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Intellectual capital assessment at large Texas banks prior to the pandemic

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Abstract

The present research studies the relationship between Intellectual Capital and Financial Performance in the banking sector in Texas in the United States. The research uses the Intellectual Value Added Coefficient model and its components to measure intellectual capital. Return on Assets and Return on Equity are used to measure financial performance. This quantitative research uses data from the 100 largest Texas banks in 2023, over the period 2015 to 2019. A measurement is defined in the overall pre-pandemic period of COVID-19. Multiple linear regression analysis is the econometric mathematical model chosen to test the hypotheses. In conclusion, the study found a significant positive relationship between the Intellectual Value Added Coefficient, Return on Assets and Return on Equity. In the context of its components, the Capital Employed Efficiency Coefficient shows the most substantial effect on Return on Assets and Return on Equity. Human Capital Efficiency shows a positive statistical relationship with Return on Assets and Return on Equity. Structural capital efficiency shows a positive statistical relationship with Return on Equity, but not Return on Equity.

Keywords: intellectual capital; banking sector; value added intellectual coefficient; financial performance.

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Intellectual capital assessment at large Texas banks prior to the pandemic

Resumen

La presente investigación estudia la relación entre el Capital Intelectual y el Desempeño Financiero en el sector bancario en Texas en los Estados Unidos. La investigación usa el modelo del Coeficiente de Valor Agregado Intelectual y sus componentes, para medir el Capital Intelectual. Para medir el desempeño financiero se usan el Retorno sobre los Activos y el Retorno sobre el Patrimonio. Esta investigación cuantitativa usa información de los 100 más grandes bancos de Texas en 2023, durante el periodo de 2015 a 2019. Se define una medición en el periodo pre pandemia global del COVID 19. El análisis de regresión lineal múltiple es el modelo matemático econométrico escogido para testear las hipótesis. Como conclusión, el estudio ha encontrado una relación positiva significativa entre el Coeficiente de Valor Agregado Intelectual, el Retorno sobre los Activos y el Retorno sobre el Patrimonio. En el contexto de sus componentes, el Coeficiente de Eficiencia del Capital Empleado muestra el efecto más substancial sobre el Retorno sobre los Activos y el Retorno sobre el Patrimonio. La Eficiencia del Capital Humano muestra una positiva relación estadística con el Retorno sobre los Activos y el Retorno sobre el Patrimonio. La Eficiencia del Capital Estructural muestra una positiva relación estadística con el Retorno del Patrimonio, pero no sobre el Retorno sobre el Capital.

Palabras clave: capital intelectual; sector bancario; coeficiente de valor agregado intelectual; desempeño financiero.

1. Introduction

The resource-based view of the firm in economic theory defines that companies need to develop unique, scarce resources with no easy substitutes to generate profits. In strategic business studies, the focus can be pointed to the concept of competitive advantage and sustainable competitive advantage (Barney, 2018). As referred by Kianto et al., (2017), the concept of Intellectual Capital (IC) has been employed to explain how the knowledge management of organizations is used to create value, incorporating definitions such as knowledge, technology, experience, customer relations, and in general the competence of human resources. Considering both previously explained approaches, the IC is a potential resource for firms to capture exceptional profits; both potentially measure using existing techniques and standard practices as the well-known Generally Accepted Accounting Principles (GAAP). Traditionally, the GAAP has demonstrated a remarkable ability to explain and reflect tangible assets and actions, transformed into monetary measures that make sense, supporting

the general approach of taxation and internal control of firms. As expressed by Soewarno and Tjahjadi, (2020), the change in the economy general context, and the evolution from a physical base to an intangible base, have created a research line looking for new ways to measure the IC (or intangible assets), to generate value and articulated innovation. In this line of research, for example, Lim et al., (2020) expressed that the main problem is the distinction between intangible assets that the firms acquire externally and the ones that are generated internally, particularly in this last, the concept of IC connected with the Human Resource (HR) function is showing relevance. As referred by Meles et al., (2016) the banking sector is one of the industries that shows particular interest of measuring IC. Since the banking sector is based on an intangible relationship with customers, it manages a complex relationship for demanding and supplying financial services, with an inherent intangible characteristic.

Even though there are several critics of his method (Ståhle et al., 2011), Pulic (1998), with more than 1,500 citations, exposed the methodology named Value Added Intellectual Coefficient (VAIC™), as an effort to measure, using traditional finance report supported by GAAP, the IC of the firms. In this seminal article, Pulic (1998) affirms the economy's transition from an industrial economy to one based on knowledge. It is transitioning from tangible assets to knowledge and from hardware to software. The present study used VAIC™ to measure the IC in the 100 biggest banks in Texas, during 2015-2019, trying to define a measure in the pre-COVID-19 global pandemic.

