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<https://doi.org/10.55463/issn.1674-2974.50.7.1>

Relationship between Bank Risk and Intellectual Capital in the GCC Countries: An Empirical Analysis

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Received: April 17, 2023 / Revised: May 16, 2023 / Accepted: June 21, 2023 / Published: July 31, 2023

Abstract: The primary goal of this study is to determine the effect of intellectual capital efficiency (ICE), also known as knowledge capital, and its components, including human capital efficiency (HCE) and structural capital efficiency (SCE), on bank risk-taking behavior in GCC countries. This study investigates the impact of intellectual capital (IC) on risk management in the banking sectors of the Gulf Cooperation Council (GCC) countries. The scientific novelty of this research lies in its focus on an underexplored area, as there has been limited previous research on the influence of IC on risk-taking, specifically in the context of GCC countries' banking sectors. By examining the relationship between IC and risk management in this region, this research contributes to the existing body of knowledge in several ways. First, it expands the understanding of how intellectual capital, which encompasses knowledge, expertise, intellectual property, and information, can affect risk management practices within banks. This exploration provides valuable insights into the role of IC as a potential lever for mitigating risks and enhancing the performance of banking institutions. To demonstrate this impact, the study used the generalized method of moment (GMM) estimator, the ordinary least square estimate (to test robustness), and unbalanced panel data from 172 banks in GCC countries, totaling 3268 bank-year observations from 2000 to 2019. Our findings show that is strongly and positively related to a bank's credit risk, indicating that credit risk increases as intellectual capital efficiency also increases and both human and structural capital efficiency rise. In addition, bank performance (ROA), RWATA, macrovariable inflation, and size have a negative impact on bank risk, whereas has a positive one. Finally, the study's findings will be useful to stakeholders, policymakers, and academics for future research.

Keywords: intellectual capital, efficiency, risk-taking.

海湾合作委员会国家银行风险与智力资本的关系：实证分析

摘要：本研究的主要目标是确定智力资本效率（冰）（也称为知识资本）及其组成部分，包括人力资本效率（HCE）和结构资本效率（科学教育委员会）对银行风险承担行为的影响在海湾合作委员会国家。本研究调查了智力资本（我知道了）对海湾合作委员会（海湾合作委员会）国家银行业风险管理的影响。这项研究的科学新颖性在于它关注的是一个尚未充分探索的领域，因为之前关于我知道了对风险承担的影响的研究有限，特别是在海湾合作委员会国家银行业的背景下。通过研究该地区我知道了与风险管理之间的关系，这项研究在几个方面对现有知识体系做出了贡献。首先，它扩展了对智力资本（包括知识、专业知识、知

识产权和信息)如何影响银行内部风险管理实践的理解。这一探索为我知道了作为降低风险和提高银行机构绩效的潜在杠杆的作用提供了宝贵的见解。为了证明这种影响,该研究使用了广义矩法(高斯模型)估计器、普通最小二乘估计(以测试稳健性)以及来自海湾合作委员会国家172家银行的不平衡面板数据,总计2000年至2019年的3268个银行年度观察结果。我们的研究表明,冰与银行的信用风险呈强烈正相关,这表明信用风险随着智力资本效率的提高以及人力和结构资本效率的提高而增加。此外,银行绩效(资产回报率)、瓦塔、宏观变量通胀和规模对银行风险有负面影响,而ID则有正面影响。最后,该研究的结果将对利益相关者、政策制定者和学者的未来研究有用。

关键词: 智力资本、效率、风险承担。

Introduction

Firms undergo major transformations from labour-based to knowledge-based operations. Firms rely on knowledge, often known as intellectual capital (IC), to improve their performance. Furthermore, IC denotes knowledge, expertise, intellectual property, and information that may be used to generate income [1]. Based on this description, academics and management practitioners have paid close attention to the role of knowledge and company capacities in global competitiveness as they regard intellectual capital as a lever for preserving competitive advantage and long-term corporate success [2]. Effective intellectual capital reveals how well businesses use their intellectual capital. In this regard, businesses with higher intellectual capital are more inclined to share more information about their intellectual capital [3]. Banks, on the other hand, take funds from the public, particularly savings, and then redistribute some of the money to the public via credits or other operations that improve the public's quality of life. In recent years, there has been much scholarly and regulatory interest in ways to reduce bank risk-taking and increase performance. Banks, as a service business, are also acknowledged as an intellectual capital-intensive industrial sector [4, 5], making intellectual capital recognition and development a key part of bank management [6, 7]. The last common thread examines the impact of IC efficiency on financial performance, particularly in the banking industry. According to [8, 9], banks should manage their IC as effectively as possible because of its major implications.

