



Intellectual capital and financial performance of private banks in Ecuador

Capital intelectual y desempeño financiero de los bancos privados en Ecuador

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Abstract

This study evaluates the intellectual capital (IC) in the private banking sector of Ecuador and its impact on financial performance. Using panel data from 15 banks between 2003 and 2021 and applying the M-VAIC model to measure IC, significant trends were identified. The average M-VAIC was 2,378, with eight banks surpassing the sectorial average. Regression analyses reveal a positive correlation between IC and the indicators of Return on Assets (ROA) and Return on Equity (ROE). At the component level, physical capital leads in profitability generation, followed by human capital, while structural capital has less influence. Surprisingly, relational capital shows a negative correlation. These findings provide a profound understanding of how intangible aspects influence banking profitability over time. The analysis, unique in its panel data approach for the Ecuadorian context, contributes to the literature on knowledge management and finance, offering valuable insights for strategic decision-making in the banking sector.

JEL Code: O34, G20, G32

Keywords: intellectual capital; financial performance; banks; VAIC; M-VAIC

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Resumen

Este estudio evalúa el capital intelectual (CI) en la banca privada de Ecuador y su impacto en el desempeño financiero. Utilizando datos panel de 15 bancos entre 2003 y 2021 y aplicando el modelo M-VAIC para medir el CI, se identificaron tendencias significativas. La media del M-VAIC fue 2,378, con ocho bancos superando la media sectorial. Los análisis de regresión revelan una correlación positiva entre el CI y los indicadores de Rentabilidad sobre Activos (ROA) y Rentabilidad sobre Patrimonio (ROE). A nivel de componentes, el capital físico lidera en la generación de rentabilidad, seguido del capital humano, mientras que el capital estructural tiene menor influencia. Sorprendentemente, el capital relacional muestra una correlación negativa. Estos hallazgos aportan una comprensión profunda de cómo los aspectos intangibles influyen en la rentabilidad bancaria a lo largo del tiempo. El análisis, único en su enfoque de datos panel, para el contexto ecuatoriano contribuye a la literatura sobre gestión del conocimiento y finanzas, ofreciendo percepciones valiosas para la toma de decisiones estratégicas en el sector bancario.

Código JEL: O34, G20, G32

Palabras clave: capital intelectual; rendimiento financiero; bancos; VAIC; M-VAIC

Introduction

The knowledge economy has transformed business management, where value creation and competitive advantage are centered on intangible assets (Buallay et al., 2020; Xu et al., 2022). Intellectual capital (IC), which encompasses human, structural, and relational capital, has been highlighted as a crucial strategic asset (Edvinsson & Malone, 1997; Nimtrakoon, 2015).

Although the positive influence of IC on competitiveness and financial performance in organizations has been demonstrated (Nazari, 2014; Xu, Haris, & Irfan, 2022), the empirical evidence collected on the impact of IC on the financial performance of banks presents different nuances, although studies are confirming a significant positive relation between intellectual capital and banks' financial performance (Buallay et al., 2020; Faruq et al., 2023a; Ousama, 2019; Soewarno & Tjahjadi, 2020; Tran & Vo, 2020). Empirical evidence has also been found where this relation is marginal or null (Firer & Mitchell Williams, 2003; Haris et al., 2019; Yao et al., 2019).

With its unique characteristics, Ecuadorian banking is an intriguing and little-explored context. There is bank concentration, high regulation, and a minimal presence of foreign banks, and operations are carried out in a dollarized economy, making it interesting to test the intellectual capital approach to financial performance. In addition, no regulation motivates the measurement and disclosure of IC, which implies that banks are not managing their intellectual capital to meet strategic objectives and improve financial performance (Peñarreta et al., 2022).

This study not only addresses the need for more research in the specific context of Ecuadorian banking in terms of its intellectual capital but also offers a unique methodological contribution by applying

panel data and regression models in a field where empirical evidence is scarce. The research also stands out by adopting the M-VAIC approach to measure IC, considering relational capital, thus providing a more comprehensive view of the intangible assets that could influence the financial performance of private banks. This comprehensive approach seeks to fill a relevant gap in the understanding of knowledge management and the influence of IC on economic performance, thus providing valuable contributions to both the academic literature and business practice in the Latin American region.

The study is divided into sections. After the introduction, section two provides the theoretical basis for the study. Section 3 presents the methodology. Section 4 shows the results of the study and the discussion. Finally, the conclusions are presented in section 5 of the document.

Theoretical basis

Definition and measurement of IC

IC in the modern economy plays an important role and can be conceptualized as the set of intangible assets, knowledge, capabilities, and relations, among others, which combined contribute to the generation of value and competitive advantage of companies, with a significant impact on their financial and non-financial performance and which, in the face of company management and entrepreneurial success, assume the role of strategic assets (Edvinsson & Malone, 1997; Mondal & Ghosh, 2012; Zerenler et al., 2008).

Based on the triadic model, IC can be classified into human capital, structural capital, and relational capital (Faruq et al., 2023a; Secundo et al., 2016). Human capital is the mix of knowledge, skill sets, competencies, and experience of employees gained through training and experience (Nawaz, 2019; Soewarno & Tjahjadi, 2020). Structural capital comprises the organization's infrastructure, procedures, and other factors that support employee performance and business profitability (Alrowwad et al., 2020; Mollah & Rouf, 2022). Relational capital refers to the company's ability to preserve its relations with shareholders, customers, suppliers, and government (Baima et al., 2020; Weqar & Haque, 2022).

