Impact of intellectual capital on financial ratios: evidence from Polish banks listed on the Warsaw Stock Exchange

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DOI: 10.24427/az-2022-0015

Abstract

The goal of this article is to evaluate the impact of intellectual capital efficiency on the financial ratios of Polish banks listed on the Warsaw Stock Exchange. The timespan of the study covers the years 2014-2020. Various research methods were applied in the study – descriptive analysis, desk research, the VAIC™ method, descriptive statistics and multiple regression analysis – by the panel least squares method. The results obtained confirmed the influence of intellectual capital efficiency on return on equity (ROE), return on assets (ROA) and total shareholder return (TSR). Moreover, a varied influence in the efficiency of individual components of intellectual capital was found on the indicated metrics describing the results of the studied companies (i.e. financial ratios). The study confirms that, in the knowledge-based economy, intellectual capital plays a critical role in strengthening banks' financial ratios. The application of the presented methods should provide additional knowledge on the role of intellectual capital in management of a commercial bank and interest a broad spectrum of people: scientists, management staff, representatives of supervisory institutions as well as practitioners on the market: investors and analysts.

Keywords

intellectual capital, intellectual capital efficiency, banks, financial ratios, financial performance

Introduction

With the advent of the knowledge-based economy, the sources of wealth creation changed for companies. The role of traditional factors of production, such as: land, capital and labor, decreased significantly. However, the significant importance

of intangible assets making up intellectual capital started to be perceived [Komnenic et al., 2010, p. 25]. Intellectual capital is currently considered to be one of the most important resources for value creation in enterprises, a factor contributing to a permanent competitive advantage and to improvement of financial performance [Moczydłowska, 2008; Dženopoljac et al., 2016; Chowdhury et al., 2019; Xu et al., 2020; Xu and Liu, 2021; Xu and Li, 2022]. The significance of intellectual capital can be seen in all branches of the economy, including in the finance and banking sector.

This serves as a premise for the need to conduct research concerning the impact of intellectual capital on the financial ratios of enterprises. Research of this type requires measurement of intellectual capital by means of the appropriate tool, since traditional systems of measurement, adopted for tangible capital, are insufficient [Michalczuk et al., 2021, p. 17]. Growing demands in this scope spurred the development of a series of measuring methods [Sveiby, 2010].

The goal of this article is to evaluate the impact of intellectual capital efficiency on the financial ratios of Polish banks listed on the Warsaw Stock Exchange. The research sample consists of Polish commercial banks belonging to the WIG-Banki [WSE-Banks] index. The timespan of the study covers the years 2014-2020. Diverse research methods were applied in the study, including: descriptive analysis, desk research, the VAIC™ method (Value Added Intellectual Coefficient), descriptive statistics, and multiple regression analysis – by means of the panel least squares method.

The choice of the banking sector as the subject of research was dictated by the fact that banks are increasingly generating income arising from the possession and proper utilization of intangible resources, as indicated by the growth of the gap between their market and book value. The banking sector plays a key role in the process of economic development in every country, because it enables the growth and success of its constituent enterprises through financing. Moreover, it determines the level of consumption and investment and constitutes an institution of public trust [Korzeb, 2018]. This sector is dependent on the intensive, knowledge-based nature of banking and finance. It applies specialized knowledge, know-how, utilizes modern technologies and builds relational capital with clients. Because of this, it frequently serves as an area for research on intellectual capital [Kamath, 2007; Ismail and Karem, 2011; Meles et al., 2016; Le and Nguyen, 2020; Sannino et al., 2021; Mollah and Rouf, 2022; Xu et al., 2022].

The article is organized as follows. The first part is a literature review referring to the subject matter of defining intellectual capital and relationships between intellectual capital and banks' financial ratios. The second part contains a description of

the research methodology, tools for measuring intellectual capital, and a characterization of the research sample. The third part of the article presents obtained results of research. The next part is an analysis and discussion of conducted research, which also indicates the limitations of the article. The paper is concluded by a summary containing conclusions drawn from research and presenting potential practical applications of the research results as well as directions of future research in this field.

1. Literature review

In the 1980's, significant sources of competitive advantage in the financial services sector were traditional factors such as: bank's financial situation, low operating costs and factors related to offered services (their quality and variety). In the 1990's, as a result of a reorientation in the significance of causes of enterprise growth, the role of intangible resources grew in significance and garnered attention. Research conducted over the past decade or so in various branches of the economy, including in the financial services sector, confirms that the economic value of modern enterprises depends on intangible assets to a significant extent [Harasim, 2008, p. 42; Al-Musali and Ku-Ismail, 2016, p. 527; Ousama et al., 2020, p. 87; Uslu, 2022, p. 244). Currently, valuation of intellectual capital by investors causes the book value of many companies listed on the stock exchange to be substantially lower than their market value.

