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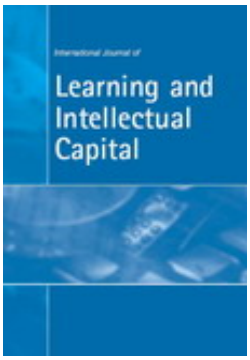

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The effects of intellectual capital on risk and return of banks: nonlinear modelling approach

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Abstract: This study examines the nonlinear effects of intellectual capital (IC) on the risks and returns of banks. Using the annual data of 366 banks from 26 African countries during 2007 to 2015, the study estimates the following: IC using the value-added intellectual coefficient (VAIC); risks and returns of banks using net interest margin; risk-adjusted return on assets; and insolvency risk. The results indicate that the relationship between net interest margin/insolvency risk and IC is nonlinear, U-shaped/ inverted U-shaped. The study's findings provide evidence for the extent of IC's contribution to the performance and stability of banks in Africa. This study's multidimensional conceptualisation of IC, risks and returns provides a robust systematic approach to a comprehensive understanding of aspects of the banking sector in emerging economies in Africa.

Keywords: intellectual capital; nonlinear; performance; stability; banks; Africa.

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1 Introduction

The performance and stability of the banking sector are essential for the performance of the entire financial sector and the economy at large (Claessens and Laeven, 2004). However, it is perceived that the risks and returns of the banking sector are underscored by banks' intellectual capital (IC) investments. Irrespective of this assertion, Nkundabanyanga (2016) argues that the performance of Sub-Saharan African banks has generally remained inadequately explained which underscores the importance of managing risks and returns. Johnson and Kaplan (1987) emphasise the vital role IC plays in the performance and stability of firms in general. However, a review of the literature does not offer conclusive evidence on whether the effect of IC on firms' performance/productivity is positive or negative.

Some studies identify a positive relationship between IC and the performance of firms (Neves and Proença, 2021; Hoang et al., 2020; Nawaz, 2019; Asare et al., 2017; Alhassan and Asare, 2016; Mondal and Ghosh 2012; Phusavat et al., 2011; Zeghal and Maaloul, 2010; Ting and Lean, 2009; An et al., 2011; Chen et al., 2005). Other studies find that IC has a more complex or negative relationship with performance and does not have an absolute positive effect on firms' performance (Weqar and Haque, 2020; Mehralian et al., 2012; Mosavi et al., 2012; Maditinos et al., 2011; Firer and Williams, 2003). However, in their study on the effect of innovation capital and information technology capital on firm performance, Huang and Liu (2005) find that investments in innovation capital produced a positive effect on performance before an optimum point, beyond which the influence of innovation capital on performance could become negative.

This study examines the relationship between IC and the performance and stability of African banks. Our investigation finds that, the return on IC depends on how well banks capitalise on their IC investment efforts to create competitive advantages. The nexus of IC-firm performance in the banking sector is nonlinear and cannot be categorised unambiguously as positive or negative contrary to findings in previous literature and

depends on the bank's ability to capitalise on their IC investments. Specifically, our findings show that the relationship between IC and performance can be U-shaped over a sufficiently broad range of variables. The relationship is positive over some variable ranges and negative over other ranges. Our study shows that findings of both positive and negative relationships between IC and performance in prior studies may be a function of the range of variables considered in the studies, and may not be contradictory, as previously thought. Consequently, the purpose of this study is not to proclaim which side of this enduring debate is correct. Rather, the purpose of this study is to examine whether the relationship between IC and bank performance (BP) (risk and return ratio) can be nonlinear; more importantly, it is to identify scenarios where the relationship between IC and BP can be positive and scenarios where it is negative.

Additionally, many of the previous studies employed static models. This current study contributes to the IC-firm performance nexus from an empirical method standpoint using the generalised methods of moment (GMM) regression estimation technique – a dynamic panel data estimator. This offered the opportunity to treat bank risks and returns as dynamic variables in various situations.[1] This study adopts a rigorous nonlinear model technique to test for a nonlinear relationship between IC and risks and returns as advocated by Lind and Mehlum (2010), which preceding studies have not examined. The study's outcomes provide insights which beef-up the IC and performance and stability literature. The discovery of a nonlinear relationship has implications for further studies, and suggests that utilising a nonlinear model to analyse IC and firm performance is ideal, contrary to the extensive use of the linear model in prior studies.

Overall, the results indicate that IC performance (ICP) positively affects financial performance and stability significantly. The impacts on financial performance and stability are nonlinear, i.e., U-shaped and inverted U-shaped, respectively. The initial levels of ICP (high) result in low net interest margin (NIM), indicating a decrease in interest income relative to interest paid. However, beyond a certain point of investment and performance in IC, increasing ICP also results in high financial performance in NIM. Similarly, at the initial levels of ICP, the insolvency risk (i.e., z-score) of banks increases (i.e., good stability) but beyond a point, higher ICP may result in poor bank stability. The findings have essential implications for practice, policy and future research.

The remaining part of this study is structured as follows. The ensuing section provides an overview of the banking sector in Africa. Section 3 is a review of pertinent literature. Section 4 focuses on the methods and data used. Empirical results are presented in the penultimate section with conclusions and thoughts for further research directions given in the last section.