Intellectual capital is a complicated notion that involves both entrepreneurial and organizational components [10]. The impact that IC might have on organizational financial performance should be investigated further [11]. Furthermore, IC components such as personal experience and expertise, bank customer relationships, and bank organizational or management conditions are more likely to impact

liquidity risk [3, 12]. Higher IC will lower liquidity risk because banks that properly manage their IC may be able to reduce their liquidity risk [3]. Furthermore, IC can have an effect on capital rules, bank ROA, capital restrictions, and leverage [13].

Several studies on the influence of IC on bank performance, profit-sharing financing, bank size, corporate performance, bank bankruptcy, capital efficiency, and bank productivity have been conducted [3, 14-17]. Despite this, relatively few studies have been conducted to assess the impact of IC on bank risk-taking [14, 18]. The GCC countries are Asian developing countries that have experienced rapid economic expansion during the previous two decades. The GCC countries' governments have steadily adopted banking sector changes in recent years; however, there has been little research on the impact of IC on GCC countries' banks' risk management. This study attempts to fill these gaps. This study attempts to address these gaps and determine the influence of intellectual capital on risk management in GCC countries' banking sectors. Furthermore, this research adds to the literature on intellectual capital by analyzing its impact on risk management in the specific context of the GCC countries. These countries have experienced rapid economic growth and have undergone changes in their banking sectors, making it important to understand the role of IC in the risk management practices of GCC banks. The findings of this study will shed light on the relationship between IC and risk management in this unique setting, providing valuable insights for policymakers, bank managers, and researchers. This study focuses on the banking sectors of the GCC countries. The selection of the GCC countries as the research objects is justified by their significant economic expansion and recent changes in their banking sector. By concentrating on this specific region, the research aims to capture the dynamics and challenges associated with IC and risk management in a distinct economic context. However, it is important to acknowledge the limitations of the

application of the results obtained. The findings of this study may be specific to the GCC countries' banking sectors and may not be directly applicable to banking sectors in other regions or countries. The unique characteristics and regulatory frameworks of the GCC countries may limit the generalizability of the results. The availability and quality of the data may pose limitations to the research. Depending on the data sources and access, the study may rely on specific datasets, timeframes, or indicators, which could impact the comprehensiveness and representativeness of the analysis. This research focuses on the relationship between IC and risk management but may not account for all external factors that could influence risk-taking behavior in the banking sector. Other contextual factors, such as macroeconomic conditions, regulatory environment, and geopolitical factors, could also play a role in shaping risk management practices. The study's methodology, such as the choice of statistical models or data analysis techniques, may have certain limitations that should be acknowledged. These limitations could include assumptions, sample size, or potential biases inherent in the chosen methodology.

The rest of the paper is organized as follows. Section 2 examines the relevant literature and the assumptions that underpin the analysis in the study. The data and techniques are presented in Section 3. Section 4 provides the empirical results, discusses them, and examines their robustness. Finally, Section 5 summarizes the research.

1. Literature Review

1.1. Theoretical and Conceptual Background

1.1.1. Valuation of Intellectual Capital and Element of Intellectual Capital

Intellectual assets (IA), also known as IC, are the most important resources in today's organizations, yet most institutions cannot identify what constitutes an IA [19]. Simply put, intellectual capital refers to the creativity of the human brain or mind. IC is connected to the value and intangibility of assets. IC is defined as "knowledge that can be transformed into value" [20]. The knowledge can be used to make money [21]. According to non-accounting researchers, "intellectual is the gap between the firm's market value and its entity's book value" [1, 22, 23]. Many academics and analysts have attempted to classify IC. From a non-accounting standpoint, Sveiby [23] first classified IC into three types: 1) employee (individual) competence, 2) internal structure, and 3) external structure. Stewart [1] concurred with Sveiby, but termed these assets human capital, structural capital, and customer capital, respectively. Bontis [24], Edvinsson and Sullivan [25] proposed three categories of IC: people's know-how (human capital); the entity's routines, procedures, processes, and databases (structural capital); and the

