

## Determinants of Financial Performance in Portuguese Banks: An Intellectual Capital Perspective<sup>1</sup>

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*Determinantes do desempenho financeiro dos bancos portugueses: uma perspetiva do capital intelectual*  
*Determinantes del desempeño financiero de los bancos portugueses: una perspectiva de capital intelectual*

*The aim of this study is to empirically analyse the effect of intangible resources, that is, the efficiency of intellectual capital (IC) on the financial performance of the seven largest banking groups operating in Portugal, for the period from 2012 to 2023. The aim is to assess whether factors such as the Value Added Intellectual Coefficient (VAIC<sup>TM</sup>), measured by the efficiency of human capital, structural capital and capital employed, influence bank performance, as measured by return on equity (RoE). To this end, econometric models of strongly balanced panel data were used, using four multiple linear regression models to estimate the results. The results show a significant positive relationship between the value-added intellectual coefficient (VAIC<sup>TM</sup>) and financial performance, as measured by RoE. The results also show a significant positive association between performance and the variables human capital efficiency and capital employed efficiency, suggesting that RoE captures the value-added intellectual coefficient of both human and capital employed. Finally, structural capital shows a negative and insignificant relationship.*

*O objetivo deste estudo é analisar empiricamente o efeito dos recursos intangíveis, ou seja, a eficiência do capital intelectual (CI) no desempenho financeiro dos sete maiores grupos bancários a operar em Portugal, para o período de 2012 a 2023. O objetivo é avaliar se fatores como o Coeficiente de Valor Acrescentado Intelectual (VAIC<sup>TM</sup>), medido pela eficiência do capital humano, do capital estrutural e do capital empregue, influenciam o desempenho dos bancos, medido pela rentabilidade dos capitais próprios (RoE). Para o efeito, foram utilizados modelos econométricos de dados em painel fortemente balanceados, recorrendo a quatro modelos de regressão linear múltipla para estimar os resultados. Os resultados evidenciam uma relação positiva significativa entre o coeficiente de valor acrescentado intelectual (VAIC<sup>TM</sup>) e o desempenho financeiro, medido pelo RoE. Os resultados também mostram uma associação positiva significativa entre o desempenho e as variáveis eficiência do capital humano e eficiência do capital empregue, sugerindo que o RoE capta o coeficiente de valor acrescentado intelectual tanto do capital humano como do capital empregue. Por fim, o capital estrutural apresenta uma relação negativa e insignificante.*

*El objetivo de este estudio es analizar empíricamente el efecto de los recursos intangibles, es decir, la eficiencia del capital intelectual (CI), en el rendimiento financiero de los siete mayores grupos bancarios que operan en Portugal, para el período 2012 a 2023. El objetivo es evaluar si factores como el Coeficiente de Valor Añadido Intelectual (VAIC<sup>TM</sup>), medido por la eficiencia del capital humano, el capital estructural y el capital empleado, influyen en el rendimiento bancario, medido por la rentabilidad sobre recursos propios (RoE). Para ello, se utilizaron modelos econométricos de datos de panel fuertemente equilibrados, utilizando cuatro modelos de regresión lineal múltiple para estimar los resultados. Los resultados muestran una relación positiva significativa entre el coeficiente de valor añadido intelectual (VAIC<sup>TM</sup>) y el rendimiento financiero, medido por el RoE. Los resultados también muestran una asociación positiva significativa entre el rendimiento y las variables de eficiencia del capital humano y eficiencia del capital empleado, lo que sugiere que RoE captura el coeficiente de valor añadido intelectual tanto del capital humano como del capital empleado. Por último, el capital estructural muestra una relación negativa e insignificante.*