Multiple methodological proposals have been proposed to measure IC in organizations over time, such as the Skandia Navigator model (Edvinsson & Malone, 1997), the Intangible Assets Monitor (Sveiby, 1997), the Balanced Score (Kaplan & Norton, 1996), the market capitalization method, and the VAIC—Value Added Intellectual Coefficient model (Pulic, 1998, 2000).

The VAIC model allows for calculating the contribution of human, structural, and physical capital in the creation of added value, taking information from the balance sheet of companies (Meles et al., 2016; Tiwari, 2020). It essentially states that a higher value of VAIC indicates greater efficiency in

using intellectual capital, and it is calculated from the sum of capital employed, human capital efficiency, and structural capital efficiency (Pulic, 2000). Nevertheless, the model has some limitations.

The design of the VAIC model is not made to measure IC but rather the efficiencies of the inputs of the companies referred to above. It also does not incorporate the level of risk of the companies (Chu et al., 2011), and since it is calculated based on the financial data of the companies, the VAIC is a measure of the value created in the past and not of the value creation potential of the companies (Janošević et al., 2013). In addition, the measure of structural capital is incomplete because it ignores the existence of relational capital and innovation capital (Nimtrakoon, 2015).

Nevertheless, this model is one of the most widely used methods by researchers and managers to measure IC efficiency based on companies' human, structural, and physical capital (Gupta & Raman, 2021; Kasoga, 2020; Weqar & Haque, 2022). In addition, the VAIC methodology has been updated, including relational capital within the model; this update is called the M-VAIC (Modified Value-Added Intellectual Capital) model (Bayraktaroglu et al., 2019; Nadeem et al., 2019; Soewarno & Tjahjadi, 2020), and its main advantage is to explain better how IC is generated and, therefore, to manage more elements of measurement and analysis for the design of future value strategies (García Castro et al., 2021).

Intellectual capital, components, and financial performance

Recent studies of the nexus between IC, its components, and financial performance in banking show that IC positively and significantly influences bank financial performance measured by return on assets (ROA) and return on equity (ROE) (Akkas & Asutay, 2022; Anifowose et al., 2018; Chowdhury et al., 2018). At the level of influence of IC components on bank profitability, some studies provided evidence for human capital efficiency (HCE) and capital employed efficiency (CEE) as two of the main components influencing the ROA and ROE of banks (Buallay et al., 2020; Mollah & Rouf, 2022; Nawaz, 2019; Ousama, 2019; Uslu, 2022).

Meanwhile, the study by Momani and Nour (2019) on commercial banks in Jordan showed that capital employed efficiency (CEE) and structural capital efficiency (SCE) are the main drivers of ROE. Nazir et al. (2021), based on a comparative study of banks in Hong Kong, China, and Taiwan, showed that HCE and CEE are the driving IC components of ROA.

Research by Githaiga (2022) on East African banking and Tiwari and Vidyarthi (2018) on banks listed on the Indian Stock Exchange showed that SCE is the main driver of ROA, while Nimtrakoon (2015) showed that CEE and HCE are the most influential components of financial performance and that SCE and relational capital efficiency (RCE) have less relevance. In contrast to these results, Selvam et al. (2020) found that HCE and RCE are the main drivers of ROA and ROE of foreign banks operating in

India. Using the same model, Tran and Vo (2020) determined that CEE, SCE, and RCE influence the ROA and ROE of banking in Vietnam. The results of the panel data study by Weqar et al. (2020) on Indian banking found that HCE, SCE, and CEE are influential on ROA. Yao et al. (2019) and Saruchi et al. (2019), applying the M-VAIC model, conclude that HCE is the most influential IC component in the ROA of banking in Pakistan and Islamic banking.

These findings confirm that IC management is crucial for banking organizations. In order to provide their customers with high-quality products and services, banks depend on their investments in IC-related elements such as their human resources, brand building, systems, processes, and relations with the external environment, which in turn results in improved performance (Nawaz, 2019, Yao et al., 2019).

Despite the general evidence of a positive relation between IC and bank financial performance, some studies did not find this causality. Joshi et al. (2013), using a sample of 40 financial institutions in Australia, showed that IC measured by VAIC is not influential on ROA. Vo and Tran (2021), after evaluating 16 listed banks in Thailand, concluded that IC does not influence bank profitability, unlike some of its components. Mondal et al. (2022), in the analysis of 59 banks in Bangladesh, conclude that IC does not affect ROA and ROE, while in the context of listed banks in Colombia, the role of IC measured by VAIC in profitability is not clear (Garcia Castro et al., 2021).

Methodology

Hypothesis development

In order to measure the influence of IC and the financial performance of banks in Ecuador, five testable research hypotheses have been formulated. The first hypothesis is related to the positive link between IC and the financial performance of banks. IC and tangible assets can enable banks to achieve competitive advantages and improve returns over time (Farooq & Ahmad, 2023; Faruq et al., 2023; Meles et al., 2016). IC efficiency is measured using the M-VAIC model approach. Thus, the first hypothesis is as follows:

H1: CI positively influences the financial performance of banks in Ecuador,

The studies consulted showed that HCE, SCE, and RCE are the main components of IC that, jointly with physical capital (CEE), can positively influence the financial performance of banks (Buallay et al., 2020; Mohammed & Irbo, 2018; Nawaz, 2019; Tran & Vo, 2020). Thus, the following set of hypotheses is put forward:

H2: HCE positively impacts the financial performance of banks in Ecuador.

H3: SCE positively impacts the financial performance of banks in Ecuador.