firm's capacity to interact with markets and stakeholders (social and relational capital). Furthermore, [26] classified IA into five divisions, concentrating on measurement concerns and persuading intangibles on the capital market and investors. These five elements are R&D, advertising, capital expenditures, information systems, and technology acquisition. Scholars in IC have advocated for the inclusion of human capital and structural capital as IC components [20, 27, 28]. In this study, we will assess the efficiency of IC by considering HC and SC as components of IC (customer/relational capital will also be included in SC via SFA). Employees' skills, knowledge, and experiences comprise human capital, which may be enhanced via training [23]. HC is described as "the ability to operate in various situations to develop both physical and intangible assets." Efficient and effective use of an entity's workers' knowledge, experiences, skills, creativity, and so on ensures proper usage of HC, which is used to address business challenges [2]. Structural capital is also known as supporting capital because it includes everything in a company that helps employees and allows human capital to function correctly [2]. A firm's structural capital comprises structures, systems, organizational cultures, procedures, routines, hardware, databases, innovations, processes, copyright, patents, technology, and strategy [29]. The gap between value-added and human capital is referred to as structural capital ($SC = VA - HC$) [30-32]. According to Pulic [31], VA is defined as the value addition of current year resources, which is computed as $VA = \text{Output (total sales)} - \text{Input (cost of materials, components, and services)}$. Pulic [31] also provided the following method for measuring VA:

$$VA = OP (\text{Operating Profit} + EC (\text{Employee Cost}) + D (\text{Depreciation}) + A (\text{Amortization})).$$

Furthermore, [33] cited economic value added (EVAe) as a complete metric for analyzing overall business success and offered the following equation for calculating EVAe: $EVAe = \text{Net sales} - \text{operating expenditures} - \text{taxes} - \text{capital charges}$. A firm's relationship capital is defined as its relationships with all of its interested parties [34]. Relational capital is defined as the value of an entity's ties with the individuals with whom it enhances business [2].

2. Empirical Review and Hypothesis Development

2.1. Relationship between ICE and Risk

Various studies have been undertaken with continuous and contradictory results regarding whether efficiency is superior to risk or whether risk has a substantial influence on bank efficiency [35]. There is an ongoing discussion over whether intellectual capital efficiency minimizes risk. The conventional expectation is that the relationship between IC

efficiency and risk is negative. This implies that enhanced IC efficiency will aid in risk management. Therefore, we should predict a negative association according to this study; however, various results have been reported in the earlier literature addressing the link. [36-41] demonstrated a negative relationship between IC efficiency. However, contrary findings have been reported by [39, 42, 43], who argued that IC might have a beneficial influence on credit risk since they aid in evaluating organizational competitiveness and offer a good picture of the firm's management team. According to [37, 38], there is no significant association detected between risk and *HCE*, and capitalized banks are better capable of absorbing risk and improving *HCE*.

Because the amount of research on intellectual capital efficiency and bank risk-taking behavior is limited, this study additionally considers the link between total efficiency and risk. [16, 44-46] discovered a negative link between total efficiency and risk.

Positive relationships have also been reported in previous research [47, 48]. [47] state that risk increases as the monitoring and screening of loans are reduced, yet technical efficiency increases the number of bank loans. [48] discovered a positive association between risk and efficiency and suggested that international banks' risk-taking and cost-efficiency go hand in hand. Altunbas et al. [35] asserted no substantial association between efficiency and risk.

This study attempted to quantify the influence of a specific component of IC on risks, such as human capital or structural capital, but the impact of total IC efficiency on risk-taking behavior was missing. In this study, we attempt to fill the vacuum by demonstrating the influence of total IC efficiency estimated using SFA on bank risk-taking behavior. While these and other studies show a positive/negative link between risk and efficiency, there is insufficient evidence to indicate a clear cause-and-effect relationship between total IC efficiency and risk. According to the literature, most research is conducted on banks in industrialized nations. There is no research on the GCC countries' banking industry.