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## 1. Introduction

Since the 1990s, developments on the identification and measurement of intellectual capital (IC) have allowed the emergence of relevant models that have made significant contributions to this issue (Silva et al., 2014). Among others, two major contributions to this issue can be highlighted, namely the models such as the Balanced Scorecard® (Kaplan and Norton, 1992) and the models based on the Value Added Intellectual Coefficient (VAIC™) of (Pulic, 1998; 2000). The intellectual capital efficiency measure presented in this study is based on author Pulic (2000) proposal, named VAIC™ and which according to author Marzo (2022) is entirely consistent with the knowledge based economy and a more objective alternative to traditional measures such as EBITDA - Earnings Before Interest, Taxes, Depreciation and Amortization. According to author Tan et al. (2007), the selection of the VAIC™ model to measure the efficiency of intellectual capital, allows for greater ease of calculation since it can be extracted from publicly available financial statements. Furthermore, they may be even more reliable sources when financial statements are audited (Young et al., 2009), a situation that occurs in the present study, when the sample considered in the work carried out is based on banking sector entities. Also according to the authors Silva et al, 2021, intellectual capital is a critical element of value creation in organizational performance, contributing sustainably to greater financial profitability. Recently, studies have shown an increased interest in the services sector and particularly in banking organizations (Mollah and Rouf, 2021; Thaha and Sulaiman, 2022; Majumder et al., 2023; Lim et al., 2024 and Sayed and Nefzi 2024) in understanding the impact of intellectual capital on bank performance, measured by RoE and its relationship with intellectual capital efficiency factors. Thus, studies carried out in the banking sector have presented mixed and sometimes ambiguous results on the relationship between bank performance and intellectual capital. This study therefore seeks to contribute to the literature in this area by empirically testing the impact of intellectual capital on the performance of banks operating in Portugal, since there is a lack of research into Portuguese banking institutions. The aim of this study is to analyse the determinants of the financial performance of Portuguese banks, from an intellectual capital perspective, for the period from 2012 to 2023 (12 years). In order to realize this objective, the aim is to understand a set of ambiguities that make it possible to validate the level of financial performance of Portuguese banking entities and to identify the existing associations between performance and intellectual capital efficiency, such as: intellectual capital efficiency (VAIC™), human capital, structural capital, applied capital, size banks, number of branches, leverage and listed banks. The final document is structured as follows: in addition to the first introductory section, a second section on the literature review is presented, detailing the literature review, highlighting the evidence of similar studies and the hypotheses to be tested, as well as the concepts of the VAIC™ model. The third section on the sample and methodology describes the methodology adopted in this study, first presenting the sample and the study variables, then moving on to the specification of the econometric model adopted and finalizing with an analysis of the statistical data and the results obtained. Finally, the fourth point, the conclusion of the study, is presented, reflecting on the main conclusions of this research and the main limitations of the study.

### KEYWORDS

**Performance,  
banks, intellectual  
capital, VAIC,  
panel data.**

### PALAVRAS-CHAVE

**Desempenho,  
bancos, capital  
intelectual, VAIC,  
dados em painel.**

### PALABRAS CLAVE

**Rendimiento,  
bancos, capital  
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## 2. Literature Review

### 2.1. Empirical Studies

In a pioneering study, Pulic (2001) analyses the value creation efficiency of 20 banks in the Croatian economy from 1996 to 2000. To this end, the author uses the value-added intellectual coefficient (VAIC™) as a tool for measuring the efficiency of intellectual capital performance, separated into three components (efficiency of applied capital, efficiency of human capital and efficiency of structural capital). In this way, the efficiency of each Croatian bank is measured and then compared with the average performance of all banks. The results obtained in the study indicate that the intellectual potential in the human capital efficiency component is of crucial importance for the sustainable performance of the banking business.

In the same vein, Gigante (2013) and Mention and Bontis (2013) investigated the effects of intellectual capital and its components (human, structural, applied and relational capital) on business performance in banking institutions, measured by the profitability indicators RoE and RoA - Return on Assets, among others. The results obtained were consistent in both studies and led to the conclusion that human capital has a positive and statistically significant association with business performance in the banking sector.

Focusing on a national sample, the study by Silva et al. (2014) analyses the impact of bank-specific factors on the different components of intellectual capital: human capital, structural capital and relational capital in 2010 and 2011, with a sample of 32 banks operating in Portugal. The study concluded that there is a positive relationship between the size of banks and the composition of the Board of Directors, which have an impact on intellectual capital.

Nawaz (2017), in a study of 64 Islamic financial institutions operating in eighteen different countries, adopted the RoA indicator as a measure of bank financial performance. The study was carried out for the period 2007 to 2011 and the development of the work aimed to empirically examine the effect of the three components of the intellectual value added coefficient (VAIC™) on bank performance. The results show a significant positive relationship between VAIC™ and the financial performance of Islamic banks, as measured by RoA. In turn, the results also indicate a significant positive relationship between financial performance and the efficiency of applied capital and human capital, but not a significant negative relationship with the efficiency of structural capital.