This new illness named COVID-19 started in Wuhan, China, in December 2019. In the middle of January 2020, the first case was detected in the U.S. (Baghchechi et al., 2020). In Texas an explosive accumulation of cases and fatalities were registered. According to Texas Department of State Health Services (DSHS, 2023) as of December, the 31st of 2022, the total confirmed cases were 6,507,176, and 90,585 fatalities from COVID-19. This information revealed that the effect of COVID-19 in Texas was strong from 2020.

Considering the previous COVID-19 information, the present study investigates the relationship between the IC and the Financial Performance (FP) in the 100 biggest banks in Texas, during 2015 and 2019, trying to avoid any potential effect of the COVID-19 pandemic in this eventual relationship. The list of the 100 biggest banks in Texas retrieved from the Texas Department of Banking (2023) which organized the banks as the size of their assets.

2. The banking sector in Texas

The history of the banking industry in Texas can be traced up to the year 1865, when the first Texas bank was chartered in the city of Galveston. From this first icon, Texas witnessed a rapid proliferation of banks. In 1900, Texas had counted 440 National Banks. Since then, a sequence of legal decisions, commercial fusions and acquisitions, and other political, business, and social events have been changing the bank industry in Texas. Some of these highlighted events are the following: The creation of the FDIC from the Federal Reserve Act, in 1993 ; the Federal Deposit Insurance Act in1950 ; the foundation of the Texas Savings and Loan Department, in 1963 ; the creation of the Texas Credit Union

Commission act, in1969, in which the responsibilities for Credit Unions were transferred, and the Gramm-Leach-Bliley Financial Services Modernization Act, in 1999, among many other important laws and regulations at the federal and local level (Texas Department of Banking, 2021). Nowadays, there are 403 FDIC-insured banks in Texas with more than 5,000 offices, and more than a million of millions of dollars in assets (FDIC, 2021). In the period between 2019 and 2020, the Texas WorkForce Report informed that banking and financial industry held more than 802,100 workers, with a substantial increase of 11.6% compared with other industries, since 2015. In this same report, citing the U.S. Census Bureau, Annual Estimates of Resident Population, July 1, 2018, to July 1, 2019, it can be seen that Texas is one of the states in the U.S. with the most significant increase in population, with a growing rate of 1.3% and an estimate population of 29 millions by 2020.

One of the main factors of this successful development of banking industry in Texas is the IC, especially considering that banks are intrinsically intensive in using intangible assets to create value for their customers. The present research aims to investigate the relationship between the IC and the FP for the 100 most prominent banks in Texas. Currently, there is a lack of research focusing on intellectual capital in the context of the Texas banking sector.

3. Intellectual Capital: Literature review

Vo (2018) states that the banking industry is intensive in using the IC since it is composed fundamentally of service-based companies. The IC scientific studies have been numerous and prolific. Several aspects of the IC from the points of view of enterprise practice and scientific research have been studied (Cuozzo, et al. 2017).

As mentioned by Soewarno and Tjahjadi (2020), in the modern economy based on knowledge and intangible assets, global businesses have evolved rapidly, based on the fast-growing information and telecommunication technologies, the application of science, and an intense global competency. The authors affirmed that this change from an economy based on tangible assets to an economy based on knowledge had motivated academic researchers to find new approaches to measure intangible assets, including the IC. Special attention to the IC from professional management and scientific researchers still exists today. This special attention is based on the ability of IC to create value for the companies in addition to tangible assets (Oppong and Pattanayak, 2019). The same authors conclude that the mix of physical, human, and organizational resources help the companies to create and sustain competitive advantage, generating returns for the organization.

Cuozzo et al. (2017) mentioned that the level of publications about the IC in the U.S. has been historically low. They attributed this behavior to the U.S. publishing system and the use of different terminology to refer to the IC as Intangible Assets (IA). However, the same authors highlighted those emerging innovations in IC, like integrated reports, divulgation ecosystems, and the involvement of the stakeholders, opening new possibilities for future research. Nevertheless, a research made by Meles, et al. (2016), marked an exception in this trend. They study the relationship between IC and FP in 5,749 banks, between 2005-2012

which results will be contrasted with the ones arose from this article.

Vo (2018) offers three important points of view regarding banking industries. First, he established that these kinds of organizations have unique characteristics, especially positives, for the study of the IC, due to the fact that in this industry, business processes relate to the customers in order to find competitive advantages.

Second, the author highlighted that the banking products are not tangible; instead, there are services based on the IC to create value. In this way, the value equation for the banking industry is to invest in human resources, name and prestige, systems, and processes to create value for their customers. Third, the author affirms that banks should control their IC in the most efficient possible manner. This article highlights the potential of the Texas banking industry, U.S., as a valuable foundation for future research, given its unique industrial characteristics and the limited existing studies at both the national and state levels.