According to the literature, most research is conducted on banks in industrialized nations. There is no research on the GCC countries' banking industry. In this study, we may use the GMM approach and SFA to examine banks in GCC countries.

H1: There is a significant negative relation between IC efficiency and risk of banks in the GCC countries.

H2: There is a significant negative relation between HC efficiency and risk of banks in the GCC countries.

H3: There is a significant negative relation between SC efficiency and risk of banks in the GCC countries.

3. Materials and Methodology

3.1. Data

This research is based on secondary data on GCC countries' banks from 2000 to 2019. The data on intellectual capital, risk measures, ownership structure, and performance measurements were collected mostly from bank annual reports, individual bank websites, and some information from the banks' scope database (www.bvinfo.com), Bloomberg, and OSIRIS databases. The data on microeconomic factors were gathered from the World Bank database.

Following the data gathering, they were organized in the required pattern for analysis. In this study, Aigner et al.'s [49] stochastic frontier analysis (SFA) was adopted to quantify the efficiency of intellectual capital, human capital efficiency, and structural capital of the selected banks over the study period. This study examined the association between risk-taking behavior and intellectual capital efficiency using a single-step generalized method of moments (GMM) estimate and ordinary least square (OLS) estimator. This study employed multiple statistical software programs for computation and analysis, including Stata 15.

Table 1 Variable definitions and data sources

Variables	Symbol	Definition
Risk	NPLTL	Ratio of non-performing loans to total loans
Intellectual capital efficiency	ICE	Intellectual capital efficiency
Human capital efficiency	HCE	Human capital efficiency
Structural capital efficiency	SCE	Structural capital efficiency
Return on assets	ROA	Return on assets (ROA)
Income diversification	ID	Ratio of non-interest income to total income
Risk-weighted assets to total assets	RWAT A	Ratio of risk-weighted assets to total assets
Bank size	SIZE	Natural logarithm of the total assets
Inflation rate	INFR	Annual inflation rate
Growth in GDP	GGDP	Annual growth in the real gross domestic product

Table 2 Descriptive statistics for all the variables

Variable	Obs	Mean	Std.	Dev.	Min
NPLTL	1,817	.893226	2.576916	-51.9149	9.5593
ICE	1,043	.832592	.2278833	.000402	2.13632
HCE	1,809	.016974	.0373595	-.002667	.903801
SCE	1,783	.5360369	1.502396	-36.2083	28.1881
ROA2	1,644	1.430626	5.796583	-10	92.222
ID	1,166	.5390841	.6281148	-6	6.33193
RWATA	2,254	.4554911	.5306163	.02	1.95
SIZE	1,846	14.81343	92.15184	-25.3071	2146.36
GGDP	2,259	5.042413	3.954412	-7.07586	26.1702
IFR	2,254	5.335958	3.364921	.5	17.6

3.1.1. Stochastic Frontier Analysis Is Used to Determine the Efficiency of Intellectual Capital (SFA)

We employed SFA in evaluating efficiency by following [35, 44, 50-52], and this work used the production function of SFA to deter intellectual capital efficiency. This study introduces a new dimension of

intellectual capital efficiency calculated using the SFA of the banking industry. In this study, we calculate each bank's efficiency using the Aigner [49] and stochastic frontier production techniques. The n th bank is

$$\ln IC_n = f(\ln Q_i, P_j) + \varepsilon_n$$

where IC_n represents the bank's intellectual capital; Q_i represents three outputs: Q_1 = total operating revenue, Q_2 = loan and advances, and Q_3 = non-interest income; P_j represents three inputs: P_1 = fixed assets, P_2 = personal costs, and P_3 = non-performing loan; n denotes the departure of a bank's real intellectual capital from the intellectual capital-efficient frontier, with two disturbance terms illustrated below:

$$\varepsilon_n = V_n - U_n$$

where V_n is a random error term that is independently and identically distributed $N(0, \sigma^2)$, U_n denotes intellectual capital inefficiency and is considered independent of V_n and to have a half-normal distribution, i.e., $N(0, \sigma^2)$.