2 Overview of the banking sector in Africa

Financial systems development in Africa is behindhand in view of other jurisdictions (Beck and Cull, 2014). "Underdeveloped financial systems are often distinguished from more developed ones by their lack of long-term finance" [WB Group, (2015/2016), p.10]. Financial systems in Africa are largely bank-based and the level of financial intermediation is low comparative to other regions (Adasme et al., 2006). Financial systems in Africa are small, both in absolute and relative terms (Adasme et al., 2006). For instance, Amidu and Kuipo (2015) state that, in 2011 credits to the private sector was at an average of 78% of GDP for Sub-Saharan African banks compared to 132.50% on

other emerging markets in the Pacific and East Asia. Similarly, banks in Africa are characterised by low loan-to-deposit ratios. Large shares of assets held in the banks are in the form of liquid assets and government securities. Their loaning is generally short-term, with about 60% of advances having a maturity of a year or less (Mlachila et al., 2013). Market structures are characteristically oligopolistic, which tend to restrain the intensity of competition (Mlachila et al., 2013). The criticisms suggest that while the banking environment in Africa is comparatively less penetrated and shallow, it is as competitive as those in other developing and developed regions (Nyantakyi and Sy, 2015). In Africa, central banks exist in sovereign states to regulate banking activities in their jurisdictions. The central banks have continually attempted to exercise authority as regulators, consistent with international conventional standards. These banks in Africa have attempted to instigate a series of tough regulatory measures to grow and develop the sector to contribute meaningfully to economic development.

3 Related literature

Few empirical studies if any are yet to consider the nature of the relationship between IC and firm risks even though there are enough evidence on IC and firm performance. This study chose to build on the evidence of IC and performance nexus and fill the gap in research on the nature of the relationship between IC and risk/return using banks in Africa. The evidence on nonlinearity of the relationship between IC (and its components) and performance and stability is few, if any in the literature. Also, the findings as enumerated below are based on studies that are not quite as comprehensive as this current study; most are even country specific with this being continent-wide (Africa).

As at the year 2010, 42 valuation methods for measuring intangible assets had been identified and it was likely that more methods would evolve (Sveiby, 2010). Among them, both academics and practitioners have increasingly adopted the value-added intellectual coefficient (VAIC) in measuring IC performance (ICP). The average VAIC reported by previous studies in different countries and continents included, but is not limited to; Sardo and Serrasqueiro (2017) in Europe (1.7473), Ozkan et al. (2017) in Turkey's banking sector (3.8868), Alhassan and Asare (2016) in Ghana's banking sector (2.0877), El-Bannany (2008) for UK banks (10.80), Goh (2005) for Malaysian banks (7.11), Makki et al. (2008) for Pakistani listed corporate sector (7.60) and Joshi et al. (2010) in Australia (3.80). Abeysekera (2007) attributes these dissimilarities in the ICP to economic, social and political factors.

On the whole, empirical evidence indicates that about two-thirds of firms have low levels of ICP (Asare, 2018; Joshi et al., 2013). This implies that the ability of most firms to use their IC to create value for stakeholders is quite low. Further, in terms of the components of VAIC, human capital efficiency (HCE) is usually higher than structural capital efficiency (SCE) and capital employed efficiency (CEE) (Ozkan et al., 2017 in Turkey; Sardo and Serrasqueiro, 2017 in Europe; Asare et al., 2017 in Ghana; Alhassan and Asare, 2016 in Ghana; Joshi et al., 2013 in Australia; Lu et al., 2013 in China; Joshi et al., 2010 in Australia; Ting and Lean, 2009 in Malaysia; Goh, 2005 in Malaysia; Mavridis, 2004 in Japan). This extols the impact and essence of the human capital in the various capitals of firms.

IC accounting research has placed prominence on the consequence of IC elements on firm performance, building on previous studies about the cause-effect perspective on the constituents of IC (Ng, 2006). On ICP and firm performance, empirical evidence reveals mixed findings. Some studies (Hoang et al., 2020; Nawaz, 2019; Asare et al., 2017; Mondal and Ghosh 2012; Clarke et al., 2011; Phusavat et al., 2011; Alipour, 2012; Chen et al., 2005; Zeghal and Maaloul, 2010) support the proposition that IC (i.e., VAIC) has a positive effect on firm financial performance. More specifically, Neves and Proença (2021), Alhassan and Asare (2016), Mondal and Ghosh (2012), Ting and Lean (2009), El-Bannany (2008) and Swartz and Firer (2005), using bank data, indicate a significant positive relationship between ICP (i.e., VAIC) and financial performance.

Also, there are contrary results which put forward that more investments in IC are not always good (Huang and Liu, 2005); that not all elements of IC i.e., HCE, SCE and CEE have a positive effect on a firm's financial performance (Kweh et al., 2019; Mehralian et al., 2012; Mosavi et al., 2012; Daryaee et al., 2011; Maditinos et al., 2011; Yalama and Coskun, 2007; Firer and Williams, 2003). Joshi et al. (2013) and Yalama and Coskun (2007) thus considered the connection between VAIC and bank performance (BP) over a period. Their evidence is inconclusive and inconsistent with the findings of other studies that indicate a positive relationship between VAIC and BP. Also, Daryaee et al. (2011), using Tobin's Q as a proxy for ICP, find no evidence signifying that return on assets (ROA) relates to a firm's ICP. On the other hand, few studies have considered the effects of IC and its elements on risk or stability of firms. Risk or stability issues are important to the practice of banking and as such determining the effects of IC on stability/risk is not far-fetched.