H4: RCE positively impacts the financial performance of banks in Ecuador.

H5: CEE positively impacts the financial performance of banks in Ecuador.

Data, variables, and models

The data corresponding to the balance sheet information and financial performance indicators of the banks were collected using the Superintendency of Banks of Ecuador database on the website www.superbancos.gob.ec. The study sample comprises 15 of 24 private banks operating in Ecuador with access to all the information, with 285 observations. Nine banks were excluded from the sample because they did not present all the information for the study period.

This study, following the proposal of recent empirical evidence (Akkas & Asutay, 2022; Faruq et al., 2023; Mollah & Rouf, 2022; Nazir et al., 2021), considers return on assets (ROA) and return on equity (ROE) as dependent variables.

ROA measures the bank's ability to create profits from its assets. Equation 1 shows how it is calculated:

$$\text{ROA} = \text{Net profit} / \text{Total assets} \quad (1)$$

ROE measures the bank's profitability by illustrating how much revenue the organization generates with the money shareholders have financed. It is usually considered one of the most important financial indicators for investors and is estimated based on Equation 2:

$$\text{ROE} = \text{Net profit} / \text{Total equity} \quad (2)$$

Regarding the independent variables, the study uses the M-VAIC model to measure the banks' IC. The estimation of the M-VAIC is carried out in three phases:

The first phase consists in determining the value added (VA) of the banks following Equation 3:

$$\text{VA} = \text{OP} + \text{EC} + \text{D} + \text{A} \quad (3)$$

Where VA is the value added, OP is the operating margin, D is depreciation, and A is the amortization of banks.

The second phase calculates intellectual capital efficiency (ICE), the sum of HCE, SCE, and RCE. HCE measures how much value has been created by monetary investment in employees, and SCE

shows how much capital has been created by SC. Pulic (1998, 2000) noted that SC is negatively and symmetrically correlated with HC. SCE indicates how much value has been created by an invested unit of RC. The calculations are as follows:

$$ICE = HCE + SCE + RCE \quad (4)$$

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

$$SCE = (VA - HC)/VA \quad (6)$$

$$RCE = VA/RC \quad (7)$$

Where HC corresponds to employees' salaries and wages, and RC is the advertising expenditure incurred by the banks.

The third and final step is calculating capital employed efficiency (CEE). The CEE measures the value created per dollar of capital employed. It is calculated as follows:

$$CEE = VA/CE \quad (8)$$

Where SC corresponds to the book value of total assets.

Therefore, the M-VAIC is defined as follows:

$$M - VAIC = ICE + CEE \quad (9)$$

It can also be expressed as follows:

$$M - VAIC = HCE + SCE + RCE + CEE \quad (10)$$

M-VAIC indicates the effectiveness of the organization's value creation. The higher the M-VAIC, the better the organization has used intellectual capital resources (Asutay & Ubaidillah, 2023; Faruq et al., 2023).

The study to recognize the specific effect of M-VAIC on the performance of private banks includes leverage and asset size as sector control variables (Nazir et al., 2021; Uslu, 2022; Weqar & Haque, 2022). Leverage is determined based on the liability-to-equity ratio of banks. Size is expressed as the logarithm of assets (LogAssets). Regarding the macroeconomic variable, this study, in line with previous studies (Akkas & Asutay, 2022; Rehman et al., 2022), considers Gross Domestic Product (GDP) as the environmental variable.

The study includes a dummy variable for periods of financial crisis (FC). For crisis periods, it assumes the value of 1 (financial crisis, 2008-2010; Covid-19, 2020-2021) and 0 for the rest of the periods. Previous studies also employed a similar dummy variable in order to measure the behavior of CI and its impact on banks' ROA and ROE (Alabass, 2019; Farooq & Ahmad, 2023; Faruq et al., 2023; Oppong & Pattanayak, 2019).

Models (1) and (2) are used to evaluate the relation between IC and the financial performance of banks:

$$ROA_{it} = \alpha_0 + \alpha_1 MVAIC_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (1)$$

$$ROE_{it} = \alpha_0 + \alpha_1 MVAIC_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (2)$$

Models (1a-1d) and (2a-2d) are used to analyze the extent to which the components of intellectual capital (HCE, SCE, RCE, and CEE) influence the financial performance of banks as measured by ROA and ROE. The regression models are described below:

$$ROA_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (1a)$$

$$ROA_{it} = \alpha_0 + \alpha_1 SCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (1b)$$

$$ROA_{it} = \alpha_0 + \alpha_1 RCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (1c)$$

$$ROA_{it} = \alpha_0 + \alpha_1 CEE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} + \alpha_5 FC_{it} + \varepsilon_{it} \quad (1d)$$

$$ROE_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} \alpha_4 + \alpha_5 FC_{it} \alpha_5 + \varepsilon_{it} \quad (2a)$$

$$ROE_{it} = \alpha_0 + \alpha_1 SCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} \alpha_4 + \alpha_5 FC_{it} \alpha_5 + \varepsilon_{it} \quad (2b)$$

$$ROE_{it} = \alpha_0 + \alpha_1 RCE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} \alpha_4 + \alpha_5 FC_{it} \alpha_5 + \varepsilon_{it} \quad (2c)$$

$$ROE_{it} = \alpha_0 + \alpha_1 CEE_{it} + \alpha_2 LEV_{it} + \alpha_3 LNTA_{it} + \alpha_4 GDP_{it} \alpha_4 + \alpha_5 FC_{it} \alpha_5 + \varepsilon_{it} \quad (2d)$$

Where *i* indicates the *i*-th bank, *t* the period, *LNTA* indicates that the variable is in natural logarithms and ε_{it} is the random error.