Arslan and Kizil (2019) studied the correlation between a set of financial indicators and bank performance, measured using the VAIC™ model and the market-to-book value of 13 banks in Turkey in 2017. The authors concluded that indicators such as RoA and RoE show a strong positive correlation with intellectual capital performance.

**Table 1** below summarizes other studies by authors who have looked at the subject in the 21st century:

Table 1. - Summary of the studies

Authors (Year)	Period (Sample)	Model Specification	Performance Metric	Factors	Signal Obtained
Mollah and Rouf (2021)	2014-2018 (Bangladesh, 28 listed banks)	Panel Data and Multiple Linear Regression	RoA RoE Revenue Growth Rate	- VAIC™ - Capital Employed Efficiency - Human Capital Efficiency - Structural Capital Efficiency	+ +/- +/- +/-
Thaha and Sulaiman (2022)	2018-2021 (Indonesia, 29 listed banks)	Simple Linear Regression	RoA	- VAIC™ - Capital Employed Efficiency - Human Capital Efficiency - Structural Capital Efficiency	+ + + +
Majumder et al. (2023)	2010-2019 (Bangladesh, 32 banks)	Dynamic Panel and Multiple Linear Regression	RoA	- Solvency - Size - Leverage - Gross Domestic Product - VAIC™ - Capital Employed Efficiency - Human Capital Efficiency - Structural Capital Efficiency	+ +/- +/- + + + + +
Lim et al. (2024)	2011-2022 (Cambodia, 23 banks)	Panel Data and Multiple Linear Regression	RoA	- Size - VAIC™ - Capital Employed Efficiency - Human Capital Efficiency - Structural Capital Efficiency	+/- + + + +
Sayed and Nefzi (2024)	2012-2022 (Saudi Arabia, 10 banks)	Panel Data and Multiple Linear Regression	RoE Net Profit Margin	- Size - Leverage - Inflation Rate - Pandemic Crisis - VAIC™ - Capital Employed Efficiency - Human Capital Efficiency - Structural Capital Efficiency	- + - - + + + +/-

Source: Author's own elaboration.

The empirical studies analyzed relate the measurement of bank performance based on intellectual capital. Therefore, this study aims to launch a new perspective, investigating the effect of intellectual capital on the profitability of Portuguese banks, measured by RoE, using the VAIC™ technique developed by Pulic (2000). For the author, the main argument to justify the relationship between intellectual capital and performance stems from the knowledge of human resources that create economic value for the company. Therefore, the author considers spending on staff as an investment in intellectual capital and as such a return is expected. In this sense, it can be concluded that intellectual capital makes it possible to generate value for companies' businesses. The authors Nawaz (2017), Arslan and Kizil (2019), Mollah and Rouf (2021), Thaha and Sulaiman (2022), Majumder et al. (2023), Lim et al. (2024) and Sayed and Netzi (2024) found a positive and significant relationship between intellectual capital and bank profitability. The following hypothesis is therefore formulated based on this justification:

**H1: Intellectual capital has a significant positive impact on the profitability of the largest banks in Portugal**

In addition, the resource-based theory implies that a company's success depends to a large extent on intangible resources (Majumder et al. 2023). Thus, among the different components of intellectual capital in the VAIC™ model, it is necessary to evaluate the level of human capital efficiency (HCE), structural capital efficiency (SCE) and capital employed efficiency (CEE). In the literature, it is widely considered that human capital is of vital importance to the economic performance of the business (Pulic, 2001; Gigante, 2013; Mention and Bontis, 2013 and Nawaz 2017). In turn, this argument is supported by more recent studies by the authors Mollah and Rouf (2021), Thaha and Sulaiman (2022), Majumder et al. (2023), Lim et al. (2024) and Sayed and Nefzi (2024), who analyzed the influence of the value-added intellectual coefficient (VAIC™) on bank profitability, measured by indicators such as RoA and RoE, for various financial markets and for a time horizon between 4 and 12 years. From the results obtained, they concluded that the human capital and applied capital components have a significant positive influence on banks' financial performance. In contrast, the structural capital component sometimes shows a mixed and statistically insignificant relationship with bank profitability. Therefore, in line with the various authors, this study formulates the following hypothesis:

*H2: The different components of intellectual capital have a significant positive impact on the profitability of the largest banks in Portugal*