Juxtaposing this to the resource based-view, it can be inferred that banks need resources especially intangibles, (i.e., IC) to be able to create competitive advantage thus creating values to relevant stakeholders in order to improve their risk management and performance. In that regard, positive investments in IC by banks will lead to higher ICP and a higher performance and stability.

Concisely, this study's review indicates that research does not provide definite results on whether the effect of IC on firm performance is positive or negative. Some studies, as enumerated above, identify a positive relationship between IC and firm performance while others highlight that IC has a complex or negative relationship with firm performance and that, IC does not have an absolute positive effect on firms' performance. This study does not aim to declare a victor in this long-standing debate. Rather, it seeks to demonstrate whether, despite their oppositions, both positions might be correct over some ranges of the variables. For instance, Huang and Liu (2005) examined the effect of innovation capital and information technology capital on firm performance and concluded that, investments of innovation capital reduced a positive effect on performance before an optimal point, beyond which the influence of innovation capital on performance could become negative. Based on these conceptualisations, this study suggests that the relationship between IC and risk and return may be nonlinear. Consequently, this study suggests that there is a nonlinear relationship between IC and risk and return and that, the inconsistent findings in previous literature may be due to the failure to consider this nonlinear relationship (see also Lind and Mehlum, 2010).

On structural capital (i.e., a component of IC), it can be theorised that as banks engage in research and development, drafting of policies to guide operations, among others.. they are accruing initiatives and innovative capacities. Akin to the resource-based view, once adequately accrued, they enable banks to assimilate and exploit knowledge

and thereby profit from their investments in structural capital. Subsequently, the relationship of their IC with overall bank risk and return could be positive. In contrast, managers that superintend over banks with insufficient IC investments are usually incapable of making favourable returns on their IC investments; hence, the relationship of their banks' IC with overall bank risk and return could be negative.

Using the above as the basis, the study hypothesises that:

H1 The relationship between ICP (its components) and risk and return is nonlinear (U-shaped).

4 Data and methods

The financial data from the unconsolidated financial statements of banks were sourced from the Bankscope database. Country-specific data on macroeconomy and governance were also obtained from the Global Financial Development Database (GFDD) of the World Bank and the World Development Indicators (WDI) database. Data on a sample of 366 banks from 26 African countries for the period 2007 to 2015 is thus used for this study.

4.1 Description of variables

4.1.1 Bank performance (risk and return)

Three return and risk variables are measured and used for the study. They include NIM, risk-adjusted return on assets (RAROA) and insolvency risk (Z-SCORE). The NIM is set by banks to cover all the risks and costs of intermediation (Marinković and Radović, 2014). 'Adequate NIM should generate sufficient income to increase the capital base as risk exposure increases' [Angbazo, (1997), p.56]. NIM as intermediation spread of banks is measured as:

$$\text{NIM} = (\text{Net interest income} / \text{Total income})$$

Additionally, the study uses bank-specific data to compute one risk-adjusted performance measure of return on assets (RAROA) by dividing ROA by its standard deviation (σ) (see also Asare, 2018; Sissy et al., 2017; Amidu and Wolfe, 2013).

$$\text{RAROA} = \left(\text{ROA} / {}^{\sigma}\text{ROA}\right)$$

where ROA is the ratio of profit before tax to total assets of a bank; $^{\sigma}$ROA is the standard deviation of ROA.

For a measure of bank insolvency risk, the study employs the Z-SCORE (see Alhassan and Biekpe, 2017; Demirguc-Kunt and Huizinga, 2010; Turk-Ariss, 2010; Berger et al., 2009), which signifies a universal measure of the bank risk. Z-SCORE as an indicator of BP measures the number of standard deviations that a bank's rate of return should fall to in order to drive it into insolvency. The Z-SCORE thus reflects the firm's buffer in equity and profits with the standard deviations of profits (Alhassan and Biekpe, 2017). Hence, a higher value indicates a high distance to default and consequently high solvency and stability and vice versa. Following prior studies (Alhassan and Biekpe,

2017; Sissy et al., 2017; Pasiouras and Gaganis, 2013) on financial markets, the equation for estimating the Z-SCORE is given as

$$\text{Z-SCORE} = \left[(\text{ROA} + \text{Equity}) / {}^{6}\text{ROA} \right]$$

where ROA is the ratio of profit before tax to total assets of a bank; equity captures the ratio of equity to assets of bank; ^{6}ROA is the standard deviation of the ROA.

4.1.2 Intellectual capital

The various ontological and epistemological differences in relation to the IC construct result in a lack of a wholly established measure of IC performance (ICP) (Swartz and Firer, 2005). There are many approaches recognised in the literature for quantifying and appraising IC (Al-Musalli and Ismail, 2015). Amid these approaches, the value-added intellectual coefficient (VAIC) is advocated by researchers as the utmost applicable technique to quantify ICP and has been widely used in the literature (Alhassan and Asare, 2016; Mondal and Ghosh, 2012; Joshi et al., 2010; Ting and Lean, 2009; Goh, 2005; Mavridis, 2004). This study adopts the VAIC as proposed by Pulic (2008, 2004) to measure ICP. A greater value for VAIC demonstrates a grander efficiency of the firms' resources in generating value (Pulic, 2004).