Results

Descriptive statistics

Table 1 shows that the average ROA and ROE values were 0.011 and 0.109, respectively, indicating that banks generate higher equity returns with their own funds than bank assets. The average debt-to-equity ratio was 8.8. In terms of intellectual capital, HCE has the highest average value (1.960) compared to SCE (0.318), RCE (0.062), and CEE (0.039). The sum of HCE, SCE, and RCE (2.340) exceeds the mean value of CEE (0.039), indicating that banks generate more value through IC than physical and financial capital. With a mean M-VAIC of 2.378, banks, on average, generate 2.378 for each monetary unit invested.

Table 1
Descriptive statistics

Variables	N	Mean	Standard deviation	Minimum	Maximum,	Skewness	Kurtosis
ROA	285	0.011	0.007	0.000	0.041	1.108	2.149
ROE	285	0.109	0.064	0.000	0.310	0.245	-0.376
M-VAIC	285	2.378	1.685	-18.628	6.703	-7.260	86.604
HCE	285	1.960	0.778	-0.468	5.803	0.682	2.309
SCE	285	0.318	1.309	-19.737	3.135	-13.239	197.814
RCE	285	0.062	0.074	-0.011	1.059	9.034	119.101
CEE	285	0.039	0.017	-0.006	0.091	0.866	1.232
LEV	285	8.800	2.683	2.261	16.292	-0.268	-0.022
LNTA	285	13.332	1.628	9.333	16.411	-0.394	-0.544

GDP	285	0.029	0.036	-0.078	0.082	-1.115	1.864
FC	285	0.263	0.441	0.000	1.000	1.081	-0.836

Note: ROA, ROE, M-VAIC, HCE, SCE, RCE, CEE, LEV, LNTA, GDP, and FC represent return on assets, return on equity, modified value-added ratio, human capital efficiency, structural capital efficiency, relational capital efficiency, capital employed efficiency, leverage, natural logarithm of assets, gross domestic product, and financial crisis, respectively.

Source: created by the authors

Correlation analysis

Table 2 shows that M-VAIC maintains a positive correlation with the ROA and ROE of banks. Regarding the intellectual capital components, HCE, SCE, and CEE positively correlate with bank performance measures, while RCE does not correlate with ROA and ROE. Regarding control variables, the financial crisis is correlated with bank performance measures with a negative sign, while Leverage and LogAssets positively correlate with ROE.

Table 2
Correlation matrix

Variables	ROA	ROE	M-VAIC	HCE	SCE	RCE	CEE	LEV	LNTA	GDP	FC
ROA	—										
ROE	0.907***	—									
M-VAIC	0.767***	0.763***	—								
HCE	0.769***	0.765***	0.992***	—							
SCE	0.753***	0.749***	0.995***	0.979***	—						
RCE	-0.025	0.035	-0.035	-0.060	-0.081	—					
CEE	0.461***	0.345***	0.344***	0.350***	0.329***	-0.242***	—				
LEV	0.031	0.370***	0.161**	0.163**	0.151*	0.247***	-0.312***	—			
LNTA	0.201***	0.236***	0.363***	0.351***	0.349***	0.421***	-0.382***	0.290***	—		
GDP	0.291***	0.340***	0.177**	0.183**	0.163**	-0.024	0.265***	0.153**	-0.164**	—	
FC	-0.230***	-0.215***	-0.137*	-0.144*	-0.123*	-0.050	-0.198***	0.7264	0.051	-0.109	—

Note: * p < ,05, ** p < ,01, *** p < ,001

Source: created by the authors

The results of the correlation matrix show that in some cases the correlations are high, considering that the variables are exposed in terms of interaction, as is the case of M-VAIC and its HCE and SCE components, which suggests a problem of multicollinearity of the variables. To overcome this problem, the study included the independent variables in separate models.

IC coefficient in Ecuador's private banks

Table 3 reveals that the mean M-VAIC for private banks in 2003-2021 was 2 378. Bancos Internacional (3 417), Bolivariano (3 233), and Guayaquil are among the best performers. On the other hand, Pacifico (1 763), Litoral (1 528), and Amazonas have the lowest M-VAIC indices. At the industry level, 60% of the banks exceed the IC average, indicating value creation.

On the other hand, comparing the performance of M-VAIC with recent empirical evidence shows that they are below the mean in countries such as the Persian Gulf (4.39), Jordan (7.19), Vietnam (5.25), Ethiopia (9.16), Pakistan (3.92), and Bangladesh (3.95) as reported by Ousama (2019), Momani and Nour (2019), Vo and Tran (2021), Mohammed and Irbo (2018), Haris et al. (2019), and Mondal et al. (2022).

The results at the IC component level show that HCE was more influential, with a mean of 1 960 compared to SCE (0.318), RCE (0.062), and CEE (0.039). These findings are to be expected because banks tend to be human capital intensive in providing financial services (Bayraktaroglu et al., 2019; Nawaz, 2019; Nazir et al., 2021).