As referred by Lentjushenkova et al., (2019), despite the acknowledged importance of intellectual capital (IC) in corporate competitiveness and sustainability, and the extensive research on this topic, there remains a lack of consistency in IC disclosure according to established accounting or management standards. Furthermore, the authors highlight the need for a more unified understanding of IC's role within organizations.

Pedro et al., (2018), established that the historical evolution of the studies on IC can be divided into fourth stages: The first, related to the development of a theoretical framework, from the end of 1980's until the end of the 1990's, with a research line based on how the IC determines the competitive advantage. The second, aimed to the development of empirical support, from the year 2000 to the end of 2003, with an investigation line based on the IC's measure, management, and communication. The third, intended to perform emergent implications in using the IC in the organization's management, from 2004 until today, with a research line based on the practical analysis of IC management in different organizations. The fourth and last stage focused on ecosystems for the IC in specific cities and regions with a research line centered on the national and regional ecosystems of the IC.

The findings of the authors mentioned above were used to help focus the present study. These authors also stated that the IC, in its collective role, is an essential part of supporting the general performance, with a positive influence on the organization's efficiency, profitability, and productivity. It is an important vector for value creation and developing competitive advantages. The present article can be placed in the second and fourth stages of Pedro et al., (2018) classification. This research addresses the problem of measuring intellectual capital (IC) and correlating this measure with the financial performance (FP) of the 100 largest banks in Texas, viewed as an IC ecosystem.

To establish a valid taxonomy for understanding the concept of IC, a subset of the dominant components of the IC as: Structural Capital, Human Capital, Capital Employed, and Relational Capital, declared by Pedro et al., (2018), were used. This valid taxonomy was considered fundamental since professional executives, managers, and bankers need to understand the terminology used in Intellectual Capital.

Moreover, this affirmation is particularly true in the U.S. based on the findings of Cuozzo et al., (2017). Therefore, the initial step in addressing this problem was to ensure a comprehensive understanding of the intellectual capital (IC) concept, eliminating ambiguity and potential misinterpretation.

For Structural Capital, Aramburu and Sáenz (2011), established that it is the intangible factor that employees leave in the company when they go home. The different arrangements of knowledge storage, such as: process manuals, procedures, management systems, organizational structure, daily tasks, policies, and strategies can represent elements of this factor. Also, structural capital refers to the organization's knowledge included in management systems, software, computer networks, documents, and other knowledge artifacts, methodologies, models, processes, copyrights, and trademarks, among others.

In relation to Human Capital, Jardon and Martinez-Cobas (2021) affirmed that it refers to a group of values, attitudes, competencies, and skills which employees have that allow them to create value for the organization. Human capital includes knowledge, experience, competencies, teamwork, loyalty, and people's motivation. It is understood as a set of tacit knowledge, defined by Kianto et al., (2020) as personal, dependent on the context, and based on experience and practice, in contrast to the explicit knowledge that can be expressed, codified, and stored using formal methods.

Considering a Capital Employed, Xu et al., (2019), stated that it is represented by the efficiency of the organization's physical capital. The latter refers to tangible assets or money invested by the organization's stockholders (or owners) to create value. In regard to Relational Capital, it is the value of the business relationship with individuals and other organizations, in line with the creation of organization's value. This type of capital includes the relationship with the external stakeholders, supplier networks, distributors and organizations that have a commercial relation with the organization, partners, customer relationship management (image management, loyalty with the trademark, partners, and investors), and trademark (attitude, preferences, reputation, acknowledge of the trademark).

In order to measure the IC, the methodology VAIC™ designed by Pulic (1998, 2004), is especially applicable in the context of the financial sector and banking industry. Pulic and Bornemann's original studies were performed in Austria's prominent banks between 1993 and 1995 (Ozkan et al., 2017). As referred by Pulic (2004), VAIC™ can show efficiency, highlighting intellectual capacity. In synthesis, VAIC™ can demonstrate how the value is created in each resource. The primary approach of Pulic is to consider human resources as an investment instead of an expense for the company, formulating the concept of Value Added (VA).

4. Hypotheses development

The model VAIC™ as exposed by Pulic (2004), defines the Value Added (VA) in the following way:

$$VA = OP + EC + D + A \quad \text{(Equation 1)}$$

Where OP = Operating Profit before Tax, EC = Employee's cost (salary

and benefits), D = Depreciation, and A = Amortization. The equation (1) means, according to Pulic (2004), that all the resources are investment oriented to value creation.

The Intellectual Capital for Pulic (2004) is constructed with two components: Human Capital and Structural Capital. Calculating the Efficiency of Human Capital (HCE) as follows:

$$HCE = VA / HC \quad \text{(Equation 2)}$$

Where HC = Total salaries and wages.