## 2.2. Definition of the VAIC™ Model

The intellectual value added coefficient is an instrument for measuring the efficiency of intellectual capital performance. Developed in the initial studies by Pulic (1998) and in later studies by Pulic (2000; 2001; 2004a; b; 2005 and 2008), it is relatively easy to determine. Mathematically, VAIC™ can be calculated as the sum of its three components, or alternatively, by the sum of two components:

$VAIC^{\text{TM}} = HCE + SCE + CEE$	=	Human Capital Efficiency (HCE) + Structural Capital Efficiency (SCE) + Capital Employed Efficiency (CEE)
$VAIC^{\text{TM}} = ICE + CEE$	=	Intellectual Capital Efficiency (ICE) (HCE + SCE) + Capital Employed Efficiency (CEE)

The relationship between the three components can be developed from the value added of companies, which basically consists of the capacity of a company to create economic value. Thus, Value Added (VA) can be determined by the difference between total income (OUT) and total expenditure (IN):

$VA$	=	Income (OUT) - Expenses (IN)
$VA = OUT - IN$	=	Results + Personnel Costs + Depreciation + Amortization

The added value obtained from a company generates the capacity of resources to create value, therefore, it becomes relevant to assess the result of the efficient management of these resources.

As shown in the calculation of value added (VA), personnel costs are not an integral part of expenditure, but are nevertheless a basic element in the creation of value. The coefficient that translates the degree of success with which human capital creates economic value is the Human Capital Efficiency (HCE):

$$HCE = \frac{\text{Value Added (VA)}}{\text{Personnel Costs (HC)}}$$

Thus, HCE makes it possible to measure the relationship between VA and HC, materializing how much value added was created by a monetary unit spent on the company's employees. Another relationship dependent on value added and in opposite proportion to personnel costs is determined by the Structural Capital Efficiency (SCE):

$$SCE = \frac{\text{Value Added (VA)} - \text{Human Capital (HC)}}{\text{Value Added (VA)}}$$

Thus, SCE means that the higher the percentage of HC in VA, the lower the proportion of structural capital. In other words, it means that the higher the staff costs, the less the company will spend on its operating structure (operational processes, technologies, etc.). The sum of the human capital efficiency (HCE) and structural capital efficiency (SCE) components is called Intellectual Capital Efficiency (ICE):

$$ICE = \text{Structural Capital Efficiency (SCE)} + \text{Employed Capital Efficiency (ECE)}$$

The last relationship dependent on value added is called the Capital Employed Efficiency (CEE):

$$CEE = \frac{\text{Value Added (VA)} - \text{Value Added}}{\text{Total Net Assets} - \text{Intangible Assets}}$$

The CEE translates the added value generated by a unit of capital used in the companies' assets, except for intangible assets because they are not considered physical capital.

Finally, by aggregating the coefficients of human capital, structural capital and employed capital, or alternatively the coefficients of intellectual capital and applied capital, one can obtain an instrument to measure the efficiency of intellectual capital performance, the so-called VAIC™ model. Therefore, in conclusion, if the aggregate value of the coefficients is greater than 1, then the company was efficient in creating economic value taking into account its intellectual capital.

## 3. Sample and Methodology

### 3.1. Data Analysis and Description

To collect the data in this study, we used content analysis of the publications of the reports and accounts of the banks in the sample, as well as the financial elements provided by the database of statistical publications of the Portuguese Banking Association, for the period from 2012 to 2023 (twelve years), totaling 84 observations. The sample considered is composed of the 7 largest banks in terms of volume of net assets (year 2023) operating in the Portuguese banking system, which represent 80.7% (373.7 billion euros) of all aggregate net assets in the Portuguese banking system (463.0 billion euros), as shown in **table 2**:

**Table 2. - Portuguese banking system - sample**  
values in million euros, except when expressly indicated

Banking Groups	Total Assets	
	Value	%
<b>CGD</b> - Caixa Geral de Depósitos	99 294	21,4
<b>MBCP</b> - Millennium BCP	94 380	20,4
<b>BST</b> - Banco Santander Totta	54 587	11,8
<b>NB</b> - Novo Banco	43 501	9,4
<b>BPI</b> - Banco Português de Investimento	38 628	8,3
<b>CA</b> - Crédito Agrícola	25 302	5,5
<b>MG</b> - Montepio Geral	17 989	3,9
<b>TOTAL</b>	<b>373 681</b>	
<b>Portuguese Banking System</b>	<b>463 011</b>	
<b>%</b>	<b>80,7</b>	

Source: Author's own elaboration.