Table 3
 Intellectual capital efficiency values of private banks

Private Bank	M-VAIC	HCE	SCE	RCE	CEE
BP AMAZONAS	0.7025	1.0373	-0.4251	0.0671 ^a	0.0232
BP AUSTRO	2.9149 ^a	2.2412 ^a	0.5339 ^a	0.1031 ^a	0.0368
BP BOLIVARIANO	3.2333 ^a	2.5366 ^a	0.6001 ^a	0.0617	0.0349
BP CITIBANK	2.3785	1.8432	0.4971 ^a	0.0052	0.0331
BP COMERCIAL DE MANABI	2.5764 ^a	2.0505 ^a	0.4308 ^a	0.0438	0.0515 ^a
BP GENERAL RUMIÑAHUI	2.2436	1.7921	0.3843 ^a	0.0344	0.0328
BP GUAYAQUIL	3.1892 ^a	2.4632 ^a	0.5816 ^a	0.1060 ^a	0.0384
BP INTERNACIONAL	3.4167 ^a	2.7238 ^a	0.6203 ^a	0.0332	0.0393 ^a
BP LITORAL	1.5284	1.3554	0.1048	0.0150	0.0533 ^a
BP LOJA	2.9198 ^a	2.2905 ^a	0.5465 ^a	0.0428	0.0400 ^a
BP MACHALA	1.8611	1.4377	0.2982	0.0923 ^a	0.0329
BP PACIFICO	1.7625	2.2462 ^a	-0.6156	0.1038 ^a	0.0281
BP PICHINCHA	2.3923 ^a	1.8340	0.4310 ^a	0.0961 ^a	0.0311
BP PRODUBANCO	2.7180 ^a	2.1042 ^a	0.5080 ^a	0.0725 ^a	0.0333
BP SOLIDARIO	1.8400	1.4392	0.2785	0.0533	0.0691 ^a
Average 2003 to 2021	2.3785	1.9597	0.3183	0.0620	0.0385

Note: VAIC, M-VAIC, HCE, SCE, RCE, and CEE represent intellectual value-added coefficient, modified value-added coefficient, human capital efficiency, structural capital efficiency, relational capital efficiency, and capital employed efficiency, respectively.

^a Represent values higher than the mean value

Source: created by the authors

Diagnostic tests

Before running the panel data regression, the problem of multicollinearity among the variables was investigated through the Variance Inflation Factor (VIF). The results in Table 4 confirm no multicollinearity problem in the variables. Moreover, the VIF values are below 10; Gujarati and Porter (2010) believe that VIF above 10 indicates a multicollinearity problem.

In this context, multicollinearity has no adverse effect on the models proposed in this study.

Table 4
VIF results

Variables	M-VAIC_ ROA_ROE	HCE_ ROA_ROE	SCE_ ROA_ROE	RCE_ ROA_ROE	CEE_ ROA_ROE
M-VAIC	1.06	—	—	—	—
HCE	—	1.17	—	—	—
SCE	—	—	1.01	—	—
RCE	—	—	—	1.06	—
CEE	—	—	—	—	1.46
LEV	1.48	1.49	1.48	1.49	1.64
LNTA	1.55	1.63	1.51	1.54	1.55
GDP	1.18	1.23	1.15	1.15	1.25
FC	1.07	1.08	1.07	1.07	1.1

Source: created by the authors

Subsequently, applied four diagnostic tests were applied. The first test corresponds to the Hausman test in Table 5 to determine whether the type of regressions with panel data will be with fixed effects or random effects. The second test corresponds to the Wald test in Table 6 to determine the presence of heteroscedasticity in the models. The third test, in Table 7, applies the Wooldridge test to identify possible autocorrelation in the models. The fourth test applied the Pesaran test to check for contemporaneous correlation, and the findings are shown in Table 8.

Table 5
Hausman test results

Model	Statistic	Probability “p”	Effect type
M-VAIC_ROA (1)	X2= 112.18	Prob> X2= 0.0000	Fixed
M-VAIC_ROE (2)	X2= 92.60	Prob> X2= 0.0000	Fixed
HCE_ROA (1a)	X2= 28.43	Prob> X2= 0.0000	Fixed
HCE_ROE (2a)	X2= 66.53	Prob> X2= 0.0000	Fixed
SCE_ROA (1b)	X2= 53.34	Prob> X2= 0.0000	Fixed
SCE_ROE (2b)	X2= 81.48	Prob> X2= 0.0000	Fixed
RCE_ROA (1c)	X2= 55.40	Prob> X2= 0.0000	Fixed
RCE_ROE (2c)	X2= 78.69	Prob> X2= 0.0000	Fixed

CEE_ROA (1d)	X2= 33.67	Prob> X2= 0.0000	Fixed
CEE_ROE (2d)	X2= 56.71	Prob> X2= 0.0000	Fixed

Note: Ho = No systematic difference between the coefficients (random); H1 = There is a systematic difference between the coefficients (fixed)

Source: created by the authors

Table 6

Wald test results

Model	Statistic	Probability	Result
M-VAIC_ROA (1)	X2= 2026.34	Prob> X2= 0.0000	Heteroscedasticity
M-VAIC_ROE (2)	X2= 388.70	Prob> X2= 0.0000	Heteroscedasticity
HCE_ROA (1a)	X2= 1639.77	Prob> X2= 0.0000	Heteroscedasticity
HCE_ROE (2a)	X2= 271.48	Prob> X2= 0.0000	Heteroscedasticity
SCE_ROA (1b)	X2= 1419.69	Prob> X2= 0.0000	Heteroscedasticity
SCE_ROE (2b)	X2= 354.66	Prob> X2= 0.0000	Heteroscedasticity
RCE_ROA (1c)	X2= 1263.12	Prob> X2= 0.0000	Heteroscedasticity
RCE_ROE (2c)	X2= 297.39	Prob> X2= 0.0000	Heteroscedasticity
CEE_ROA (1d)	X2= 1358.75	Prob> X2= 0.0000	Heteroscedasticity
CEE_ROE (2d)	X2= 386.20	Prob> X2= 0.0000	Heteroscedasticity