Pulic (2004) calculates the Structural Capital (SC) as follows:

$$SC = VA - HC \quad \text{(Equation 3)}$$

Once SC is obtained, the calculation for Structural Capital Efficiency (SCE) is:

$$SCE = SC / VA \quad \text{(Equation 4)}$$

Since Human Capital and Structural Capital compound the IC, the Intellectual Capital Efficiency (ICE) can be estimated by combining equations (2) and (4) as follows:

$$ICE = HCE + SCE \quad \text{(Equation 5)}$$

According to Pulic (2004), the last components needed are the financial and physical capital, implicit in the taxonomy as Capital Employed. Therefore, the Capital Employed Efficiency Coefficient (CEE) is calculated as follows:

$$CEE = VA/CE \quad \text{(Equation 6)}$$

Where CE = Book Value of the Assets of the firm.

Finally, the Value Added Intellectual Coefficient - VAIC™, can be worked out in the following way:

$$VAIC = ICE + CEE \quad \text{(Equation 7.1)}$$

or

$$VAIC = HCE + SCE + CEE \quad \text{(Equation 7.2)}$$

VAIC™ combined the three components of efficiency: the Efficiency of Human Capital (HCE), the Efficiency of Structural Capital (SCE), and the Efficiency of the Capital Employed (CEE). This separation allows to create the hypothesis for the present research.

Once we have clearly defined the IC measurement, it is necessary to define a method to calculate FP. The financial performance will be determined by a classic and widely used approach, conformed by: Return on Assets (ROA) and Return on Equity (ROE) (Soewarno and Tjahjadi, 2020) with the following formulas:

$$ROA = EAT / TA \quad \text{(Equation 8)}$$

$$ROE = EAT / TE \quad \text{(Equation 9)}$$

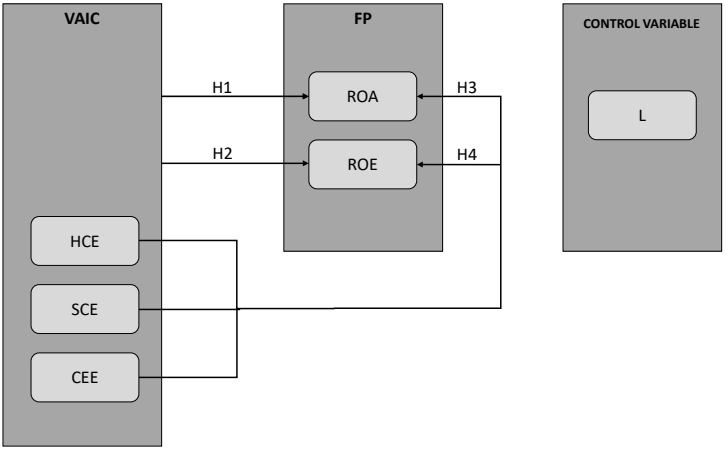
Where EAT = Earnings After Tax, TA = Total Assets, and TE = Total Equity.

Another helpful indicator used in the present research is the Leverage (L) working as a control variable and it is calculated as follows:

$$L = TL / T \quad \text{(Equation 10)}$$

The conceptual model and hypothesis context, inspired by the theoretical framework of Ousama et al., (2020) and applied in this investigation is shown in diagram 1.

Diagram 1
Conceptual model and hypothesis context



Considering the conceptual model described above, the hypotheses with their respective implications are illustrated in the chart 1.

Chart 1
Hypothesis and Implications

Hypothesis	Implication
H1: For the 100 big banks in the US Texas State, a significant statistical relationship exists between VAIC and ROA.	The efficiency in using the resources of IC can contribute to the overall financial performance of the banks.
H2: For the 100 big banks in the US Texas State, a significant statistical relationship exists between VAIC and ROE.	The efficiency in the use of resources of IC can contribute to the overall return for investors in the banks.
H3: For the 100 big banks in the US Texas State, a significant statistical relationship exists between the components of VAIC (HCE, SCE, and CEE) and ROA.	The efficiency in the use of resources of IC and its components, like the Efficiency of Human Capital (HCE), the Efficiency of Structural Capital (SCE), and the Efficiency of the Capital Employed (CEE), can contribute to the overall financial performance of the banks.
H4: For the 100 big banks in the US Texas State, a significant statistical relationship exists between the components of VAIC (HCE, SCE, and CEE) and ROE.	The efficiency in the use of resources of IC and its components, like the Efficiency of Human Capital (HCE), the Efficiency of Structural Capital (SCE), and the Efficiency of the Capital Employed (CEE), can contribute to the overall return for investors in the banks.