Using the intermediation technique [53], we developed the following multiproduct translog production function to define the intellectual capital function:

$$\ln IC_n = \alpha + \sum_i \alpha_i \ln Q_i + \sum_j \beta_j \ln P_j + \frac{1}{2} \sum_i \sum_k \gamma_{ik} \ln Q_i \ln Q_k + \frac{1}{2} \sum_j \sum_h \delta_{jh} \ln P_j \ln P_h + \sum_i \sum_j \lambda_{ij} \ln Q_i \ln P_j + \varepsilon$$

According to [54], the predicted value of U_n is conditional to demonstrate the inefficiency of bank intellectual capital (termed as C_n).

$$C_n = E(U_n | \varepsilon_n) = [\lambda / (1 + \lambda^2)] [\phi(\varepsilon_n / \sigma) / \Phi(\varepsilon_n / \sigma) + \varepsilon_n / \sigma]$$

where the cumulative standard normal density function stands for the standard normal density function and is the ratio of the standard deviation to the standard deviation of V_n . C_n may be calculated using Equation 3. In this study, Coelli's Frontier Version 4.1 computer program, released in 1996, was used to calculate efficiency using the Frontier production function computed using the maximum likelihood technique.

3.2. Model

To describe the empirical model of the investigation, we created the following three simultaneous equations by following [35, 45-47]:

$$RISK_{i,t} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 ICE_{i,t} + \beta_3 ROA_{i,t} + \beta_4 ID_{i,t} + \beta_5 RWATA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 GGDP_t + \beta_8 INFR_t + \varepsilon_{i,t}$$

$$RISK_{i,t} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 HCE_{i,t} + \beta_3 ROA_{i,t} + \beta_4 ID_{i,t} + \beta_5 RWATA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 GGDP_t + \beta_8 INFR_t + \varepsilon_{i,t}$$

$$RISK_{i,t} = \beta_0 + \beta_1 RISK_{i,t-1} + \beta_2 SCE_{i,t} + \beta_3 ROA_{i,t} + \beta_4 ID_{i,t} + \beta_5 RWATA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 GGDP_t + \beta_8 INFR_t + \varepsilon_{i,t}$$

where the i subscript represents the cross-sectional dimension across banks and the t subscript represents the temporal dimension. The primary risk indicator is $NPLTL$ (dependent variable). The primary independent variables in this study are the overall efficiency of IC, designed as ICE , HCE , and SCE . Internal control variables (independent variables) ROA , ID , $RWATA$, $SIZE$ are to be used as internal control variables (independent variables) for individual banks, and some macroeconomic factors $INFR$, $GGDP$ are to be used as (independent variables) affecting the relationships between IC efficiency, risk. In addition to the variables listed above, we involved the following instrumental variables to support the model in regression analysis: $NPLTL$ ($t-1$), ICE , ROA , ID , $RWATA$, $SIZE$, LIQ , $LEVE$, $GOVS$, INF , and constant.

Equation (1) investigates whether the level of risk may be impacted by changes in IC efficiency, whereas Equation (2) investigates how the risk is affected by changes in HCE efficiency, and Equation (3) investigates whether the level of risk may be affected by changes in SCE efficiency over the research period.

Table 3 Correlation matrix

	npltl	ice	hce	sce	roa2	id	rwata	size	ggdp	ifr
Npltl	1.000									
Ice	-0.200	1.000								
Hce	-0.107	0.360	1.000							
Sce	0.113	0.000	-0.063	1.000						
roa2	0.059	0.079	0.019	0.119	1.000					
Id	0.025	-0.043	0.057	0.042	0.165	1.000				
Rwata	0.071	0.1000	-0.086	-0.044	-0.011	-0.068	1.0000			
Size	0.1338	0.2740	0.150	-0.000	0.009	0.034	-0.028	1.000		
Ggdp	0.128	-0.032	-0.046	0.069	0.059	0.030	-0.137	0.083	1.000	
Ifr	0.036	0.004	-0.072	0.021	0.072	-0.035	-0.051	0.0153	0.1916	1.0000

Notes: The table represents Pearson's correlation matrix for the variables used in this study. The dependent variable in the regression model is non-performing loans (NPLTL). The primary explanatory variables are intellectual capital efficiency (ICE), human capital efficiency (HCE), and structural capital efficiency (SCE), where ROA, ID, RWATA, size, growth of gross domestic product (GGDP), and inflation (IFR) are used as the independent variables. In addition to the above, CAP, LIQ, LEV, GOVS, and NPLTL ($t-1$) are used as instrumental variables along with all independent variables.

