hi-square test indicate that the significance of this impact is at the 1% level (Table 7).

Table 7: Realized values of the test of linear constraints for hypothesis H_{-1}

Regressor	(test of linear restrictions)	
	Dependent variable - ROA	Dependent variable - ROE
ICE and ICE*Size	55.26***	2.11
ICE and ICE*Leverage	54.37***	2.14

Notes: The asterisks ***, ** and * indicate 1%, 5%, and 10% levels of significance respectively.

Source: Results of the analysis conducted by the author in STATA software

The model is generally significant (the realized value of Wald's hi-square statistics is 98,536.03; p -value = 0.0000) and the model explains a significant part of the total variability of the dependent variable ($R^2 = 0.8862$) (Table 6).

In the results obtained from the estimation of another model in which ROE is a dependent variable (presented in Table 6), the insignificance of both regressor ICE and interactions of this regressor with the regressors Size and Leverage may at

first lead to the conclusion that ICE has an insignificant impact on ROE. However, as in the previous case, it is necessary to carry out an additional test of linear constraints to draw a correct conclusion about the significance of the impact of ICE on ROE. Realized values of hi-square tests suggest that efficient use of intellectual capital has no significant impact on banks' profitability measured by ROE, regardless of the size of the bank and the level of its indebtedness. (Table 7).

Finally, in both presented models the regressor CEE has an estimated positive coefficient, significant at the 1% level, which indicates a significant positive impact of the efficient use of capital employed (physical and financial) on the profitability of commercial banks, regardless of whether the measure of profitability is ROA or ROE.

Since in both previous specifications the estimated coefficients of the regressor Size and the interaction ICE*Size are not significant, a linear regression with panel-corrected standard errors is estimated with neither the regressor Size nor the ICE*Size interaction, which represents a check of the robustness of the previously obtained results. As in the previous case, the reason for applying this model is the violation of the mentioned assumptions of a random error (the results of testing the fulfillment of these assumptions are given in Table 5, from the third to the sixth row). The results of the estimation of these new specifications (with dependent variables ROA and ROE) are given in Table 8.

In the specifications without regressor ICE*Size, as in the previous case, individual effects are still significant at the 1% level, while time effects are not significant, regardless of whether the dependent variable is ROA or ROE (Table 5, third and fourth rows). Also, in both specifications as well as in the previous models, CEE has a significant positive effect on the dependent variable at a 1% level of significance.

Table 8: Results of estimation of linear regression with panel-corrected standard errors (models without interaction ICE*Size)

Linear regression with panel-corrected standard errors				
Regressor	Dependent variable			
	ROA - Return on Assets		ROE - Return on Equity	
	Estimated coefficient		Estimated coefficient	
	with regressor Size	without regressor Size	with regressor Size	without regressor Size
ICE	0.010341***	0.010509***	-0.002878	-0.002222
CEE	0.190928***	0.191252***	1.006955***	1.009120***
Size	0.004220	--	0.020074	--
Leverage	-0.033142	-0.019368	-0.157999***	-0.092742**
ICE*Leverage	-0.013294***	-0.013506***	0.003750	0.002905
Values				
R ²	0.8855	0.8849	0.9746	0.9734
Individual FE test (χ^2)	110,000.00***	180,000.00***	23,660.05***	26,729.62***
Significance of model (Wald χ^2)	372,584.13***	17,135.24***	1,060,000.00***	309,277.38***

Notes: The asterisks ***, ** and * indicate 1%, 5%, and 10% levels of significance respectively.

Source: Results of the analysis conducted by the author in STATA software

In the first specification the estimated coefficient of the regressor ICE is significant at the 1% level (in the previous model with the dependent variable ROA this parameter was not significant). The estimated parameter of the interaction ICE*Leverage remains significant at the 1% level and has a negative sign. The results of the test of linear constraints of the regressor ICE and its interaction with the regressor Leverage indicate a significant impact of ICE on profitability measured by ROA at a 1% level of significance (the realized value of the hi-square test is 43.66; p-value = 0.0000). The coefficient of determination remains at a very high level ($R^2 = 0.8855$). As in the previous case, the model has high significance (the realized value of Wald's hi-square statistics is 372,584.13; p-value = 0.0000). Let us now consider what the effect of the indebtedness level will be on ROA's dependence on the efficient use of intellectual capital. In mathematical form it looks as follows:

$$\begin{aligned} \text{Impact of ICE on ROA} &= 0.010341 * \text{ICE} - 0.013294 * \text{ICE} * \text{Leverage} = \\ &= (0.010341 - 0.013294 * \text{Leverage}) * \text{ICE} \end{aligned} \quad (12)$$

It can be seen that increased indebtedness decreases the positive impact of ICE on ROA, so that at a certain level of indebtedness this effect becomes negative. In particular, this change in ICE's impact on ROA occurs when the value of the

regressor Leverage is 0.77787 (77.79% of the share of liabilities in the total value of the financing sources), which is a level of indebtedness slightly above the average (from Table 4 we see that the mean value of the regressor Leverage is 0.765712). Therefore, it can be concluded that the efficient use of intellectual capital has a significant impact on the bank's profitability measured by ROA, which is positive below the mentioned level of indebtedness and negative above that level. Therefore, the significance of the impact of ICE on ROA is ambiguous because the sign of that impact depends on the level of the bank's indebtedness.