4.1. Research design

The sample for this research consisted of 100 big banks in Texas (Texas Department of Banking, 2023). Data from 2015 to 2019 were collected for each bank, excluding the COVID-19 pandemic's effects. The information was collected from banks' web pages, using annual reports, and from the Federal Financial Institutions Examination Council's (FFIEC) website. To test the hypotheses, a linear regression with the models shown in Table 1 was used.

Table 1
Models, hypothesis, and regression equations

Model	Hypothesis Tested	Regression Equation
1	H1	$ROA = \beta_0 + \beta_1 VAIC + \beta_2 L + \varepsilon$
2	H2	$ROE = \beta_0 + \beta_1 VAIC + \beta_2 L + \varepsilon$
3	H3	$ROA = \beta_0 + \beta_1 HCE + \beta_2 SCE + \beta_3 CEE + \beta_4 L + \varepsilon$
4	H4	$ROE = \beta_0 + \beta_1 HCE + \beta_2 SCE + \beta_3 CEE + \beta_4 L + \varepsilon$

5. Relationship between intellectual capital and financial performance in the banking sector: results and discussions

The average value of VAIC for the banks under study was 2.8108, as it is shown in Table 2, below.

Table 3
VAIC mean value per bank

Bank Name	VAIC	Bank Name	VAIC	Bank Name	VAIC
State Bank Of Texas	7.9927	Comerica Bank	2.8423	Firstcapital Bank Of Texas, National Association	2.3561
Nexbank	6.1795	Cadence Bank, N.A.	2.8401	Commercial Bank Of Texas, National Association	2.3545
Bank Of The Ozarks	5.3340	Guaranty Bank & Trust, N.A.	2.8179	Security State Bank & Trust	2.3524
Texas Exchange Bank, Ssb	4.8102	Wallis Bank	2.8166	Tbk Bank, Ssb	2.3419
Happy State Bank	4.5145	Amarillo National Bank	2.8163	The American National Bank Of Texas	2.3374
East West Bank	4.2860	Texas Community Bank	2.8037	Texas Partners Bank	2.3048
First State Bank Of Uvalde	4.2844	Southside Bank	2.7912	Bbva Usa	2.2666
Inwood National Bank	3.8583	Simmons Bank	2.7861	American Bank Of Commerce	2.2184
Prosperity Bank	3.8490	Regions Bank	2.7779	Tib National Association	2.2146
Beal Bank	3.8408	Texas Bank And Trust Company	2.7566	First United Bank & Trust	2.2027
Interbank	3.7877	First United Bank	2.7395	Southstar Bank, S.S.B.	2.2023
Citizens State Bank	3.5249	First Financial Bank, National Association	2.7301	North Dallas Bank & Trust Co.	2.2000
International Bank Of Commerce	3.4546	Wells Fargo Bank	2.7073	First Horizon Bank	2.1778
Bth Bank, National Association	3.4235	Falcon International Bank	2.6943	Broadway National Bank	2.1594
First National Bank Of Central Texas	3.3505	Citizens National Bank Of Texas	2.6674	First State Bank	2.1019
Central National Bank	3.2933	Frost Bank	2.6653	Jefferson Bank	2.0906
Veritex Community Bank	3.2039	Communitybank Of Texas, N.A.	2.6326	Verabank, National Association	2.0761
Capital One	3.1998	The Moody National Bank	2.6146	American National Bank & Trust	2.0590

Cont... Table 2

Weststar Bank	3.1215	Usaa Federal Savings Bank	2.6095	Alliance Bank	2.0521
West Texas National Bank	3.0391	Pioneer Bank, Ssb	2.5993	Vista Bank	2.0297
Charles Schwab Bank, Ssb	3.0114	First Bank & Trust	2.5979	Lone Star National Bank	2.0018
Golden Bank, National Association	3.0099	Firstbank Southwest	2.5955	Vantage Bank Texas	2.0009
Independent Bank	2.9947	Truist Bank	2.5190	Origin Bank	1.9933
Jp Morgan Chase Bank	2.9876	Texas First Bank	2.5185	Susser Bank	1.9641
First National Bank Texas	2.9824	Zions Bancoporation, N.A.	2.4805	Spirit Of Texas Bank, Ssb	1.9609
Horizon Bank, Ssb	2.9291	Bokf	2.4740	American Bank, National Association	1.9511
American First National Bank	2.9087	Bank Of America	2.4661	City Bank	1.8561
Texas Capital Bank	2.8632	Austin Bank, Texas National Association	2.4660	Extraco Banks, National Association	1.7885
Pinnacle Bank	2.8534	The Northern Trust	2.4570	Texas Regional Bank	1.7057
Citibank	2.8516	United Texas Bank	2.4027	Woodforest National Bank	1.6874
Community National Bank	2.8495	The City National Bank Of Sulphur Springs	2.3856	Third Coast Bank, Ssb	1.6429
American Momentum Bank	2.8448	Allegiance Bank	2.3741	Plainscapital Bank	1.5476

In the yearly analysis, 2018 shows the highest VAIC with a value of 2.8921. (Table 3).