VAIC determines the efficacy of human, structural and financial capitals. The VAIC measures ICP as the value of the difference between firm outputs and inputs. VAIC is composed of structural capital efficiency (SCE), human capital efficiency (HCE) and capital employed efficiency (CEE) (i.e., VAIC = HCE + SCE + CEE). HCE is best explained as benefits derived from expenditures incurred on employees. However, because these expenditures are not considered as inputs and hence not reported, they are often classified as investments. Investments in employees are evidenced when employees utilise their skills and experiences (creativity, tolerance, formal training, commitment, education, etc.) when engaging with the activities of the firm. The evaluation of employee engagement with the firm is thus replicated in firm performance and stability. Human capital investments are of the essence once the skills and experiences of employees are tapped and put to effective use. Such unique skills and experiences may be lost when employees leave the firm. On the other hand, the value created from investments in structural capital (SC) remains in the firm even when employees leave the firm. SCE is the SC of a firm divided by the value added (SC/VA) to the firm. VA is computed as the difference between total revenues of banks made up of interest income, fees and commission income etc. (denoted as OUT) and inputs represents operative costs of banks made up of interest, finance and administration expenses (exclusive of personnel expenses, which are treated as investments) (denoted as IN).

Thus, SCE depicts value creation in firms that arise from investments in SC (organisational cultures, systems, database, management processes, learning capacity, financial systems, etc.) of firms. A combination of SCE and HCE within a firm is termed IC efficiency (ICE = HCE + SCE). Also, CEE shows the value creation arising from investments by shareholders. It shows the contribution of a firm's net assets to VA of the firm (CEE = VA / CE), where CE is the net assets book value. In sum, the combination of HCE, SCE, and CEE shows the overall ICP of a firm (VAIC = ICE + CEE).

4.1.3 Other variables

Bank size is measured as a natural logarithm of the bank's fiscal year-end total assets (Asare et al., 2020; Maji and Goswami, 2020; Onumah et al., 2013). Banking market structure is determined in line with Asare et al. (2021), Alhassan and Asare (2016) and Al-Musalli and Ismail (2012); the CLR5 (5-bank loan concentration ratio) is used to measure banks' lending concentration in the economies studied. CLR5 is the ratio of the total loan assets of the five largest banks to total industry loan assets. CRL5 ranges between 0 (low concentration) and 100 (high concentration). Gross domestic product per capita growth (GDPpcg) is incorporated as justification for differences in macroeconomic environments of the countries (Sissy et al., 2017; Amidu and Wolfe, 2013). GDPpcg is used to control for general economic growth and development and macroeconomic stability that somehow affect IC and performance and stability of banks in a country.

4.2 Specification of the model and estimations

Panel regression models are specified to assess the nature of the relationship between IC and performance and stability. The equation focuses on the extent to which IC influences risk and return. The control variables namely the size of the bank, the 5-bank loan concentration ratio and the respective countries' macro-economic environment, i.e., GDPpcg are used. The variables are used as controls as their exclusion could bias the results of the causality and cointegration analysis and lead to simultaneity bias (Gujarati, 1995). The equation (1) and estimation strategy adopted follows arguments put forward by Roodman (2009) and Valverde and Fernández (2007) that banks maximise wealth by considering both opening and end-of-period information and that previous values of risk and return may affect present risk and return values. The dynamic model technique is thus employed to estimate the regressions. The study also adopts the ordinary least-squares (OLS) as a benchmark technique for the analysis. The OLS panel corrected standard errors (OLS-PCSE) estimate is robust to not only unit heteroskedacity, but it is also against possible contemporaneous correlations across the units that are common in time-series-cross-sectional data (Bailey and Katz, 2011). The basic models of this study are first estimated with the OLS-PCSE.

Furthermore, the nonlinear model is adopted. In probing the nonlinearity of the relationships between variables of interest, the inflection points[2] of the quadratic terms are estimated. As a rule of thumb, negative values of the point of inflection reveal the minimum function and a relationship, which is U-shaped; while positive values reveal a maximum function and a relationship, which is inverted U-shaped (see also Asare, 2018; Alhassan and Biekpe, 2017). As a final point on the hypothesis tested in the equation, positive signs for both the linear (β_1) and quadratic (β_2) coefficients indicate that increasing VAIC (increasing ICP) increases the risk and return of banks, i.e., NIM, RAROA, Z-SCORE.