### 3.2. Study Variables

In order to determine the performance of the banks in the sample, a set of variables was defined based on the literature review for this study, such as:

- For the dependent variable of bank profitability, the performance measure of return on equity, measured by the RoE indicator, was adopted in this study, following studies by the authors (Gigante, 2013; Mention and Bontis, 2013, Mollah and Rouf, 2021 and Sayed and Nefzi, 2024). Taking into account the previous literature in this study, it was decided to use the RoE indicator as it is one of the most widely used by authors on this subject;
- The independent variables used in this study are indicators related to the efficiency of intellectual capital, separated into four categories (value added intellectual coefficient - VAIC™, human capital, structural capital and applied capital). In addition, following recent studies by Nawaz, 2017, Arslan

and Kizil 2019, Lim et al. 2023, Majumder et al. 2023 and Sayed and Nefzi, 2024, control variables such as size, risk level, number of branches and listed banks were included. The variables included in the model, as well as their means of determination and the expected signs for the regression coefficients of the explanatory variables, are as follows (**table 3**).

**Table 3. - Variables of the study included in the model**

Variables	Notation	Form of Determination	Expected Sign
<b>Dependent:</b> Return on Equity	RoE	Net Profit / Equity Capital	
<b>Independent:</b> <b>Efficiency of the CI</b> VAIC™ Coefficient	VAIC	Human Capital + Structural Capital + Capital Employed	(+)
Human Capital	HCE	Value Added / Personnel Costs	(+)
Structural Capital	SCE	(Value Added – Personnel Costs) / Value Added	(+)
Employed Capital	CEE	Value Added / (Net Assets – Intangible Assets)	(+)
<b>Control Variables:</b> Dimension	LOGATIV	Logarithm (natural) of Net Asset Value	(+)
Level of Risk	RISC	Leverage = Liabilities / Assets	(+)
Listed on the Stock Exchange	CBV	Dummy Variable (binary) where: 0 – If the bank is not listed; 1 - If the bank is listed	(+)
Agencies	AGEN	Number of branches	(+)

Source: Author's own elaboration.

### 3.3. Econometric Model

The studies by authors who assess the factors that determine bank performance, such as Gigante (2013), Nawaz (2017), Arslan and Kizil (2019), Mollah and Rouf, (2021), Lim et al. (2023), Sayed and Nefzi (2024) and others, essentially apply linear regression models using the panel data technique, which make it possible to develop and measure which independent variables have explanatory power over the dependent variable. Therefore, in order to fulfil the purpose of this study, the following four multiple linear regression models were developed (**table 4**).

**Table 4. - Multiple linear regression model**

$RoE_{it} = \beta_0 + \beta_1 VAIC_{it} + \beta_2 LOGATIV_{it} + \beta_3 RISC_{it} + \beta_4 DUMCBV_{it} + \beta_5 AGEN_{it} + \epsilon_{it}$ – Model 1
$RoE_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 LOGATIV_{it} + \beta_3 RISC_{it} + \beta_4 DUMCBV_{it} + \beta_5 AGEN_{it} + \epsilon_{it}$ – Model 2
$RoE_{it} = \beta_0 + \beta_1 SCE_{it} + \beta_2 LOGATIV_{it} + \beta_3 RISC_{it} + \beta_4 DUMCBV_{it} + \beta_5 AGEN_{it} + \epsilon_{it}$ – Model 3
$RoE_{it} = \beta_0 + \beta_1 CEE_{it} + \beta_2 LOGATIV_{it} + \beta_3 RISC_{it} + \beta_4 DUMCBV_{it} + \beta_5 AGEN_{it} + \epsilon_{it}$ – Model 4

Source: Author's own elaboration.