4. Empirical Results and Discussion

4.1. Results of the GMM Approach

We employed a generalized method of moments

(GMM) estimator. The GMM estimate employs Hansen's [55] instrumental variables for the probability of original model implementation. According to them, the OLS is less efficient than the GMM estimator, but

it allows heteroskedasticity [56]. Table 4 summarizes the major findings of this study.

Table 4 Effects of IC efficiency, HCE, and SCE on credit risks (The authors' calculation through Stata 15)

	(1)	(2)	(3)
	npltl	Npltl	npltl
L.npltl	0.517*** (51.30)	0.316*** (83.23)	0.270*** (85.45)
ice	1.937*** (-17.42)		
hce		7.995*** (-11.37)	
sce			1.752*** (27.07)
roa2	-0.00350 (-0.69)	0.00964*** (7.45)	0.0101*** (10.61)
id	0.0360*** (6.55)	0.235*** (-34.20)	0.147*** (-21.78)
rwata	-0.498*** (7.22)	-0.418*** (11.61)	-0.387*** (13.39)
size	0.00273 (1.42)	0.00338*** (14.01)	0.00155*** (4.86)
ggdp	0.0212*** (13.68)	0.0397*** (32.95)	0.0394*** (24.19)
ifr	-0.00712*** (-5.09)	-0.0348*** (-36.25)	-0.0391*** (-23.89)
_cons	1.828*** (15.31)	0.837*** (36.22)	-0.0769*** (-4.14)
The Sargan test	1.0000	1.0000	1.0000
AR(2)	0.1377	0.6821	0.2546
N	683	967	960

Notes: The table shows the empirical results of the GMM panel estimator. Non-performing loan to total loan (NPLTL) is the dependent variable. This study uses two factors, ID and RWATA, to control bank-specific heterogeneity. The Sargan test is for over-identifying restrictions. AR (2) is second-order autocorrelation. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively.

When the independent variables *IC* efficiency, *HCE*, and *SCE* are included, Models 1, 2, and 3 are employed. When a dependent variable's lag value is positive (Models 1, 2, and 3), it suggests that the previous year had an effect on credit risk.

According to the findings (Model 1), credit risk (*NPLTL*) is positively and substantially related to *ICE*, meaning that a 1% increase in *ICE* boosts credit risk by 1.937%. Hypothesis 1 states that there is a substantial inverse link between *IC* efficiency and GCC countries' bank risk. As a consequence, the conclusions of this study (Model 1) contradict the findings of [37, 38]. Models 2 and 3 show a positive and significant link between credit risk and *HCE* and *SCE* when *HCE* (*SCE*) is used as an independent variable rather than *ICE*. *HCE* and *SCE* reveal that *HCE* (*SCE*) increasing by 1% increases credit risk by 7.995% (1.752 percent).

The results of Models 2 and 3 are comparable with those of Model 1. Hypotheses 2 and 3 demonstrate a substantial negative association between *HC* efficiency (*SC* efficiency) and the risk of banks in the GCC countries. Therefore, the study findings (Models 2 and 3) do not support Hypotheses 2 and 3. Unfortunately, Model 3 demonstrates a negligible association between