Note: Ho = Homoscedasticity; H1 = Heteroscedasticity

Source: created by the authors

Table 7

Wooldridge test results

Model	Statistic	Probability	Result
M-VAIC_ROA (1)	F= 9.082	Prob = 0.0093	Autocorrelation
M-VAIC_ROE (2)	F= 9.349	Prob = 0.0085	Autocorrelation
HCE_ROA (1a)	F= 7.260	Prob = 0.0174	Autocorrelation
HCE_ROE (2a)	F= 8.527	Prob = 0.0112	Autocorrelation
SCE_ROA (1b)	F= 9.986	Prob = 0.0070	Autocorrelation
SCE_ROE (2b)	F= 9.497	Prob = 0.0081	Autocorrelation
RCE_ROA (1c)	F= 10.844	Prob = 0.0053	Autocorrelation
RCE_ROE (2c)	F= 9.754	Prob = 0.0075	Autocorrelation
CEE_ROA (1d)	F= 6.716	Prob = 0.0213	Autocorrelation
CEE_ROE (2d)	F=12.253	Prob = 0.0035	Autocorrelation

Note: Ho = No autocorrelation; H1 = Autocorrelation

Table 8

Pesaran test results

Model	Pesaran Test Value	Probability	Result
M-VAIC_ROA (1)	4.737	Prob= 0.0000	There is a contemporary correlation
M-VAIC_ROE (2)	4.624	Prob = 0.0000	There is a contemporary correlation
HCE_ROA (1a)	0.263	Prob = 0.7929	No contemporary correlation
HCE_ROE (2a)	0.722	Prob = 0.4702	No contemporary correlation
SCE_ROA (1b)	6.124	Prob = 0.0000	There is a contemporary correlation
SCE_ROE (2b)	5.952	Prob= 0.0000	There is a contemporary correlation
RCE_ROA (1c)	6.017	Prob= 0.0000	There is a contemporary correlation
RCE_ROE (2c)	5.777	Prob= 0.0000	There is a contemporary correlation
CEE_ROA (1d)	1.697	Prob = 0.0897	No contemporary correlation

CEE_ROE (2d)	2.676	Prob = 0.0074	There is a contemporary correlation
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Note: Ho = There is no contemporary correlation; H1 = There is a contemporary correlation
Source: created by the authors

From the different diagnostic tests applied to the models, it is concluded that there are heteroscedasticity, autocorrelation, and contemporaneous correlation problems. In order to solve these problems, the Driscoll-Kraay estimation (Driscoll & Kraay, 1998) is applied, which considers these drawbacks (Torres-Reyna, 2007). According to Joshi et al. (2021), the Driscoll-Kraay estimation allows for robust estimations in autocorrelation, heteroscedasticity, and contemporary correlation problems.

Regression analysis

In Table 9, the results confirm that the IC measured by M-VAIC is significantly positive with ROA (Model 1) at a 95% confidence level. The positive impact of M-VAIC on ROA suggests that if banks create M-VAIC, banks' return on assets is expected to increase by 0.00165 units. Consequently, hypothesis 1 is accepted.

Regarding IC components, HCE, SCE, and CEE are positively and significantly related to ROA at 1% in models 1a, 1b, and 1d, which supports the validity of hypotheses H2, H3, and H5. Regarding RCE, the results indicated that it is significantly correlated with ROA but with a negative sign in model 1c. Therefore, H4 is rejected. CEE and HCE are the main drivers of ROA.

At the level of impact of the control variables, bank leverage measured by LEV, bank size expressed by LNTA, and FC financial crisis are statistically significant but negatively with ROA. The macroeconomic performance variable measured by GDP had the opposite behavior. Indeed, GDP is significantly positive with banks' ROA.

Table 9
Results of fixed effects regressions between IC and ROA

Variables	(Model 1) ROA	(Model1a) ROA	(Model1b) ROA	(Model1c) ROA	(Model1d) ROA
M-VAIC	0.00165** (0.000609)				
HCE		0.00647*** (0.000771)			
SCE			0.000997*** (0.000264)		
RCE				-0.0156*** (0.00301)	
CEE					0.362*** (0.0589)

LEV	-0.0380** (0.0145)	-0.0276* (0.0135)	-0.0436** (0.0167)	-0.0435** (0.0174)	-0.0112 (0.0151)
LNTA	-0.00445*** (0.000586)	-0.00340*** (0.000242)	-0.00449*** (0.000881)	-0.00433*** (0.000889)	-0.000578 (0.000546)
GDP	0.0179** (0.00650)	0.00463 (0.00663)	0.0264*** (0.00748)	0.0273*** (0.00764)	0.00618 (0.00703)
FC	-0.00229*** (0.000607)	-0.00152*** (0.000300)	-0.00252*** (0.000756)	-0.00263*** (0.000766)	-0.000666 (0.000495)
Constant	0.100*** (0.0174)	0.0686*** (0.0106)	0.109*** (0.0239)	0.108*** (0.0242)	0.0150 (0.0162)
R-square	0.4432	0.6407	0.3318	0.3199	0.5774
Observations	285	285	285	285	285

Note: *** p<0.01, ** p<0.05, * p<0.1

Source: created by the authors

Table 10 presents the results of panel data regressions with fixed effects between IC and ROE. Model (2) results show that M-VAIC is significant and positive with banks' ROE. The results show that a one-unit increase in M-VAIC can increase banks' ROE by 0.0122. This result enables the acceptance of H1.