Evidence in favour of the resource-based view can only be arrived at if the coefficients of $\beta_1$and β_2 are positive (i.e., NIM, RAROA, as dependent variables) and negative (i.e., Z-SCORE, as dependent variable). With respect to the U-shaped relationship, a positive coefficient is expected for β_1 while a negative coefficient is expected for β_2. A reverse of the coefficients for both the linear and quadratic terms will result in an inverted U-shape.

$$BP_{it} = \alpha + \beta_1 BP_{it-1} + \beta_2 VAIC_{it} + \beta_3 VAIC_{it}^2 + \sum_{l=1}^{L} \delta_l CONTROLS_{it}^l + \varepsilon_{it} \quad (1)$$

where $VAIC_{it}$ is VAIC, an IC performance measure of a bank i in the time t; BP_{it} is the risk and return of a bank i in the time t. BP_{it-1} is one period lagged observations of the respective variable of a bank. Again, $VAIC_{it}^2$ represents VAIC squared. $CONTROLS_{it}$ is a vector of control variables including bank size (BSIZE); 5 bank loan concentration ratio (CRL5) and gross domestic product per capita growth rate (GDPpcg). α is the constant; β and δ are the coefficients; ε_{it} is the error term.

5 Empirical results

It can be realised from Table 1 that, the average VAIC of the banks is 2.3483 and ranges from –8.4692 to 12.7358. The low standard deviation (2.2987) signifies low variations of VAIC across the banks. This suggests that African banks created an average value of 2.3483 for every 1 monetary unit employed in them. A higher value for VAIC depicts a greater efficiency of IC in creating values for a firm (Pulic, 2004). This value is the minimum for efficient firm performance in the banking sector (i.e., sufficient value is being created to cover for employees' salaries, amortisation, bank interests, taxes, dividends to shareholders) with enough left for intensive investments in development (Pulic, 2008). Thus, on average the value creation efficiency of African banks from the perspective of IC is quite low compared to banks/firms on other continents. The average VAIC of the banking sector in this study is lesser than the values reported by Ozkan et al. (2017) in Turkey's banking sector (3.8868), El-Bannany (2008) for UK banks (10.80), Goh (2005) for Malaysian banks (7.11), Makki et al. (2008) for Pakistani listed corporate sector (7.60) and Joshi et al. (2010) in Australia (3.80). Abeysekera (2007) attributes these dissimilarities in the average VAIC values to economic, social and political factors.

In terms of the components of VAIC, HCE is 1.4405 and is higher than SCE and CEE. Therefore, in the banking sector of Africa HCE is the principal constituent of VAIC. Comparatively, it could be inferred that human capital contributes most significantly towards the value creation efficiency of the banks. This finding is consistent with the results of many studies undertaken on the banking sector in specific countries and continents (Ozkan et al., 2017; Sardo and Serrasqueiro, 2017; Asare et al., 2017; Alhassan and Asare, 2016; Joshi et al., 2013; Lu et al., 2013; Joshi et al., 2010; Ting and Lean, 2009; Goh, 2005; Mavridis, 2004); which also find that HCE dominates the VAIC of firms. The efficiency of human capital is mostly seen as the key resource that ultimately drives all the capitals of banks including the other constituents of IC (Alhassan and Asare, 2016).

Thus, on average the NIM, RAROA and Z-SCORE is 6.4557, 3.5891 and 10.6496 respectively. The RAROA is relatively lower than Sissy et al.'s (2017) average (i.e., 5.884) for banks in Africa but higher than that obtained by Amidu and Wolfe (2013) for banks in Africa (2.482). The NIM in this instance is not similar to Marinković and

Radović, (2014) of 9.416%. The Z-SCORE is lesser than what the following studies had Sissy et al. (2017) – (39.259) and Amidu and Wolfe (2013) – (18.69). Z-SCORE which signifies a universal measure of bank insolvency risk is quite low (i.e., high insolvency risk) and depicts that most African banks might be gravitating towards insolvency. NIM in African banks is also usual and reflects normal intermediation spreads in banks. RAROA also looks usual. These depict the efficacy of the banks in utilising risk assets to make high returns.

The results also indicate an average BSIZE of 4.3482 over the period. The CRL5 of banks is 82.3796%. This is greater than what Alhassan and Asare (2016) realised in the specific context of Ghana, i.e., 53.27%. This indicates that about 82% of the loan portfolio of banks is controlled by the five largest banks in specific countries in Africa. In terms of the macro-economic indicators, the average GDPpcg in Africa is 2.7578% with a small standard deviation of 2.7873. Sissy et al. (2017) and Amidu and Wolfe (2013) obtained average GDPpcg of 3.10% and 5.20%, respectively.

Table 1 Summary statistics

	Obs.	*Mean*	*Max*	*Min*	*SD*
VAIC	2,450	2.3483	12.7358	–8.4692	2.2987
HCE	2,286	1.4338	11.5007	–5.3824	1.7156
SCE	2,327	0.8406	11.4167	–8.6051	1.6744
CEE	2,430	0.2152	7.8322	–2.6879	0.5325
NIM	2,440	6.4557	49.2400	–16.7500	5.0926
RAROA	2,424	3.5891	65.3918	–76.5106	10.0000
Z-SCORE	2,415	10.6496	41.8036	–12.0247	8.5786
BSIZE	2,439	4.3482	7.2304	1.0828	1.1987
CRL5	2,489	82.3796	100.0000	55.7144	13.6246
GDPpcg	2,052	2.7578	12.4243	–7.9079	2.7873

Notes: VAIC is the IC performance; HCE, human capital efficiency; SCE, structural capital efficiency; CEE, capital employed efficiency; NIM is net interest margin; RAROA, risk-adjusted return on assets; Z-SCORE, is bank insolvency risk; BSIZE, bank size; CRL5, 5 bank loan concentration ratio; GDPpcg, gross domestic product per capita growth rate.