Where,

- $RoE_{it}$  represents the return on equity ratio of bank  $i$  in period  $t$ ;
- $VAIC_{it}$  represents the intellectual capital efficiency of bank  $i$  in period  $t$ ;
- $HCE_{it}$  represents the coefficient of the human capital efficiency of bank  $i$  in period  $t$ ;
- $SCE_{it}$  represents the coefficient of the structural capital efficiency of bank  $i$  in period  $t$ ;
- $CEE_{it}$  represents the coefficient of the efficiency of capital employed of bank  $i$  in period  $t$ ;
- $LOGATIV_{it}$  represents the (natural) logarithm of bank  $i$  net assets in period  $t$ ;
- $RISC_{it}$  represents the leverage indicator of bank  $i$  in period  $t$ ;
- $DUMCBV_{it}$  represents the dummy of listed entities of bank  $i$  in period  $t$ ;
- $AGEN_{it}$  represents the number of branches of bank  $i$  in period  $t$ ;
- $\beta_0$  is the constant term;
- $\varepsilon_{it}$  is the statistical error term of bank  $i$  in period  $t$ .

### 3.4. Analysis and Results

#### 3.4.1. Descriptive statistical data

The descriptive statistics of the study variables were as follows (**table 5**):

**Table 5. - Descriptive Statistics**  
Values in percentage, except when expressly indicated

Variables	N.º Obs.	Mean	Standard Deviation	Min.	Max.
Return on Equity (RoE)	84	.658233	13.5239	-47.890	22.6285
VAIC™ Coefficient	84	1.82278	2.59217	-6.9419	16.9833
Human Capital (HCE)	84	1.27912	1.61797	-4.3188	4.46726
Structural Capital (SCE)	84	.533514	2.21183	-7.0670	17.0463
Capital Employed (CEE)	84	.010145	.010403	-.02578	.024655
Dimension	84	17.5921	.616100	16.4974	18.5765
Level of Risk	84	.922960	.016785	.891985	.968509
Agencies	84	546.417	167.476	232	914
Listed on the Stock Exchange	Dummy variable (between 0 e 1)				

Source: Author's own elaboration.

From the data observed in **table 5**, it can be seen that bank profitability, measured by RoE, for the period between 2012 and 2023, had a positive mean (0.66%), with a minimum value of -47.9% and a maximum value of 22.6%. Regarding the variable of the VAIC™ coefficient, it can be seen that Portuguese banks show on average a positive intellectual capital efficiency index of 1.82, with minimum values of -6.94 and maximum values of 16.98. Thus, Portuguese banks were generally efficient in creating value from their intellectual capital.

### 3.4.2. Correlation matrix data

Next, the correlation matrix of the independent variables and control variables applied in the econometric model of the study is presented in [table 6](#).

**Table 6. - Correlation matrix**

	<i>vaic</i>	<i>hce</i>	<i>sce</i>	<i>cee</i>	<i>logativ</i>	<i>risc</i>	<i>agen</i>	<i>Cbv</i>
<i>vaic</i>	1	-	-	-	-	-	-	-
<i>hce</i>	0.5306	1	-	-	-	-	-	-
<i>sce</i>	0.7815	-0.1141	1	-	-	-	-	-
<i>cee</i>	0.4772	0.9452	-0.1369	1	-	-	-	-
<i>logativ</i>	-0.1068	-0.0120	-0.1156	-0.1898	1	-	-	-
<i>risc</i>	-0.1123	-0.1061	-0.0532	-0.1764	0.0675	1	-	-
<i>agen</i>	-0.1567	-0.0548	-0.1437	0.0259	0.2596	0.4092	1	-
<i>cbv</i>	0.0871	0.3192	-0.1325	0.2366	0.3363	0.2323	0.1565	1

Source: Author's own elaboration.

**Table 6** analyses the relationships between the study variables and, as expected, the correlation matrix shows that there is a strong positive correlation between value-added intellectual capital (VAIC) and structural capital efficiency (SCE) with a value of 78.2%. In turn, the human capital efficiency variable (HCE) has a strong positive correlation with the applied capital efficiency variable (CEE) with a value of 94.5%.

### 3.4.3. Results – model estimation

The model was estimated using the statistical data analysis tool (STATA), using the panel data technique that combines cross data (banks) with time series (years), thus obtaining a balanced panel data. For that purpose, it was necessary to take into consideration the data treatments used in order to highlight a longitudinal panel, composed of a set of banks (N=7 banks) and over several time periods (T=12 years), thus corresponding to 84 observations.

In order to model the functional relationship between the variables, four multivariate linear regression models were adopted and the generalized least squares random effects model was used ([table 7](#)).