Models 2a, 2b, and 2d regarding the IC components confirm that HCE, SCE, and CEE maintain a positive link with ROE. In addition, the results at the component level showed that CEE is the most influential component on ROE, followed by HCE and SCE. These results allow the acceptance of hypotheses H2, H3, and H5. In the case of RCE, the findings showed a statistically significant negative relation with ROE (model 2c); consequently, H4 is rejected.

Regarding the control variables, leverage is not influential on banks' ROE. Bank size and the financial crisis have a statistically significant effect on ROE but in a negative way. Crises reduce the ability of banks to generate return on equity. For the case of the macroeconomic variable GDP, the result was different. GDP is statistically significant and positive with ROE.

Table 10
Results of fixed effects regressions between IC and ROE

Variables	(Model 2) ROE	(Model2a) ROE	(Model2b) ROE	(Model2c) ROE	(Model2d) ROE
M-VAIC	0.0122*** (0.00419)				
HCE		0.0457*** (0.00575)			
SCE			0.00787*** (0.00187)		
RCE				-0.126*** (0.0193)	
CEE					2.323***

					(0.416)
LEV	0.180	0.251	0.139	0.140	0.344
	(0.155)	(0.163)	(0.169)	(0.170)	(0.222)
LNTA	-0.0384***	-0.0309***	-0.0389***	-0.0376***	-0.0133**
	(0.00548)	(0.00345)	(0.00785)	(0.00804)	(0.00610)
GDP	0.217**	0.127	0.278***	0.285***	0.153
	(0.0831)	(0.0851)	(0.0901)	(0.0918)	(0.0900)
FC	-0.0174***	-0.0120***	-0.0191***	-0.0200***	-0.00714
	(0.00559)	(0.00362)	(0.00663)	(0.00667)	(0.00520)
Constant	0.431**	0.209	0.498**	0.491*	-0.111
	(0.172)	(0.163)	(0.231)	(0.237)	(0.254)
R-square	0.4807	0.6225	0.3911	0.3806	0.5355
Observations	285	285	285	285	285

Note: $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: created by the authors

Banking in Ecuador is still a brick-and-mortar banking system and requires physical infrastructure to channel its portfolio of banking products and services. In addition, banking has not yet been able to consolidate itself considering that only 50% of Ecuadorians have access to banking products and services, where financial education levels are low. In Ecuador, banking is quite traditional, with low levels of specialization in its portfolio of banking products and services. These environmental characteristics could be limiting bank strategists' management of intangibles.

Another interesting result of the study shows that although HCE maintains a positive link with ROA and ROE, it is not very significant, indicating that banks are inefficient in managing human talent. High operational staff turnover and low salary incentives could be the main causes.

Regarding SCE, it is the component of IC with the second-highest positive influence on ROA and ROE. This could be because Ecuadorian banks still have low levels of R&D investment. In addition, these investments have delayed effects on profitability and require the design and implementation of strategies linked to HCE.

The significant link, but with a negative sign, of RCE with bank profitability is another novel finding in the study. This link, contrary to IC theory, shows that investing in marketing and advertising does not generate short-term returns in the Ecuadorian context. This discrepancy can be explained by the fact that the expenditure associated with these activities is recorded as an expense on the bank's balance sheet, which reduces the net margin and negatively impacts profitability (ROA; ROE) in the short term.

Robustness analysis

To check that the results are not influenced by the estimation method, a test with the Prais-Winsten regression will be performed, and standard errors will be corrected for heteroscedastic panels, which

considers the problems of heteroscedasticity, autocorrelation, and contemporaneous correlation (Labra & Torrecillas, 2014; Moreno-Brieva et al., 2019). Tables 11 and 12 present the results of the regressions for the dependent variables ROA and ROE.

Table 11
Prais-Winsten Regression Results for the Dependent Variable ROA

Variables	(Model 1) ROA	(Model 1a) ROA	(Model 1b) ROA	(Model 1c) ROA	(Model 1d) ROA
MVAIC	0.00116*** (0.000241)				
HCE		0.00587*** (0.000453)			
SCE			0.000512** (0.000258)		
RCE				-0.00723 (0.00498)	
CEE					0.253*** (0.0314)
LEV	-0.0330** (0.0136)	-0.0230* (0.0120)	-0.0396*** (0.0147)	-0.0397*** (0.0149)	-0.00953 (0.0144)
LNTA	0.000519 (0.000388)	-0.000130 (0.000321)	0.000699 (0.000445)	0.000794* (0.000454)	0.00140*** (0.000390)
GDP	0.0254*** (0.00821)	0.00911 (0.00699)	0.0261*** (0.00808)	0.0253*** (0.00806)	0.0117 (0.00737)
FC	-0.00391*** (0.000786)	-0.00248*** (0.000667)	-0.00439*** (0.000807)	-0.00443*** (0.000810)	-0.00245*** (0.000744)
Constant	0.0312*** (0.0114)	0.0223** (0.0100)	0.0373*** (0.0125)	0.0368*** (0.0126)	-0.00836 (0.0128)
R-square	0.310	0.525	0.251	0.246	0.423
Observations	285	285	285	285	285

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 12
Prais-Winsten Regression Results for the Dependent Variable ROE