Source: Bank scope and authors' computations, 2019

5.1 Effects of IC on performance of banks

The test for multicollinearity[3] in Table 2 is carried out to detect the presence or otherwise of any form of multicollinearity between the explanatory variables employed. A problem of multicollinearity exists when the explanatory variables are highly correlated with each other. The output results of the test, in this case, suggest that there is low correlation between the variables. BSIZE is bank size.

Table 2 Correlation matrix of the variables

	VAIC	*HCE*	*SCE*	*CEE*	*VAIC2*	*HCE2*	*SCE2*	*CEE2*	*BSIZE*	*CRL5*	*GDPpcg*
VAIC	1.0000										
HCE	0.6886***	1.0000									
SCE	0.5652***	–0.1613***	1.0000								
CEE	0.3073***	0.2314***	–0.1516***		1.0000						
VAIC2	0.7272***	0.5236***	0.3802***	0.2054***	1.0000						
HCE2	0.5967***	0.7848***	–0.0061	0.0251	0.7076***	1.0000					
SCE2	0.2722***	–0.2213***	0.6317***	–0.1150***	0.5743***	–0.0559***	1.0000				
CEE2	0.2050***	0.0622***	–0.013	0.6825***	0.2734***	0.0645***	–0.0167	1.0000			
BSIZE	–0.0886***	–0.0556***	–0.0362*	–0.0395**	–0.0258	–0.0631***	–0.0180	–0.0919***	1.0000		
CRL5	–0.0568***	–0.0106	–0.0208	–0.0694***	0.0567***	0.0312***	–0.0102	–0.0555***	0.1460***	1.0000	
GDPpcg	0.0575**	0.0344	0.0190	0.0458*	–0.0636***	–0.0152	0.0037	0.0043	–0.1685***	–0.1613***	1.0000

Notes: ***, ** and * denotes significance at 1%, 5% and 10% respectively.
VAIC is the ICP; HCE, human capital efficiency; SCE, structural capital efficiency; CEE, capital employed efficiency; VAIC2 is the quadratic term of the VAIC; HCE2 is the quadratic term of the HCE; SCE2 is the quadratic term of the SCE; CEE2 is the quadratic term of the CEE; bank size; CRL5, 5 bank loan concentration ratio; GDPpcg, gross domestic product per capita growth.

Source: Bank scope and author's computations, 2019

Table 3 IC and bank risks and returns: nonlinear model

OLS-PCSE						
Dependent variable: bank performance						
	NIM		*RAROA*		*Z-SCORE*	
VAIC	0.4142***		–0.0120		0.0140**	
	(4.1300)		(–0.3600)		(0.0900)	
HCE		0.0850		0.0504		0.9098***
		(0.6300)		(1.1300)		(4.4600)
SCE		–0.1758		0.0030		–0.1701
		(–1.0700)		(0.0500)		(–0.8000)
CEE		2.9136***		0.2302*		–1.6430**
		(6.4700)		(1.6600)		(–2.5700)
VAIC2	–0.0376***		0.0035		–0.0096**	
	(–3.3200)		(0.9200)		(–0.4800)	
HCE2		–0.0027		0.0098		–0.0530*
		(–0.1400)		(1.2700)		(–1.7000)
SCE2		0.0113		–0.0041		0.0451
		(0.5700)		(–0.6100)		(1.5800)
CEE2		–0.4588***		–0.0777		0.2514**
		(–5.0800)		(–1.4600)		(2.1800)
BSIZE	–0.6466***	–0.7072***	0.0069	0.0092	0.0010	–0.3342*
	(–5.0600)	(–5.3600)	(0.1600)	(0.1800)	(0.0100)	(–1.9500)
CRL5	0.0454***	0.0510***	0.0168***	0.0131**	0.1010***	0.0867***
	(4.1000)	(4.7000)	(3.1700)	(2.1700)	(7.5100)	(6.6100)
GDPpcg	0.2109***	0.2131***	0.0087	0.0080	–0.4302***	–0.3937***
	(4.1600)	(4.2400)	(0.4900)	(0.4300)	(–6.4100)	(–6.2500)
Constant	3.8721***	3.9731***	–1.0866***	–0.8863**	4.2587***	5.2660***
	(3.9900)	(4.2300)	(–2.8300)	(–2.1900)	(3.5400)	(4.3900)
Diagnostics						
R-squared	0.0563	0.1215	0.0530	0.0800	0.0578	0.0806
Number of groups	308.00	302.00	334.00	334.00	337.00	331.00
Observations	1255.00	1160.00	1463.00	1463.00	1477.00	1351.00
Wald chi2 (5/9/5/9/5/9)	87.15***	120.38***	77.04***	63.1500	208.39***	179.30***
Inflection points	–5.5085***	–3.1753***	–	–	–3.5053***	–8.5869*, –3.2672**

Notes: ***, ** and * denotes significance at 1%, 5% and 10% respectively.
VAIC is the IC performance; NIM is net interest margin; RAROA, risk-adjusted return on assets; Z-SCORE , is bank insolvency risk; HCE, human capital efficiency; SCE, structural capital efficiency; CEE, capital employed efficiency; VAIC2 is the quadratic term of the VAIC; HCE2 is the quadratic term of the HCE; SCE2 is the quadratic term of the SCE; CEE2 is the quadratic term of the CEE; numbers in parentheses are z-statistics.