It should be highlighted that the subject literature does not provide a separate definition for "bank's intellectual capital". This concept is considered as the intellectual capital of an enterprise [Soewarno and Tjahjadi, 2020; Weqar et al., 2021; Akkas and Asutay, 2022]. A series of different definitions of intellectual capital can be found, evolving over the years. In Stewart's opinion [1997, pp. IX-X, XVI, 66-68], intellectual capital encompasses the talents and skills of individuals and groups, broadly construed knowledge, information, technological and social network, software, as well as the culture linking all of these elements. According to Edvinsson and Malone [2001, p. 39], it is non-financial capital reflecting the hidden gap between market and book value. In turn, Roos and Roos [1997, p. 415] state that intellectual capital reflects the sum of a unit's invisible assets, not given in financial statements, which also include that which remains in employees' minds both at work and after work.

When analyzing the subject matter of banks' intellectual capital, one should indicate the research conducted by Canals. This author distinguished four sources of banks' competitive advantage. These sources are: human resources, financial assets, other assets (IT and telecommunications systems as well as networks of branches),

as well as intangible assets such as: experience, image, quality of products and services, and management skills [Canals, 1993, pp. 206-210; Canals, 1997, p. 254]. Bharadway et al. [1993, p. 85] also qualified corporate culture, economy of scale, brand reputation, modern information technology and possibilities of its application among potential sources of competitive advantage in the services (including financial services) sector. Farrance [1993, pp. 3-9] also includes brand, quality of banking services and relational banking in the group of elements distinguishing banks, besides distribution, technology, segmentation, price policy and development of the product assortment.

When analyzing the subject literature, one can notice that a bank's brand, reputation and image are indicated as being among the most significant intangible assets, having primary significance from the perspective of an enterprise's efficiency and impact on the market [Devlin and Ennew, 1997, p. 80; Marcinkowska, 2008, pp. 215-218; Wrzosek, 2005, pp. 176-177]. An identifiable brand, positive image and irreproachable reputation influence all groups of consumers. They affect customers' decisions to purchase a given product, investors' decisions to purchase shares and both current and potential contracting parties' inclinations to enter into a transaction. Moreover, they influence employees, mobilizing them to work, the government, leading to the adoption of favorable legislation, and local communities and media, which then express positive opinions about the organization [Harasim, 2007, p. 243].

Employees are another important component of banks' intangible assets. Human capital is not only analyzed from the perspective of typical quantitative criteria such as: education, training and experience. In the case of a bank, what is more significant is employee efficiency, which is dependent on initiatives taken, innovation, flexibility, ability to take risks, problem-solving and teamwork [Gołębiowski, 2001, pp. 190-191]. Furthermore, the substantial role of organizational culture, manifesting in values, norms, attitudes and behaviors, is highlighted in works dedicated to the intellectual capital of a bank [Harasim, 2008, p. 53]. This author highlights that intangible assets are extraordinarily important in creating banks' competitive advantage. She also emphasizes that it is difficult to evaluate their role from a purely financial perspective [Harasim, 2008, p. 54].

The rise in interest in the concept of intellectual capital and exposure of its role in building values and competitive advantage in enterprises has caused banks' intellectual capital to more frequently be the subject of scientific research. One important area of research concerns evaluation of the relationships between the intellectual capital and financial and market performance of banks. The research that is being conducted is mainly focused on evaluating dependencies between intellectual capital

and financial ratios such as: return on assets, return on equity and market value [Ousama et al., 2020; Onumah and Duho, 2020; Nazir et al., 2021; Sannino et al., 2021; Akkas and Asutay, 2022].

Soewarno and Tjahjadi [2020] study relations between intellectual capital and the financial performance of the banking sector in Indonesia. The authors employ two models – the conventional value added intellectual coefficient model (VAIC™) and the adjusted value added intellectual coefficient model (A-VAIC™). The results obtained confirm the hypothesis that intellectual capital has an influence on banks' financial performance. Similar research is conducted by Ousama et al. [2020], who analyze the influence of intellectual capital on the profitability of Islamic banks operating in member states of the Cooperation Council for the Arab States of the Gulf (GCC). Their study indicates that intellectual capital has a positive influence on the profitability of Islamic banks. The authors also demonstrate that structural capital has an insignificant influence on the financial performance of Islamic banks in comparison to human capital, financial capital and tangible capital. Studies conducted on companies of financial index listed on the Bombay Stock Exchange demonstrated that the efficiency of human capital is significant only in the case of increasing return on assets, while the efficiency of structural capital remains insignificant for all financial ratios, whereas the efficiency of capital employed shows a significant positive relationship with the profitability of the financial sector [Weqar et al., 2021]. Sannino et al. [2021] analyze the influence of intellectual capital efficiency on the financial performance of Italian banks during and after the non-performing loans (NPL) crisis[1]. Their results showed that intellectual capital efficiency has a positive influence on the financial performance of Italian banks, regardless of the crisis. Moreover, the study proved that Italian banks' capacity to create value is commonly ascribed to the appropriate combination and management of both human capital and efficiency of capital employed. Uslu [2022] indicates the special influence on human capital on the financial performance of banks in Turkey, while simultanoeously showing the decidedly lesser significance of structural capital. In turn, Joshi et al. [2013] confirm that the capacity of the Australian financial sector to create value is largely dependent on human capital. Meles et al. [2016] reach similar conclusions, showing that the efficiency of utilizing intellectual capital has a positive influence