SCE and *NPLTA*. According to the studies, improved *IC* efficiency will raise credit risk, reducing financial stability in the country. As a result, special consideration should be given to increasing the efficiency of banks' intellectual capital in developing nations (such as GCC countries). In terms of performance, Models 1 and 2 (Model 3) are negatively (positively) related to credit risk-taking, implying that a 1% increase (reduction) in bank performance *ROA* would result in credit risk decreasing (raising) by 0.00350 percent, 0.00964 percent, and 0.0101 percent, respectively. Income diversification (*ID*) and risk-weighted assets to total assets (*RWATA*) are both positively (negatively) associated with credit risk-taking, which means that a 1% rise (reduction) in *ID* (*RWATA*) would result in a 0.0360%, 0.235%, and 0.147% increase in credit risk (0.498%, 0.418%, and 0.387%, respectively). The remaining variables are listed below: Models 2 and 3 highlight a positive link between *NPLTL* and bank size, however, Model 1 demonstrates a negative and negligible relationship. Models 1 and 3 show a positive (insignificant) link between *NPLTL* and *GGDP*; however, Model 2 shows a negative relationship. Models 2 and 3 indicate a positive link between *NPLTL* and the inflation rate, whereas Model 1 reveals a negative (insignificant) relationship between *NPLTL* and the inflation rate. This study will primarily contribute in two ways. First, from a management standpoint, the notion of assessing *IC* performance is novel. Second, this study uses SFA to analyze *IC* performance to aid in studying the link between it and risk-taking behavior. The academic community would benefit from a combined examination of the SFA and GMM models. This study demonstrates how to combine these two models to determine the factors of efficiency. This research will help the intellectual capital theory, agency theory, and stakeholders' theory. The findings of this study will be beneficial for future research by bank executives, policymakers, regulators, and academics.

4.2. Robustness Check and Analysis

Following [57-59], the robustness results in Table 5 were obtained using OLS.

Table 5 Effects of IC efficiency, HCE, and SCE on credit risks (The authors' calculation through Stata 15)

	(1)	(2)	(3)
	npltl	npltl	npltl
Ice	0.638*** (-3.29)		
Hce		4.448** (-2.19)	
Sce			0.366*** (5.50)
roa2	-0.0156 (1.44)	-0.0283*** (3.61)	-0.0300*** (3.86)
id	0.0924 (-1.60)	0.0409 (-0.87)	0.0616 (-1.31)
rwata	-0.153***	-0.152***	-0.183***

Continuation of Table 5

	(2.72)	(3.03)	(3.64)
size	-0.00193	-0.000150	-0.000870
	(0.45)	(-0.12)	(-0.78)
ggdp	0.0460***	0.0592***	0.0584***
	(5.19)	(7.67)	(7.56)
ifr	-0.000415	-0.0146*	-0.0130
	(-0.05)	(-1.69)	(-1.51)
_cons	1.625***	1.070***	0.826***
	(9.53)	(13.59)	(10.11)
N	721	1060	1050

With the exception of a few examples, the majority of the findings are identical to the primary results: when the primary findings demonstrate a favorable influence on credit risks, the ROA in Model 3 reveals a negative effect on them. When the primary findings disclose a positive (negative) effect between them, bank size and (GGDP) in Model 2 have a negative (positive) effect on credit risks. When the major findings reveal a positive relationship between them, the inflation rate in Model 3 will have an adverse effect on credit risks.

5. Conclusions

The purpose of this research is to assess the influence of IC efficiency on the risk-taking behavior of selected banks in GCC countries. According to the study, *ICE* and its component *HCE* have a considerable positive clout on bank credit risk, whereas another component, *SCE*, has a positive but small incidence on risk. The study's findings are critical for bank management to consider when investing in *IC*, since they show that there is a pitch in bank risk with more *IC* investment. The study's findings coincided with the findings of [37, 38] but differed from the findings of [41]. The study's findings slightly dissent from the resource-based theory, which states that organizations' strategic important resources aid in boosting performance and mitigating dangers (1991). In this study, *ICE* has a positive outcome on bank risk, indicating that the more invested in *IC*, a key strategic resource, the more bank risk will increase. The study's strength is that the GCC countries' banking sector, such as private commercial banks, is attempting to spend more on intellectual capital, which stimulates the researcher to conduct research on risk and intellectual capital, as well as other bank-level and macro-level factors. The significant disadvantage of this study is that it was performed exclusively in the settings of the GCC countries' banking industry, which did not include all the GCC countries' institutions. A cross-country analysis would be more credible in supporting the upshot. The report proposes that bank management strives to spend more in *IC* to improve bank performance while lowering risk. Future research should be conducted in many countries to demonstrate the influence of *ICE* and corporate governance on bank credit and solvency risks.

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