Source: Bank scope and authors' computations, 2019

Beyond the linear analysis of the relationship that exist between IC and risk and return in the extant literature, the study seeks to examine whether the relationship could be nonlinear. Tables 3 and 4 present the results of the nonlinear or quadratic models. First, the OLS-PCSE is used to estimates the relationships and subsequently, the system GMM estimation. With regard to the OLS-PCSE estimations in Table 3, the following findings were obtained. The linear coefficient of VAIC has a positive sign with NIM and Z-SCORE while the quadratic coefficient (i.e., VAIC2) becomes negative and significant with same. In addition, the VAIC has a negative association with RAROA while VAIC2 has a positive association with it. The latter remains insignificant though. Therefore, there is a U-shaped relationship[4] between VAIC and Z-SCORE; and VAIC and NIM. The relationship between VAIC and RAROA is in an inverted U-shape. This indicates that initial levels of ICP (i.e., higher VAIC) results in lower NIM or Z-SCORE indicating decreasing net interest income and higher insolvency risk. Yet, beyond the inflection point, increasing VAIC leads to higher performance with respect to NIM and good stability with respect to the Z-SCORE. In contrast, the initial levels of ICP (i.e., higher VAIC) result in higher RAROA indicating a decreasing financial performance. Yet, beyond the inflection point, higher VAIC leads to lower financial performance. However, RAROA increases at initial IC investments that results in ICP but in the long term, increased investments in IC and its performance would improve NIM though stability may suffer. This analysis depicts the dynamic and complex nature of IC, as banks need to constantly invest in IC and manage those IC using evolving contemporary approaches.

Based on the same rule of thumbs, HCE has a U-shaped relationship with Z-SCORE and NIM, but in the case of NIM it is not significant. Thus, the result highlights that though higher levels of HCE are negatively associated with Z-SCORE, the effect is not constant. Rather, for HCE levels above a certain point, higher levels of the HCE act to increase Z-SCORE in the banking sector in Africa. SCE depicts the following relationships though not significant: inverse U-shaped relationship with NIM; U-shaped relationship with RAROA; inverse U-shaped relationship with Z-SCORE.

CEE has U-shaped relationships with NIM and RAROA but an inverse U-shaped relationship with Z-SCORE. With respect to the CEE, it is significant in the case of NIM and Z-SCORE. Thus, the result suggests that although levels of CEE are negatively associated with Z-SCORE, the effect is not constant. Rather beyond a certain point, higher levels of the CEE act to increase Z-SCORE in the banking sector in Africa, all other factors being equal. This implies that in the long run improvement in ICP results in high stability of banks.

The results of the existence of quadratic relationships of VAIC (and its components) and risk and return could explain why other studies highlight that IC has a complex relationship with performance of firms and that IC does not have an absolute positive effect on firms' performance; though they did not use quadratic models (see Mehralian et al., 2012; Mosavi et al., 2012; Maditinos et al., 2011; Firer and Williams, 2003).

An examination of results for the control variables generally suggests that BSIZE has a negative and significant association with NIM and Z-SCORE which are similar to earlier findings in this study. Smaller banks are more profit efficient in NIM than RAROA. CRL5 has a significant positive relationship with RAROA and Z-SCORE. This specifies that in a concentrated banking market, bank stability and profitability is high. GDPpcg also presents significant positive and negative relations with NIM and Z-SCORE correspondingly.

In a nuthshell, the study accepts the hypothesis in the case of NIM and Z-SCORE and thus concludes that the relationship between ICP and NIM/Z-SCORE is nonlinear.

In the system GMM estimation, the AR (1) tests indicate p-values that shows that there are sufficient lags to control the dynamic part of the estimations. The AR (2) second-order serial correlation tests also present p-values, which depict that the null hypothesis of no serial correlation cannot be rejected. The Hansen J tests equally suggest that the null hypothesis of the instruments is valid, hence cannot be rejected.

In the nonlinear system GMM results, VAIC has a U-shaped relationship with NIM and RAROA; and inverted U-shaped relationship with Z-SCORE (see Alhassan and Biekpe, 2017; Lind and Mehlum, 2010). However, the relationship is significant in the case of NIM and Z-SCORE. These results are consistent with earlier results of the OLS-PCSE. As already, intimated, initial levels of ICP (i.e., higher VAIC) results in lower NIM or Z-SCORE signifying decreasing net interest income and high insolvency risk. Yet, beyond the inflection point, increasing VAIC leads to higher performance with respect to NIM and higher stability with respect to Z-SCORE.