[1] In Italy, after two years of recession (2012 and 2013), a year of flat growth (2014) and two years of sluggish growth of less than 1% (2015 and 2016), non-performing loans have reached a level that hampers the bank lending channel. In 2016, non-performing loans outstanding held by Italian banks (EUR 329 billion at 30 September accounted for a third of the total for eurozone banks (EUR 1,062 billion in Q2 2016, EBA, 2016), even though Italian bank assets account for only 13% of the Eurozone total. NPLs are defined as three subcategories: bad loans, unlikely to pay exposures and overdrawn and/or past-due exposures.

on the financial performance of American banks. The authors indicate that human capital efficiency has a greater influence on financial performance than other components of intellectual capital.

2. Research methodology

The goal of the research undertaken in this article is to evaluate the impact of intellectual capital efficiency and its components on the financial ratios of Polish banks listed on the Warsaw Stock Exchange.

For the purposes of achieving the stated goal, the following research questions were formulated: *Does the level of intellectual capital efficiency affect the financial ratios of Polish banks listed on the Warsaw Stock Exchange?*

Due to the nature of the data (cross-sectional–temporal data), panel models were used to achieve the adopted goal. Panel data is data observed in at least two dimensions. It combines cross-sectional data with time series, i.e. data is observed on multiple objects for multiple periods of time [Kufel, 2007, p. 164]. In the case of models of this type, it is assumed that, besides independent variables, certain unmeasurable, time-constant factors defined for the given object, called individual (or group) effects, affect the dependent variable [Dańska-Borsiak, 2009, p. 25]. GRETL software was used to conduct statistical analyses.

The following methods were applied for the purposes of this article: desk research based on analysis of data given in the annual reports of the studied banks, the VAIC™ method for measuring intellectual capital efficiency, descriptive statistics and multiple regression analysis - by the panel least squares method.

The research sample covered Polish commercial banks listed on the WSE, belonging to the WIG-Banki [WSE-Banks] index. The choice of the banking sector as the subject of research was dictated by the fact that banks are increasingly generating income arising from the possession and proper utilization of intangible resources, as indicated by the growth of the gap between their market and book value. The banking sector plays a key role in the process of economic development in every country, because it enables the growth and success of its constituent enterprises through financing. Moreover, it determines the level of consumption and investment and constitutes an institution of public trust [Korzeb, 2018]. This sector is dependent on the intensive, knowledge-based nature of banking and finance. Furthermore, it utilizes special knowledge, know-how, modern technologies and builds relational capital with customers, which is why it frequently serves as an area for research on intellectual capital [Kamath, 2007; Ismail and Karem, 2011; Meles et al., 2016; Le and Nguyen, 2020; Sannino et al., 2021; Mollah and Rouf, 2022; Xu et al., 2022]. Scientists

also indicate that the intangible resources that banks have at their disposal become not so much value added as an indispensable condition for functioning on the market, without which a modern bank is not able to create a competitive product assortment, build and maintain ties with customers, and as a result – perform well financially [Marcinkowska, 2008, p. 228].

As of 31/03/2022, 11 Polish banks are listed on the WIG-Banki index. Due to the limitations of applying the VAIC™ coefficient in the case where an enterprise reports a loss on operational activity [Chu et al., 2011, pp. 254-255; Rahman and Ding, 2020, p. 39; Ovechkin et al., 2021, p. 286], two banks which obtained negative operational results over the course of the studied years were excluded from the sample (Bank Ochrony Środowiska SA, Getin Noble Bank SA). The banks covered by the study are presented in Table 1.

Tab. 1. Banks included in the study [data as of the end of Q4 2020]

Item no.	Name of bank	Market share [% assets of commercial banks]	Capitalization at end of period [in mln PLN]
1.	Powszechna Kasa Oszczędności Bank Polski SA	22.33	35,900.00
2.	Bank Polska Kasa Opieki SA	14.39	16,036.92
3.	Santander Bank Polska SA	13.15	18,976.56
4.	ING Bank Śląski SA	11.72	22,247.10
5.	mBank SA	11.05	7,592.17
6.	BNP Paribas Bank Polska SA	7.49	9,375.84
7.	Bank Millenium SA	6.28	3,966.89
8.	Alior Bank SA	5.09	2,215.50
9.	Bank Handlowy SA	3.94	4,592.68

Source: own elaboration based on: [Informacja na temat sytuacji sektora bankowego w 2020 roku, 2021, Financial Supervision Commission; Warsaw Stock Exchange].