Table 3
Mean value for the different studied variables, per year

Year	ROA	ROE	HCE	SCE	CEE	VAIC
2015	1.2137	10.8769	2.2234	0.5023	0.0314	2.7571
2016	1.1862	10.6908	2.2350	0.5038	0.0310	2.7698
2017	1.2086	10.5593	2.2987	0.5167	0.0316	2.8470
2018	1.4530	12.2718	2.3285	0.5315	0.0322	**2.8921**
2019	1.4119	11.5074	2.2379	0.5188	0.0314	2.7882
Mean	**1.2947**	**11.1812**	**2.2647**	**0.5146**	**0.0315**	**2.8108**

The ANOVA analysis in Table 4 uses the following categories: N = National, SM = State Federal Reserve Board (FRB) Member State Bank, NM = Non-FRB Member State Bank, SI = State Savings Bank, SB = Federal Savings Bank. This Table 5 shows that the mean is statistically significantly different (F=9.151, p<.001). Where NM (Non-FRB Member State Bank) demonstrates a higher average of 3.198, while SM (SFRB Member State Bank) the lowest with a value of 2.578.

Table 4
ANOVA analysis by bank classes

ANOVA - VAIC					
Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Class	34.764	4	8.691	9.151	< .001
Residuals	440.660	464	0.950		
Note. Type III Sum of Squares					
Descriptives - VAIC					
Class	**N**	**Mean**	**SD**	**SE**	**Coefficient of Variation**
N	175	2.639	0.532	0.040	0.202
NM	155	**3.198**	1.387	0.111	0.434
SB	5	2.610	0.399	0.179	0.153
SI	35	2.655	1.166	0.197	0.439
SM	99	**2.578**	0.702	0.071	0.272

Using the period (year), the ANOVA analysis in Table 5 shows that the mean is not statistically significantly different (F=0.299, p=0.879).

Table 5
ANOVA analysis by period from 2015 to 2019

ANOVA - VAIC					
Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Period	1.222	4	0.306	**0.299**	**0.879**
Residuals	474.202	464	1.022		

Note. Type III Sum of Squares					
Descriptives - VAIC					
Period	**N**	**Mean**	**SD**	**SE**	**Coefficient of Variation**
2015	90	2.757	1.053	0.111	0.382
2016	93	2.770	1.106	0.115	0.399
2017	94	2.847	1.107	0.114	0.389
2018	96	2.892	0.946	0.097	0.327
2019	96	2.788	0.821	0.084	0.294

The correlation analysis in Table 6, highlights that between ROA and VAIC exists a positive Pearson's r = 0.565, and a statistically significant relationship with p<.001. It also shows a positive Pearson's r = 0.553, between ROE and VAIC and a statistically significant relationship with p<.001.

Table 6
Correlation analysis between ROA & VAIC and ROE & VAIC

Pearson's Correlations

Variable		ROA	VAIC
1. ROA	Pearson's r	—	
	p-value	—	
2. VAIC	Pearson's r	**0.565**	—
	p-value	< .001	—

Pearson's Correlations

Variable		ROE	VAIC
1. ROE	Pearson's r	—	
	p-value	—	
2. VAIC	Pearson's r	**0.553**	—
	p-value	< .001	—

5.1. Hypothesis testing

For Hypothesis H1 - The relationship between ROA and VAIC shows a statistically significant positive relationship. The control variable L shows a statistically significant negative relationship. (Table 7).

Table 7
Linear Regression ROA-VAIC-L

Model: ROA = β0 + β1 VAIC + β2 L + ε		
Hypothesis H1: For the 100 big banks in the US Texas State, a significant statistical relationship exists between VAIC and ROA.		
F-statistics	p-value	Adjusted R2
121.380	< .001	0.340
Model	Standardized Coefficient	
VAIC	0.541	
L	-0.153 (consistent with the relationship between L and ROA and ROE)	

For Hypothesis H2 - The relationship between ROE and VAIC shows a statistically significant positive relationship. The control variable L shows a statistically significant positive relationship. (Table 8).

Table 8
Linear Regression ROE-VAIC-L

Model: ROE = β0 + β1 VAIC + β2 L + ε		
Hypothesis H2: for the 100 big banks in the US Texas State, a significant statistical relationship exists between VAIC and ROE.		
F-statistics	p-value	Adjusted R2
133.395	< .001	0.364
Model	Standardized Coefficient	
VAIC	0.593	
L	0.245 (consistent with the relationship between L and ROA and ROE)	

For Hypothesis H3 - The relationship between ROA and VAIC's components shows a statistically significant relationship. HCE shows significant positive statistical relationships, CEE shows significant positive statistical relationships. SCE shows no significant statistical relationship. (Table 9).