**Table 7. - Model estimation results – regressions**

Variables	Expected Sign	Return on Equity (RoE)							
		(random effects)							
		Model 1	Model 2	Model 3	Model 4				
VAIC	+	2.0919 ***							
HCE	+		7.4879 ***						
SCE	+				-0.6751				
CEE	+						1284.4075 ***		

LOGATIV	+	-4.1260	*	-1.4558		-5.3847	**	4.6324	**
RISC	-	-230.0062	***	-163.2152	***	, -259.5701	***	-83.8865	**
AGEN	+	0.0094		0.0102	*	0.0048		0.0020	
CBV	+	10.1938	***	-0.9105		11.7365	***	-4.0095	
_CONS		271.9520		162.1918		327.4019		-15.7459	
N.º Observations:		84		84		84		84	
N.º Banks:		7		7		7		7	
R-sq:	Within	0.2844		0.8643		0.2429		0.8983	
	Between	0.5824		0.8584		0.2685		0.6571	
	Overall	0.3718		0.8624		0.2319		0.8171	
	Rho	0.0000		0.4075		0.0000		0.5986	

Note: (\*) (\*\*) (\*\*\*) Statistically significant results for a significance level of 0.10, 0.05 and 0.01 respectively.  
Source: Author's own elaboration.

**Table 7** shows the results obtained in the estimation of the regression model based on the financial performance of Portuguese banks, measured by the RoE.

Thus, the regression model was run four times and referred to in **table 7** as models 1, 2, 3 and 4, with model 1 being considered the main model and the remaining three models as a development of the main model. Thus, the results obtained make it possible to validate the formulation of hypothesis 1 and 2 for model 1, 2 and 4. However, model 3 is not sufficient to validate hypothesis 2, as explained below:

- **Model 1** is the main regression model, which analyses the relationship between bank profitability and RoE. In this context, the coefficient of value-added intellectual capital shows a positive relationship with RoE, confirming the expected sign and being considered statistically significant ( $p < 0.01$ ). These results show that Portuguese banks are efficient at creating value through their intellectual capital, that is, an increase in the intellectual capital coefficient positively influences bank profitability. In turn, the control variables related to banks (LOGATIV, RISC and CBV) are statistically significant ( $p < 0.1$  and  $p < 0.01$ ) and confirm the expected signs, except for the variable (LOGATIV). This variable shows a negative relationship, suggesting that larger banks have lower financial performance. However, this result is in line with the negative correlation shown in the correlation test (**table 6**). The quality of fit of model 1 in explaining the variables in this study is considered acceptable, with an adjusted  $R^2$  of 37.18%;
- **Model 2** follows the development of model 1, however, the measure composed of VAIC is replaced by the variable of human capital efficiency (HCE), making it possible to measure the relationship between performance (RoE) and the variable (HCE). Also as expected, the results obtained indicate a significant positive relationship for a level of statistical significance ( $p < 0.01$ ). It can therefore be concluded that human capital makes a positive contribution to financial performance in the banking sector. As in model 1, the variable (RISC) also shows a negative and statistically significant relationship ( $p < 0.01$ ). Finally, the variable (AGEN) shows a significant positive influence on RoE ( $p < 0.05$ ). Model 2 shows an excellent quality of fit in explaining the set of variables, with an adjusted  $R^2$  of 86.24%;
- **In model 3**, although all the control variables (LOGATIV, RISC and CBV) are statistically significant at significance levels of ( $p < 0.01$ ) and ( $p < 0.05$ ), they are not sufficient to demonstrate a significant

relationship between structural capital efficiency (SCE) and bank profitability (RoE). Furthermore, the relationship between the variables does not confirm the expected sign, showing an insignificant negative relationship. Thus, the results obtained suggest that greater care should be taken in managing structural intellectual capital in order to achieve the desired level of performance. In other words, the efforts made in recent times by banks to invest in strengthening and improving operational and legal procedures, along with innovative digital transformation processes (technologies), are not yet boosting organizations' value creation activities. The quality of fit of model 3 shows an adjusted  $R^2$  of 23.19%;

- **Model 4** examines the association between performance (RoE) and capital efficiency (CEE). The results confirm the expected sign, being similar to models 1 and 2 but with a significantly higher coefficient magnitude. Thus, the results suggest a significant positive relationship at the 1% level between RoE and CEE. With regard to the bank-specific control variables, the variables (LOGATIV and RISC) confirm the expected signs and are statistically significant ( $p < 0.05$ ). Finally, the quality of fit of model 4 is excellent, with an adjusted  $R^2$  of 81.71%.