Secondary data was acquired from annual consolidated financial statements of the 9 banks covered by the study. The timespan of the study covers the years 2014-2020. The year beginning the study mainly arose from the fact that the effects of two global financial crises had manifested in the years prior, particularly the second one, associated with the insolvency of countries in the Mediterranean basin. In turn, the year ending the study was dictated by availability of data. Due to the ongoing COVID-19 pandemic, the deadline for filing financial statements for the year 2021

was moved back by 3 months – from 31 March 2022 to 30 June 2022. This made it impossible to cover the year 2021 with the time horizon of the study[2].

This article evaluates the influence of intellectual capital efficiency and its components: (human capital efficiency – HCE and structural capital efficiency – SCE) on the financial ratios of Polish banks listed on the WSE. The list of variables used in the study are presented in Table 2.

Tab. 2. Description of variables used in the study

Type of variable	Explanation
Dependent variables – financial ratios	
ROA	return on assets – ratio of net profit to average assets of bank
ROE	return on equity – ratio of net profit to average own equity of bank
P/BV	price to book value – ratio of share price to book value assigned to one share
TSR	total shareholder return arising from possession of shares of the given bank over an annual period; sum of capital gains arising from change in the given bank's share price and dividends paid during the period of possession of shares by the investor, divided by the value of these shares at the beginning of the given year
Tier 1	tier 1 capital ratio
TCR	total capital ratio; the ratio of total capital to risk-weighted assets; the higher the value of this ratio, the greater the security of investors, including bondholders and clients
Independent variables – intellectual capital efficiency	
HCE	human capital efficiency of the bank
SCE	structural capital efficiency of the bank
CEE	capital employed efficiency of the bank
Control variables	
SIZE – size of the bank	natural logarithm of the sum of the bank's assets
LEVERAGE – debt ratio	ratio of total debt to the book value of total assets

Source: own elaboration.

Besides dependent and independent variables, the study employed two control variables – bank size and debt ratio, in order to avoid their influence on dependent

[2] *Regulation of the Minister of Finance of 7 March 2022* amending the regulation on defining alternative deadlines for fulfilling obligations with regard to records and within the scope of preparing, approving, making available, and transfer to the relevant registry, unit or body of statements or information.

variables in regression models [Riahi-Belkaoui, 2003, p. 221; Mondal and Ghosh, 2012, p. 522; Soewarno and Tjahjadi, 2020, p. 1093].

Descriptive statistics of dependent (explained) variables and independent (explanatory) variables covered by the study are presented in Table 3.

Tab. 3. Descriptive statistics of variables

Variables	N	Minimum	Maximum	Mean	Standard deviation
Dependent variables					
ROA	63	-0.007	0.020	0.009	0.005
ROE	63	-0.063	0.131	0.082	0.042
P/BV	63	0.340	2.330	1.286	0.461
Tier1	63	0.097	0.225	0.152	0.025
TCR	63	0.125	0.225	0.168	0.024
TSR	63	-0.540	0.723	-0.044	0.264
Independent variables					
HCE	63	1.173	3.576	2.675	0.611
SCE	63	0.148	0.720	0.600	0.123
CEE	63	0.087	0.350	0.234	0.045
ICE	63	1.321	4.297	3.275	0.729
VAIC	63	1.408	4.547	3.508	0.747
Control variables					
Size	63	17.143	19.709	18.501	0.614
Leverage	63	0.844	0.914	0.888	0.020

Source: own elaboration.

Banks listed on the WSE generate the greatest return on every Polish zloty invested in human capital – PLN 2.675 on average. This means that the employees working at banks have the greatest share in creating value added. Moreover, the HCE indicator is characterized by the greatest variability, which indicates that commercial banks differ greatly between one another when it comes to the efficiency of utilizing human capital. The return on structural capital is PLN 0.60, while capital employed efficiency (CEE) has the lowest share in creating value added for banks – PLN 0.23 per every Polish zloty invested. The data obtained also confirm studies conducted by: Ujwara-Gil [2009], Śledzik [2011] and Smuda-Kocoń [2019], who analyzed the intellectual capital efficiency of banks using the VAIC™ method.

The application of the VAIC™ method for measurement of intellectual capital efficiency, developed by Pulic, was dictated by the fact that this tool is widely used in scientific research as well as in corporate practice around the world [Fijałkowska, 2013; Dženopoljac et al., 2017; Chowdhury et al., 2019; Xu et al., 2020; Mollah and

Rouf, 2022; Shahwan and Fathalla, 2022]. VAIC™ is among the methods based on return on assets, and its main goal is to test the efficiency of creating value added from both tangible and intangible assets [Pulic, 1998; Pulic, 2000; Pulic, 2004]. The method is based on the three types of capital present in an enterprise: human capital, structural capital and capital employed (financial and tangible). The VAIC™ coefficient allows for the identification of inefficient areas of an enterprise's activity and indicates the weakest points in value creation. Moreover, it combines the classical, economic approach to results obtained by enterprises with scientific achievements in the field of intellectual capital [Michalczuk and Widelska, 2012, pp. 48-49]. The algorithm of calculations is based on financial data published by enterprises in annual statements and verified by an independent, expert auditor. In contrast to other models developed for measuring intellectual capital, Pulic's method is not adapted to the profile of a specific unit, and because of this, it enables measurement of intellectual capital efficiency in nearly every enterprise [Fijałkowska, 2013, pp. 71-72].