In the model with ROE as the dependent variable (after the regressor ICE*Size is excluded) the regressors ICE and ICE*Leverage are still not significant (as when regressor ICE*Size is included in model). The result of the test of linear constraints of regressor ICE and its interaction with the regressor Leverage also indicates that ICE has no significant impact on the profitability of banks measured by ROE, regardless of banks' level of indebtedness (the realized value of hi-square test is 1.17; p-value = 0.5580).

Similar conclusions are reached if the regressor Size is additionally excluded in both models. By testing the joint significance of regressors ICE and ICE*Leverage in the specification with dependent variable ROA, we conclude that efficient use of intellectual capital has a significant impact on profitability measured by ROA at the 1% level of significance (realized value of the hi-square test is 45.52; p-value = 0.0000). The estimated values of the regression parameters, their significance, and the share of explained in total variability remain approximately at the same level as in the specification that includes regressor Size. The impact of indebtedness level on dependence of ROA on the efficient use of intellectual capital can be quantified as follows:

$$\begin{aligned} \text{Impact of ICE on ROA} &= 0.010509 * \text{ICE} - 0.013506 * \text{ICE} * \text{Leverage} = \\ &= (0.010509 - 0.013506 * \text{Leverage}) * \text{ICE} \end{aligned} \quad (13)$$

In this case, a change in the sign of the impact of indebtedness level on the dependency of ROA on ICE occurs when the value of the regressor Leverage equals 0.77810 (77.81% of total financing source liabilities), which is almost identical to the results previously obtained. This confirms the importance of financial leverage in the dependence of banks' profitability on the efficient use of intellectual capital.

In the model with the dependent variable ROE (after regressor Size is excluded) the result of the test of the joint significance of regressor ICE and interaction

ICE*Leverage supports a conclusion identical to that in the previous specification (with regressor Size included). ICE has no significant impact on banks' profitability measured by ROE, regardless of the level of the bank's indebtedness (the realized value of hi-square test is 0.76; p-value = 0.6846). In this case, the estimated values of the regression parameters, their significance, and the share of variability explained by the model do not change significantly compared to the values in the specification that includes the regressor Size.

4. CONCLUSIONS, LIMITATIONS, AND FURTHER RESEARCH

Subsequent to the previous considerations, the most important conclusions are the following.

Firstly, that the efficient use of intellectual capital has a significant impact on the profitability of Serbian commercial banks is confirmed when ROA is used as a measure of profitability, but the sign of the impact depends significantly on the bank's level of indebtedness. Thus, in this case hypothesis H_{-1} can only be partially verified. The size of the bank does not significantly affect the dependence of bank profitability measured by ROA on the efficient use of its intellectual capital.

Secondly, a significant influence of the efficient use of intellectual capital on the profitability of Serbian commercial banks is not confirmed if ROE is used as the indicator of profitability.

Thirdly, in all considered specifications the estimated value of the parameter of regressor CEE has a positive sign and is significant at the 1% level. When comparing these values with the estimated values of the parameters of regressor ICE, the effect of the efficient use of physical and financial capital on commercial banks' profitability remains more important than the impact of the efficient use of intellectual capital. This effect is also consistent, because it depends on neither the choice of dependent variable nor the inclusion or exclusion of regressors that represent conditional effects in the model or other regressors (e.g., the regressor Size).

The size of the sample is an important limitation of this research. Although the sample includes data for 29 of the 31 banks that were operating in Serbia at the end of 2016, representing over 90% of the value of the Serbian banking sector's total assets and total income in the observed period, and the analysis was conducted for the relatively long period of 9 years, it would certainly be better if

the total number of observations in the sample were higher, in order to obtain more reliable results based on econometric analysis of the panel data.

Furthermore, the research relates to one sector (banking) in one country (Serbia). While this could be considered a limitation, it can also be considered an advantage because the observed units have been exposed to a unique macroeconomic environment. Additionally, this allows the use of certain indicators in the analysis that are characteristic of the sector from which the units are sampled (in this case the banking sector); for example, the interest margin and the share of income from fees and commissions in total operating income (although this was not the case in this study).

Data availability could also be a significant limitation (although this is not so obvious in this research). Commercial banks operating in Serbia have recently started publishing financial statements for the last ten years on their websites, but some of them still omit much important information in the notes to financial statements. The data that is readily available can define the choice of methodology used in empirical research, as well as the choice of regressors included in the econometric models. Also, the form of financial statements during the survey period was not completely consistent so additional effort was necessary to make the information more comparable.

The following recommendations are made to improve the empirical research carried out in this paper and for potential future research in this area: the expansion of sampled data into more sectors and/or more countries; the breakdown of the regressor ICE into its constituent components HCE and SCE in order to examine the significance and intensity of the impact of human and structural capital on profitability; additional testing of the robustness of the econometric models used by including new regressors in the specification; use of alternative methods to estimate regression parameters, the model characterized by the time lag of regressors, etc.

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