Variables	(Model 2) ROE	(Model 2a) ROE	(Model 2b) ROE	(Model 2c) ROE	(Model 2d) ROE
M-VAIC	0.00913*** (0.00173)				
HCE		0.0461*** (0.00348)			
SCE			0.00444** (0.00187)		
RCE				-0.0645* (0.0368)	
CEE					1.918*** (0.238)
LEV	0.274*** (0.0906)	0.358*** (0.0878)	0.217** (0.0961)	0.216** (0.0969)	0.428*** (0.105)

LNTA	0.00354 (0.00302)	-0.00160 (0.00261)	0.00505 (0.00344)	0.00592* (0.00350)	0.0105*** (0.00329)
GDP	0.255*** (0.0649)	0.132** (0.0563)	0.267*** (0.0642)	0.261*** (0.0641)	0.156*** (0.0588)
FC	-0.0324*** (0.00633)	-0.0207*** (0.00553)	-0.0359*** (0.00649)	-0.0362*** (0.00652)	-0.0214*** (0.00612)
Constant	-0.201*** (0.0699)	-0.275*** (0.0692)	-0.149** (0.0758)	-0.155** (0.0765)	-0.483*** (0.0902)
Observations	285	285	285	285	285
R-square	0.367	0.543	0.301	0.294	0.437

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results reaffirm the link between IC and banks' financial performance under different variations. At the component level, CEE is the most influential component in bank profitability in Ecuador, followed by HCE and SCE. RCE maintains influence with ROA and ROE but with a negative sign.

Discussion of results

The results and analysis provide new insights into the relation of bank profitability to IC and its components. The results of models (1)-(2) in Tables 9 and 10 indicate that IC positively influences banks' performance indicators, consistent with the results of Poh et al. (2018), Buallay et al. (2019), Nawaz (2019), Selvam et al. (2020), and Uslu (2022). Banks, to improve ROA and ROE, should invest in IC. Therefore, H1 is accepted in the study.

Regarding the components of IC, models (1d) and (2d) in Tables 9 and 10 denote that CEE is the most influential component in the ROA and ROE of banks. This finding is consistent with research by Tiwari and Vidyarthi (2018) in India, Tran and Vo (2020) in Vietnam, Ousama (2019) in Gulf countries, Gama et al. (2020) in Indonesia, Uslu (2022) in Turkey, and Faruq et al. (2023) in Bangladesh.

In Ecuador, the banking sector has yet to be consolidated; therefore, banks must continue to invest in CEE to generate higher returns. Nevertheless, in the knowledge era, investing and managing IC is essential to obtaining a competitive advantage (Xu & Li, 2020). At the component level, HCE and SCE were also shown to influence bank profitability, which supports the validity of H2 and H3. This is in line with the findings of Isanzu (2016) in Tanzanian banking, Poh et al. (2018) in Malaysia, and Githaiga (2022) in East African countries.

Regarding the significant and positive relation between RCE and banks' performance indicators, the study did not find evidence to accept H4. This finding, in agreement with the research of Saruchi et al. (2019) in Islamic banking and Weqar et al. (2020) in Indian banking, reveals that banks in a context

such as Ecuador should better manage investments in their relations with stakeholders linked to the banking business.

Conclusions

Based on a sample of 15 banks from 2003 to 2021, this study analyzes the link between intellectual capital and the financial performance of Ecuadorian private banks. The average M-VAIC achieved was 2.378 (M-VAIC). In addition, 60% of the banks are above the average efficiency level of the sector, which indicates that banks based on IC management can create value for the banking business even in times of turbulence. On the other hand, CEE, HCE, and SCE are three components of IC that positively influence bank profitability. CEE is the most influential component on ROA and ROE, followed by HCE and SCE, suggesting that banks in a context such as Ecuador should continue to invest in physical capital without neglecting investments in employee skills, processes, databases, and technology linked to the banking business to generate greater profitability.

As the industry consolidates and management becomes aware of the importance of strategic assets such as IC and its components, bank management will adopt the IC approach to create competitive advantage and improve profitability.

The significant but negative impact of RCE on ROA and ROE is a critical aspect that warrants further analysis. Banks could carry out strategies that balance long-term relations building with the need to maintain short-term profitability as part of the study's recommendations. Implementing metrics to evaluate the return on investments in RC and identifying those relations that generate greater short and long-term benefits is another improvement option, followed by training staff with the necessary skills to build and maintain effective relations to optimize the efficiency of RC management.

In this context, the pioneering study of the Ecuadorian case presents some implications. Those responsible for bank management based on M-VAIC have a metric to measure IC, which implies designing future policies to manage and promote investments in IC and its main components. Based on establishing government policies, public policymakers can encourage the development and dissemination of IC in private companies in Ecuador's banking sector.

The study was not without limitations. Although the M-VAIC model measures private banks' IC, it provides a limited measure of intellectual capital. To avoid this potential bias, collecting primary data and implementing measurement models complementary to the M-VAIC model will be necessary.

Finally, the findings of this study reinforce the theory of IC and its link to the financial performance of organizations. IC continues to be a strategic asset with a positive influence on the economic performance of banks in environments never investigated before, such as the case of Ecuadorian

banking. Therefore, future research can analyze other types of companies that make up the banking industry to assess the role of IC in financial performance. In addition, the inclusion of different measures of economic performance, such as ATO and CAMEL, can broaden the understanding of the influence of IC on the financial performance of these types of companies. Finding further explanations of the significant link between a negative sign of RCE and bank profitability would allow greater analysis of the IC theory. The role of IC interaction variables in bank performance will also need to be investigated, as no consensus is identified in the empirical evidence.

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