The method of calculating individual components of the VAIC™ coefficient is presented in Table 4.

Tab. 4. Model of calculating the VAIC™ coefficient

Item no.	Variable	Formula of calculation*
1.	Value added (VA)	VA = OP + EC + D + A
2.	Human capital efficiency (HCE)	HCE = VA / HC, where: HC = EC
3.	Structural capital efficiency (SCE)	SCE = SC / VA, where: SC = VA – HC
4.	Capital employed efficiency (CEE)	CEE = VA / CE
5.	Intellectual capital efficiency (ICE)	ICE = HCE + SCE
6.	Value added intellectual coefficient (VAIC™)	VAIC™ = ICE + CEE

* OP – operational profit; EC – employment costs; D – depreciation; A – amortization; CE – capital employed, corresponding to the book value of net assets

Source: own elaboration based on: [Pulic, 2000, pp. 706-713; Pulic, 2004, pp. 64-65; Fijałkowska, 2013, pp. 63-77].

In reference to the conventional VAIC™ model (Pulic, 2004, pp. 64-65), regression equations were determined econometrically for the dependent variables:

Model 1:
(fixed effects)

$$ROA_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (1)$$

Model 2:
(fixed effects)

$$ROE_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (2)$$

Model 3:
(fixed effects)

$$P/BV_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (3)$$

Model 4:
(random effects)

$$Tier1_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (4)$$

Model 5:
(random effects)

$$TCR_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (5)$$

Model 6:
(fixed effects)

$$TSR_{it} = \alpha_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 LEV_{it} + \varepsilon_{it} \quad (6)$$

where:
α_i – time-constant individual effect for the *i*-th object,
ε_{it} – purely random error for the *i*-th object over time t,
$\beta_1, \ldots, \beta_k$ – structural parameters.

Additionally, the research model tested in this article is presented in Figure 1.

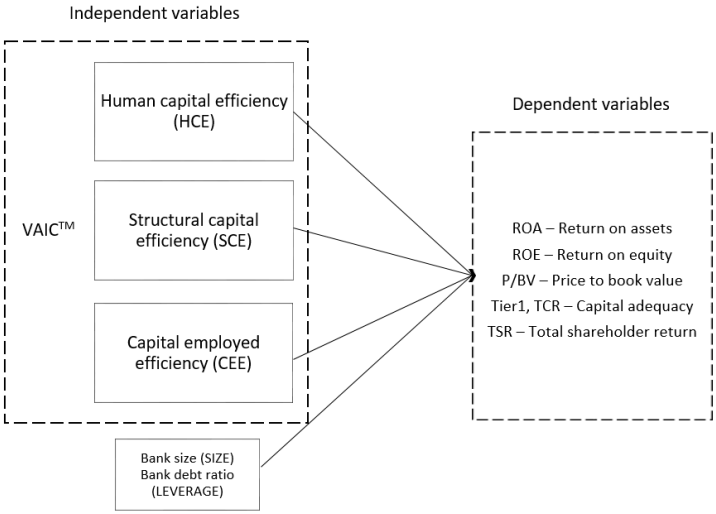

Fig. 1. Diagram of proposed research model

Source: own elaboration.

3. Research results

Determinations of the method of estimating the structural parameters of the panel model were made by means of the pooled classic least squares panel estimator. In this model, regression is performed on all available observations, which are treated as cross-sectional data. The absence of individual effects (homogeneity of the collectivity after accounting for differences in the available vector of observable variables) and absence of changes in the analyzed phenomenon over time are also assumed. Under such assumptions, all observations can be considered as originating from a simple random sample, and the classical least squares method (CLSM) can be applied. In order to verify whether the given model can be estimated by means of CLSM, it was necessary to verify the hypothesis on the existence of an individual effect, or on equal terms, whether the variance of the component of individual effects is equal to zero. The Breusch-Pagan test serves this purpose [Kufel, 2007, p. 166]. The results of the Breusch-Pagan test warranted rejection of the null hypothesis on the absence of individual effects in favor of the alternative hypothesis. The test demonstrated that the population used in the test is not homogeneous, and the application of the CLSM estimator would have led to ineffective or even encumbered estimates.

In the next stage, in the case where an individual effect was present, one of the dynamic panel models was applied. For this purpose, it was necessary to consider two types of effects – fixed effects (FE) and random effects (RE). The Hausman test was performed in order to make the right choice. The test's results indicated that for models with dependent variable: ROA, ROE, P/BV and TSR, a model with fixed effects had to be applied. Whereas, for models with dependent variables of capital adequacy – Tier 1 and TCR, models with random effects had to be applied.