Table 9
Linear Regression ROA-HCE-SCE-CEE-L

Model: ROA = β0 + β1 HCE + β2 SCE + β3 CEE + β4 L + ε		
Hypothesis H3: For the 100 big banks in the US Texas State, a significant statistical relationship exists between the components of VAIC (HCE, SCE, and CEE) and ROA.		
F-statistics	p-value	Adjusted R2
147.615	< .001	0.556
Model	Standardized Coefficient / p-value	
HCE	0.391 / p<.001	
SCE	0.107 / p=0.102	
CEE	0.485 / p<.001	
L	p<.001	

For Hypothesis H4 - The relationship between ROE and VAIC's components shows a statistically significant relationship. HCE shows a significant positive statistical relationship with ROE. SCE shows significant positive statistical relationship with ROE. CEE shows significant positive statistical relationship with ROE. The control variable L shows a statistically significant positive relationship consistent with the relationship between ROE and L. (Table 10).

Table 10
Linear Regression ROE-HCE-SCE-CEE-L

Model: ROE = β0 + β1 HCE + β2 SCE + β3 CEE + β4 L + ε		
Hypothesis H4: As Table 12 shows, for the 100 big banks in the US Texas State, a significant statistical relationship exists between the components of VAIC (HCE, SCE, and CEE) and ROE.		
F-statistics	p-value	Adjusted R2
148.405	< .001	0.557
Model	Standardized Coefficient / p-value	
HCE	0.256 / p<.001	
SCE	0.320 / p<.001	
CEE	0.484 / p<.001	
L	0.304 / p<.001	

In both hypothesis testing models H3: ROA = β0 + β1 HCE + β2 SCE + β3 CEE + β4 L + ε and H4: ROE = β0 + β1 HCE + β2 SCE + β3 CEE + β4 L + ε. the variable CEE (Capital Employed Efficiency Coefficient) is the most statistically significant, followed by the HCE (Efficiency of Human Capital). From these results it can be inferred that the 100 big banks in Texas are efficiently using physical capital or tangible assets to generate revenue for the company

operations and investors. Also, human capital, composed of knowledge, experience, competencies, teamwork, loyalty, and motivation, is efficiently used to generate profit for the company and investors.

When comparing the findings of this research with similar studies, several key aspects emerge. Meles et al. (2016), in the sole study identified within the U.S. banking industry, examined 5,749 commercial banks from 2005 to 2012. They employed the Value Added Intellectual Coefficient (VAIC) and its components, Human Capital Efficiency (HCE) and Structural Capital Efficiency (SCE), as measures of intellectual capital (IC), correlating them with return on average assets (ROAA) and return on average equity (ROAE) as measures of financial performance (FP). Using linear multiple regression models, they tested their hypotheses. Consistent with the present study, they found a statistically significant relationship between VAIC and both ROAA and ROAE. However, in contrast to our findings, Meles et al. (2016) determined HCE to be the most significant component of VAIC impacting both ROAA and ROAE.

In this research Capital Employed Efficiency (CEE) was identified as the most statistically significant variable, with Human Capital Efficiency (HCE) as per the second most influential. This contrasts with the findings of Meles et al. (2016), who reported mean values of VAIC = 2.0771, HCE = 1.8017, and SCE = 0.3348. In comparison, our study found the following mean values: VAIC = 2.8108, HCE = 2.2647, and SCE = 0.5146.

In an attempt to understand the explanatory power of HCE, two alternative models were developed, consistent with the methodology used by Meles et al. (2016), which focused solely on HCE and SCE. The models were defined as follows: AM1: ROA = β0 + β1 HCE + β2 SCE + β4 L + ε, and AM2: ROE = β0 + β1 HCE + β2 SCE + β4 L + ε. The outcomes of these models are detailed in Tables 11 and 12.

Table 11
Alternative Model 1: AM1: ROA = β0 + β1 HCE + β2 SCE + β4 L + ε

Alternative Model 1: ROA = β0 + β1 HCE + β2 SCE + β4 L + ε		
F-statistics	p-value	Adjusted R2
86.942	< .001	0.355
Model	Standardized Coefficient / p-value	
HCE	0.736 / p<.001	
SCE	P=0.02	

Table 12
Alternative Model 2: AM2: ROE = β0 + β1 HCE + β2 SCE + β4 L + ε

Alternative Model 2: ROE = β0 + β1 HCE + β2 SCE + β4 L + ε		
F-statistics	p-value	Adjusted R2
87.540	< .001	0.357
Model	Standardized Coefficient / p-value	
HCE	0.600 / p<.001	
SCE	P=0.856	

Considering the alternative models AM1 and AM2, the results converge to Meles et al., (2016). HCE is the variable with the most statistical explanatory power of FP, measured with ROA and ROE. SCE in both cases has no significant statistical impact (considering p=1%) on dependent variables (ROA, SCE p=0.02 and ROE, SCE p=0.856).