The general results are in line with the studies of the authors referenced in the literature review of this paper, with Gigante (2013), Mollah and Rouf (2021), Thaha and Sulaiman (2022), Majumder et al. (2023), Lim et al. (2024) and Sayed and Nefzi (2024) which show a significant positive association between the variables of human capital efficiency (HCE), capital employed efficiency (CEE) and value-added intellectual capital (VAIC) and bank profitability as measured by RoE. The results are also consistent with those of Gigante (2013), Mollah and Rouf (2021) and Sayed and Nefzi (2024) regarding the negative relationship between bank performance and structural capital efficiency (SCE), but they disagree with those of Mention and Bontis (2013), Thaha and Sulaiman (2022), Majumder et al. (2023) and Lim et al. (2024), who observed a positive relationship between the variables.

## 4. Conclusion

This work aims to analyze the impact of the intellectual capital of banks operating in Portugal, in the financial performance for the period from 2012 to 2023. To this end, an econometric model was used through four linear regression equations, in which it is explained, and can be adopted to predict, the explanatory factors of banks' profitability, taking into account their intellectual capital.

Thus, several conclusions emerge from this study. Thus, when analysing the banks in the sample, it can be seen that the VAIC explanatory variable explains the companies' profitability index, measured by RoE, at a statistical significance level of 10%, with a positive relationship between the variables. Thus, it can be inferred that an improvement in the efficiency of the VAIC positively influences the financial performance of the banks, validating hypothesis 1 of this study.

The same occurs when we examine the efficiency of human capital (HCE) and applied capital (CEE) separately, with both showing a significance level of 1% and therefore partially validating hypothesis 2 of the study. On the other hand, the efficiency of structural capital (SCE) shows a negative and insignificant

associated relationship, thus not allowing hypothesis 2 to be partially validated.

The study confirms that the results of the risk level control variable (RISC) show a negative and statistically significant relationship in all four models. It can therefore be inferred that an increase in the risk level of banking organizations negatively influences financial performance.

The results show that the control dummy variable for listed banks (CBV) is statistically significant for a level of 1% for the banks in the sample and only for the VAIC and structural capital efficiency (SCE) models. Thus, bank performance presents a positive relationship with the RoE variable, indicating that bank performance is influenced by the fact that the banking entity is listed on the stock exchange.

In turn, the control variable of the number of bank branches (AGEN) shows a positive and statistically significant relationship at a 5% significance level for the human capital efficiency (HCE) model, materializing that the number of branches has a positive impact on banks' financial performance. These results suggest that human resources continue to value branch space for better business profitability.

Finally, the size variable (LOGATIV) shows a negative relationship and is statistically significant for models 1 and 3, while it is insignificant for model 2. As for model 4, with regard to the capital employed efficiency component (CEE), the relationship is positive and statistically significant. It can therefore be concluded that for models 1, 2 and 3, if the size of the bank increases, financial performance decreases. In contrast, for model 4, if the size of the bank decreases, financial performance increases.

The results of the research analysis provide economic agents in the banking sector with some empirical evidence that can contribute to a better assessment of improving the efficiency of intellectual capital and the profitability of banks.

For the purposes of this study, a limited number of banks were analysed and therefore not all the banks operating in the Portuguese banking system were considered. It is therefore suggested that the study be extended to a more representative base of banks. In addition, the VAIC™ model is limited to three components and with similar weights, so it is also suggested that the model applied in the study could be extended, taking into account the efficiency of relational capital (customer relations, supplier list, consumers, image and reputation), a factor that is understood to be of vital importance for a sector that has been viewed with some suspicion, as well as using different weights for the coefficients of each capital component, taking into account the history of various studies carried out in this area.

Las funciones de impulso respuesta para variables como la exportación agrícola total, el tipo de cambio y la inflación acumulada, muestran efectos tanto positivos como negativos sobre el PIB agrícola en diferentes períodos posteriores a los choques. Si bien los intervalos de confianza del 95% evidencian variabilidad en estas relaciones a lo largo del tiempo, el estudio proporciona una visión dinámica valiosa sobre los canales de transmisión de factores macroeconómicos clave como las exportaciones, el tipo de cambio y la inflación, en el desempeño y crecimiento de la economía agrícola peruana.

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#### Notes

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