The choice of fixed effects in the majority of models is also supported by the nature of the analyzed objects. If the tested objects belong to the same sector, and it is significant to estimate group effects for those specific objects, then a model with fixed effects is more adequate in most cases. The distribution of the *y* variable is then considered conditionally for fixed values of α_i [Dańska-Borsiak, 2011, pp. 49-50].

All created models were tested for heteroskedasticity (variability of the variance of the random component), normality of distribution of remainders of the random component, autocorrelation, cross-sectional dependencies and colinearity (VIF)[3]. In

[3] The variance inflation factor (VIF) [Gujarati, 1995, p. 338] was applied to diagnose colinearity, with independent variables for which VIF > 5 being eliminated from the model [Judge et al., 1988, pp. 306-308].

the case of occurrence of autocorrelation and heteroskedasticity (variability of remainder variance) of random errors, a correction was applied using Arellano's method [1987] in order to correct the estimator's effectiveness.

The proposed research models explaining the nature of dependencies between dependent and independent variables are presented in Tables no. 5-10.

Tab. 5. Results of panel data estimation for the ROA variable – model with fixed effects (model no. 1)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	0.264	0.012	22.430	0.237	0.291	<0.0001
HCE	0.000	0.001	0.157	-0.002	0.002	0.875
SCE	0.017	0.005	3.387	0.005	0.029	0.001
CEE	0.041	0.011	3.753	0.016	0.066	0.000
Size	-0.006	0.001	-7.783	-0.008	-0.004	<0.0001
Leverage	-0.185	0.022	-8.269	-0.237	-0.134	<0.0001
LSDV R^2 0.937						
Within R^2 0.902						

Source: own elaboration.

Tab. 6. Results of panel data estimation for the ROE variable – model with fixed effects (model no. 2)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	1.562	0.186	8.420	1.134	1.990	<0.0001
HCE	-0.003	0.011	-0.2644	-0.027	0.022	0.792
SCE	0.185	0.040	4.679	0.094	0.276	<0.0001
CEE	0.386	0.118	3.265	0.114	0.659	0.001
Size	-0.060	0.009	-6.712	-0.080	-0.039	<0.0001
Leverage	-0.638	0.321	-1.985	-1.379	0.103	0.047
LSDV R^2 0.913						
Within R^2 0.886						

Source: own elaboration.

Regression models with dependent variables defining return on assets (ROA) and return on equity (ROE) are characterized by high explanatory power, amounting to, respectively, for ROA – 93.7% and 90.2%, and for ROE – 91.3% and 88.6%. In

both models, both LSDV R^2 and within R^2 adopt similar values. This means that the variability of the explained variables (ROA, ROE) is explained to a similar degree by explanatory variables when accounting for both the individual effects of banks (LSDV R^2) and by explanatory variables employed in the model, omitting the individual effects of banks (within R^2)[4]. Model no. 1 explains, at the most, 93.7% of changes of the ROA ratio, while model no. 1 explains 91.3% of changes of the ROE ratio. Model no. 1 also indicates that growth of the structural capital efficiency indicator by one unit causes growth of the ROE ratio by 0.017 units, and an increase in capital employed efficiency by one unit causes growth of the ROE ratio by 0.041 units on average. Meanwhile, according to model no. 2, growth of the structural capital efficiency indicator by one unit causes growth of the ROE ratio by 0.185 units, and an increase in capital employed efficiency by one unit causes growth of the ROE ratio by 0.386 units on average. In both models, the HCE model proved to be insignificant. This means that the model does not show sufficient evidence to support the claim that the variable explains changes of the ROA and ROE ratios.

Tab. 7. Results of panel data estimation for the P/BV variable – model with fixed effects (model no. 3)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	29.007	5.931	4.891	15.331	42.683	<0.0001
HCE	0.046	0.260	0.176	-0.554	0.646	0.860
SCE	-1.401	1.325	-1.058	-4.456	1.654	0.290
CEE	7.100	1.527	4.649	3.579	10.622	<0.0001
Size	-0.554	0.155	-3.569	-0.912	-0.196	0.000
Leverage	-20.749	6.796	-3.053	-36.420	-5.079	0.002
LSDV R^2 0.785						
Within R^2 0.694						

Source: own elaboration.

The regression model with dependent variable P/BV is also characterized by high explanatory power, amounting to, accordingly, LSDV R^2 78.5% and within R^2 69.4%. This means that it explains, at the most, 78.5% of changes of the P/BV ratio. Model no. 3 indicates that growth of the capital employed efficiency indicator by

[4] LSDV (*ang. least square dummy variable*) R^2 provides information on what part of the explained variable is explained by explanatory variables when accounting for the individual effects of banks; within R^2 shows what part of the explained variable's variability within individual units is explained by the variables used in the model.

one unit causes an increase in the P/BV ratio by 7.100 units. In model no. 3, the HCE and SCE variables turned out to be statistically insignificant. This means that model no. 3 did not provide sufficient evidence to support the claim that variables signifying intellectual capital efficiency (HCE and SCE) explain changes of the P/BV ratio.