Oppong and Pattanayak (2019), explored the relationship between IC and FP, studying 73 banks in India between 2006 and 2017. They used VAIC and its classical components (CEE, HCE, and SCE) to investigate the relationship between financial performance indicators, such as Employee Productivity (EP) and Asset turnover (ATO). These authors employed four linear regression models to test their hypotheses, revealing a statistically significant positive relationship between Value Added Intellectual Coefficient (VAIC) and its components with Asset Turnover (ATO), a measure of financial performance. Consistently, this study also observed a significant positive relationship between VAIC and its components with a range of financial performance indicators.

Soewarno and Tjahjadi (2020) examined intellectual capital (IC) in the Indonesian banking industry, employing Value Added Intellectual Coefficient (VAIC) to analyze the relationship between IC and financial performance (FP). Their study utilized a sample of Indonesian banks from 2012 to 2017, yielding 235 bank observations. They employed the standard VAIC components—Capital Employed Efficiency (CEE), Human Capital Efficiency (HCE), and Structural Capital Efficiency (SCE)—and financial performance measures such as return on assets (ROA) and return on equity (ROE). Their findings indicated that HCE had no statistically significant effect on either ROA or ROE. However, CEE and SCE demonstrated a statistically significant positive effect on both ROA and ROE. In contrast, this study found a positive relationship between CEE and ROA (standardized coefficient of 0.485, $p < .001$) and HCE and ROA (standardized coefficient of 0.391, $p < .001$), but no significant relationship between SCE and ROA ($p = 0.102$). Regarding ROE in the Texas banking sector of this study, all VAIC components showed a statistically significant positive relationship: HCE (standardized coefficient of 0.256, $p < .001$), SCE (standardized coefficient of 0.320, $p < .001$), and CEE (standardized coefficient of 0.304, $p < .001$)

According to Le and Nguyen (2020), who studied 30 Vietnamese banks between 2007 and 2019, they employed variations of the classical financial performance measures, ROA and ROE, using linear regressions to compare those with VAIC and the VAIC's components, CCE, HCE, and SCE. They found: an average VAIC of 4.783; a statistically significant positive relationship between VAIC and the financial performance of the banks, and a statistically significant positive relationship between VAIC's components and financial performance measures at the banks. Similarly, the present study shows a statistically significant relationship between VAIC and ROA, and between VAIC and ROE, the mean for VAIC for the present research was 2.8108.

6. Conclusions

Contemporary economies are increasingly driven by intangible assets rather than tangible ones. Knowledge management and intellectual capital,

in general, play pivotal roles in the performance and market success of firms. Notably, experiential knowledge gained through active market engagement is critical for business success.

Effective management of intellectual capital fosters new knowledge creation, enhancing an organization's strategic position. Intensified competition across industrial sectors has driven increased focus on intellectual capital, particularly knowledge management.

The banking industry, especially in the highly competitive Texas market, relies heavily on intellectual capital, human resources, and knowledge management to maintain competitiveness.

This research investigated the relationship between intellectual capital and the financial performance of the 100 biggest banks in Texas, in the pre-COVID-19 pandemic environment from 2015 to 2019 in order to create a framework reference for the industry. The results obtained, after the application of the selected methodology (made up of: VAIC™; ROA and ROE) lead to conclude with the following characteristics:

Banking is an industry deeply reliant on intellectual capital, with intangible assets playing a crucial role in its business execution. Given the sector's high competitiveness, evidenced by the presence of over 400 entities, the industry is driven to continuously develop and implement new knowledge to sustain its competitive edge. Consequently, the significance and measurement of intellectual capital in this mature and developed industry hold substantial interest for both academic researchers and industry practitioners.

Multiple linear regression mathematical models were used to establish the relationship between IC (VAIC and components) and FP (ROA and ROE). A significant statistically positive relationship was found between VAIC and ROA and between VAIC and ROE. Where the Non-FRB Member State Bank shows the highest mean on the VAIC measure.

Regarding the relationship between the components of VAIC and ROA, HCE and CEE show a significant statistically positive relationship with ROA. However, there is no significant relationship between SCE and ROA. Moreover, in ROE, all components HCE, CEE, and SCE show a significant statistically positive relationship with ROE. In both cases, ROA and ROE, CEE (Capital Employed Efficiency Coefficient) shows a more positive significant effect on ROA and ROE, the capital employed is the efficiency of the organization's physical capital. This means that the 100 biggest banks in Texas have the unique ability to manage the capital employed to generate revenue for the firm and stockholders.

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