Tab. 8. Results of panel data estimation for the Tier1 variable – model with random effects (model no. 4)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	0.291	0.142	2.051	0.007	0.575	0.040
HCE	0.017	0.015	1.130	-0.013	0.048	0.258
SCE	0.058	0.073	0.800	-0.088	0.204	0.424
CEE	-0.410	0.108	-3.790	-0.626	-0.193	0.000
Size	-0.001	0.005	-0.1762	-0.011	0.009	0.860
Leverage	-0.123	0.202	-0.6084	-0.527	0.281	0.543
between variance 0.0000734						
within variance 0.0001638						

Source: own elaboration.

Tab. 9. Results of panel data estimation for the TCR variable – model with random effects (model no. 5)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	-0.160	0.160	-0.996	-0.480	0.161	0.319
HCE	0.016	0.016	0.986	-0.016	0.048	0.324
SCE	0.072	0.074	0.973	-0.077	0.221	0.331
CEE	-0.398	0.126	-3.169	-0.650	-0.147	0.002
Size	0.005	0.005	1.091	-0.004	0.015	0.276
Leverage	0.267	0.161	1.658	-0.056	0.590	0.097
between variance 0.00006564						
within variance 0.00018427						

Source: own elaboration.

In models no. 4 and 5, none of the independent variables determining intellectual capital (HCE, SCE) turned out to be statistically significant, which means that there is insufficient evidence to state that intellectual capital efficiency has an influence on the capital adequacy of banks. Models no. 4 and 5 do indicate that growth of the capital employed efficiency indicator by one unit causes a decrease in the Tier1 and

TCR ratios. Moreover, models with dependent variables describing the capital adequacy of banks indicate a higher variance within group than between groups[5], meaning that they explain the variation of Tier1 and TCR between banks to a greater extent than within individual banks over time.

Tab. 10. Results of panel data estimation for the TSR variable – model with fixed effects (model no. 6)

Variables	Coefficient B	Standard error	Z (distribution)	95% confidence interval for B		Significance
				Lower bound	Upper bound	
const	8.756	3.422	2.559	0.864	16.648	0.011
HCE	0.130	0.240	0.540	-0.424	0.683	0.589
SCE	-1.246	0.512	-2.433	-2.427	-0.065	0.015
CEE	4.322	1.929	2.240	-0.127	8.771	0.025
Size	0.016	0.181	0.091	-0.400	0.433	0.928
Leverage	-10.943	3.370	-3.247	-18.714	-3.171	0.001
LSDV R^2 0.389						
Within R^2 0.344						

Source: own elaboration.

The regression model with dependent variable TSR is characterized by low explanatory power, amounting to, accordingly, LSDV R^2 38.9% and within R^2 34.4%. This means that it explains, at the most, 38.9% of changes of the TSR ratio. Model no. 6 also indicates that growth of the structural capital efficiency indicator by one unit causes a decrease of the TSR ratio by 1.246 units, and an increase in capital employed efficiency by one unit causes growth of the TSR ratio by 4.322 units. Similarly as in previous models, in model no. 6, the HCE variable proved to be statistically insignificant. This means that model no. 6 did not provide sufficient evidence to support the claim that the HCE variable explains changes of the TSR ratio.

4. Discussion of results

The results of the study confirm the influence of intellectual capital efficiency on return on equity (ROE), return on assets (ROA) and total shareholder return (TSR). However, they also revealed a varied influence in the efficiency of individual components of intellectual capital on the indicated financial ratios of the studied companies.

Structural capital efficiency (SCE) has a significant, positive influence on return on equity (ROE) and return on assets (ROA). The results obtained confirm studies

[5] *between* and *within* signify, accordingly, inter-group variance and variance within a group

by other scientists analyzing the influence of intellectual capital efficiency on the financial ratios of banks [Soewarno and Tjahjadi, 2020], as well as on the financial ratios of other types of enterprises [Alipour, 2012; Dženopoljac et al., 2017; Xu and Li, 2019]. The study also showed the negative influence of structural capital efficiency on total shareholder return (TSR), as growth of the structural capital efficiency indicator is associated with a drop in TSR value. The results obtained may seem surprising, however they may also indicate the enormous complexity of issues concerning value creation for shareholders. Intellectual capital plays a significant role in banks and is one of the most important factors deciding their performance, however under difficult external conditions, it could play a lesser role than would be the case under normal operating conditions.

No significant relationship was found in the developed models between human capital efficiency and the financial ratios of banks. The models did not provide sufficient evidence to support the claim that the HCE variable explains changes of the analyzed ratios. Nazir et al. [2021] reached similar conclusions in their studies, which demonstrated the absence of a dependency between human capital efficiency and the financial ratios of financial institutions in China, Hong Kong and Taiwan. In turn, a significant but negative relationship between human capital efficiency and the ROA and ROE ratios is confirmed by studies by Alhassan and Asare [2016], Deep and Pal Narwal [2014] as well as by Rehman et al. [2022]. Analyzing the results obtained, one must also take into account that a bank is a rather particular enterprise, in which it is very expensive to train an employee and difficult to maintain them in a specific position due to the strong influence of the competition.

Furthermore, the results obtained demonstrated that none of the components of intellectual capital explain changes of the price to book ratio (P/BV) or of banks' capital adequacy ratio (Tier1 and TCR).

This study is not without its limitations. They mainly arise from the weakness of the VAIC™ method used to measure intellectual capital efficiency. Among the weaknesses of the applied method, the following should be distinguished, among others: significant simplification in determination of the value of human capital (treatment of all expenses for employee purposes as a component of assets) as well as the model's inability to handle enterprises with a negative book value of own equity or negative operational profit. Many authors indicate that the VAIC™ model does not measure functional performance for companies with negative value added [Mehralian et al., 2012, p. 143; Chu et al. 2011, p. 252]. Moreover, the VAIC™ indicator does not account for all components of intellectual capital [Shiri et al., 2012, p. 7225]. It measures only two components – human capital and structural capital, while omitting relational capital. Its weaknesses also arise from the fact that

a short-term time horizon was the focus of this study. In addition, the research sample was small, and the study employed only selected metrics describing the performance of the analyzed entities. For this reason, generalization of its findings requires caution.

Conclusions

The study being the subject of this article made it possible to evaluate the impact of intellectual capital efficiency on the financial ratios of Polish banks listed on the Warsaw Stock Exchange.

This study fills a gap in research concerning the area of intellectual capital in the context of its relationships with financial ratios obtained by Polish banks listed on the WSE. This aspect is still insufficiently represented in studies by Polish scientists. The results obtained broaden the understanding of the role of intellectual capital in the creation of banks' financial performance, which leads to building of a competitive advantage.

From a practical perspective, this study provides managers with a deeper understanding of the significance of improving the development of intellectual capital in banks. This study suggests that, in the knowledge-based economy, intellectual capital plays an important role in strengthening banks' financial and market performance. The article provides useful information for evaluation of the financial ratios of companies and additionally allows managers to measure intellectual capital efficiency. The results of this study may be a launchpad for the development of various types of strategic project and may also be useful for the broadly construed goals of supervisory institutions and boards.

In summary, the results of this study may be of interest to a broad spectrum of people: scientists, management staff, representatives of supervisory institutions and market practitioners: investors and analysts.

The article is a starting point for further research, which is recommended to:

- account for a longer time horizon,
- apply a time delay for the purpose of checking whether intellectual capital efficiency is also associated with banks' financial ratios in the future,
- cover a larger group of entities with its scope (e.g. companies belonging to the banking sector in different countries of Europe and around the world),
- take into consideration a greater number of metrics describing the financial ratios of enterprises, such as: asset turnover ratio (ATO), net profit margin (NPM), gross profit margin (GPM), earnings before interest and taxes

(EBIT) or earnings before interest and taxes, depreciation and amortization (EBITDA),

- apply other methods of measuring intellectual capital, such as: modified value added intellectual coefficient (MVAIC™), calculated intangible value (CIV) or knowledge capital earnings (KCE™).

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Wpływ kapitału intelektualnego na wyniki finansowe i rynkowe polskich banków notowanych na Giełdzie Papierów Wartościowych w Warszawie

Streszczenie

Celem artykułu jest ocena wpływu efektywności kapitału intelektualnego na wyniki finansowe i rynkowe polskich banków notowanych na Giełdzie Papierów Wartościowych w Warszawie. Zakres czasowy badania obejmuje lata 2014-2020. W badaniu wykorzystano różnorodne metody badawcze – analizę opisową, analizę desk research, metodę VAICTM, statystykę opisową oraz analizę regresji wielorakiej – panelową metodę najmniejszych kwadratów. Uzyskane wyniki potwierdziły wpływ efektywności kapitału intelektualnego na rentowność kapitału własnego (ROE), rentowność aktywów (ROA) oraz całkowitą stopę zwrotu dla akcjonariuszy (TSR). Ponadto ukazały zróżnicowany wpływ efektywności poszczególnych komponentów kapitału intelektualnego na wskazane miary opisujące wyniki analizowanych spółek. Badanie potwierdza, że w dobie gospodarki opartej na wiedzy kapitał intelektualny

stanowi kluczową rolę we wzmacnianiu wyników finansowych i rynkowych banków. Wykorzystanie zaprezentowanych metod powinno dostarczyć dodatkowej wiedzy na temat roli kapitału intelektualnego w zarządzaniu bankiem komercyjnym oraz zainteresować szerokie spektrum osób: naukowców, kadrę zarządzającą.

Słowa kluczowe

kapitał intelektualny, efektywność kapitału intelektualnego, banki, wskaźniki finansowe, wyniki finansowe