Table 4 IC and bank risks and returns: nonlinear model

System GMM						
Dependent variable: bank performance						
	NIM		*RAROA*		*Z-SCORE*	
Lag	0.4653***	0.4999***	–0.7572***	0.0072	0.7684***	0.7528***
	(6.6700)	(6.2500)	(–3.7800)	(0.0300)	(6.7400)	(16.5100)
VAIC	0.1760*		0.0396		–0.7385***	
	(1.9500)		(0.5100)		(–2.5600)	
HCE		0.1876		0.1471		0.1422
		(1.2200)		(1.3200)		(0.5100)
SCE		0.0743		–0.0387		–0.0079
		(0.8600)		(–0.5500)		(–0.0600)
CEE		0.5976**		0.4484**		–0.5637
		(2.1300)		(2.4100)		(–1.4200)
VAIC2	–0.0057**		–0.0012		0.0767**	
	(–0.6000)		(–0.1800)		(2.2600)	
HCE2		0.0032		0.0050		–0.0258
		(0.1700)		(0.2400)		(–0.6000)
SCE2		–0.0044		0.0067		0.0094
		(–0.5000)		(0.8700)		(0.6000)

Notes: ***, ** and * denotes significance at 1%, 5% and 10% respectively.
VAIC is the IC performance; NIM is net interest margin; RAROA, risk-adjusted return on assets; Z-SCORE , is bank insolvency risk; HCE, human capital efficiency; SCE, structural capital efficiency; CEE, capital employed efficiency; VAIC2 is the quadratic term of the VAIC; HCE2 is the quadratic term of the HCE; SCE2 is the quadratic term of the SCE; CEE2 is the quadratic term of the CEE; BSIZE is bank size (logarithm of total assets); CRL5, 5 bank loan concentration ratio; GDPpcg, gross domestic product per capita growth.
Numbers in parentheses are z-statistics.

Source: Bank scope and authors' computations, 2019

Table 4 IC and bank risks and returns: nonlinear model (continued)

System GMM						
Dependent variable: bank performance						
	NIM		*RAROA*		*Z-SCORE*	
CEE2		–0.0782***		–0.0025		0.0330
		(–2.7700)		(–0.0200)		(0.6800)
BSIZE	–1.0006**	–0.7413	0.0764	–0.0672	–7.1234***	–0.8878**
	(–2.0900)	(–1.5300)	(0.2800)	(–0.4900)	(–3.6800)	(–2.1900)
CRL5	–0.0165	–0.0138	0.0340*	0.0198**	0.2946***	–0.0132
	(–0.8700)	(–0.7800)	(1.8800)	(2.1200)	(5.7700)	(–0.4500)
GDPpcg	0.0259	0.0073	0.0221	0.0121	–0.0952	–0.2022***
	(1.0800)	(0.5600)	(0.9100)	(0.7400)	(–0.8800)	(–4.9100)
Constant	8.3040***	6.6758***	–2.5675**	–1.1655**	10.1342*	8.2490***
	(4.5100)	(3.5100)	(–2.4300)	(–2.1700)	(1.9500)	(7.1300)
Diagnostics						
Number of groups	37.0000	281.0000	315.0000	309.0000	335.0000	328.0000
Number of instruments	37.0000	61.0000	44.0000	71.0000	17.0000	20.0000
Observations	958.0000	880.0000	1133.0000	1028.0000	1262.0000	1150.0000
F-test	16.4600***	13.0400***	11.5600***	2.8800***	26.8500***	70.7400***
AR(1)	–2.1400	–2.0900	–0.7400	–1.1800	–0.4200	–3.8900
p-value	0.0320	0.0370	0.4580	0.2370	0.6730	0.0000
AR(2)	–0.2100	–0.0300	0.2000	1.1300	–1.5100	–1.0000
p-value	0.8340	0.9720	0.8390	0.2600	0.1310	0.3170
Hansen J	39.5800	58.5100	48.3400	60.8500	36.6000	13.3700
p-value	0.1130	0.1910	0.1000	0.4450	0.1520	0.1470
Inflection points	2.1300**	2.4300***	–	–	1.8800**	–

Notes: ***, ** and * denotes significance at 1%, 5% and 10% respectively.
VAIC is the IC performance; NIM is net interest margin; RAROA, risk-adjusted return on assets; Z-SCORE , is bank insolvency risk; HCE, human capital efficiency; SCE, structural capital efficiency; CEE, capital employed efficiency; VAIC2 is the quadratic term of the VAIC; HCE2 is the quadratic term of the HCE; SCE2 is the quadratic term of the SCE; CEE2 is the quadratic term of the CEE; BSIZE is bank size (logarithm of total assets); CRL5, 5 bank loan concentration ratio; GDPpcg, gross domestic product per capita growth.
Numbers in parentheses are z-statistics.

Source: Bank scope and authors' computations, 2019

In terms of the components of VAIC, HCE has a U-shaped relationship with only Z-SCORE but it is not significant. This is similar to the OLS-PCSE results. Thus, the results demonstrate that though higher levels of HCE are negatively associated with Z-SCORE, the effect is not constant. Rather, for higher levels of the HCE there is an increase in the Z-SCORE in the banking sector of Africa. Hence, HCE improvement

leads to higher bank stability in the long-run. SCE depicts the following relationships though not significant: inverse U-shaped relationship with NIM; inverse U-shaped relationships with RAROA and Z-SCORE. This seems consistent with the OLS-PCSE results. CEE has U-shaped relationships with NIM and RAROA but an inverse U-shaped relationship with Z-SCORE. With respect to the CEE, it is significant in the case of NIM. This is also partly in line with the results of the OLS-PCSE for the nonlinear models. As already explained, the result submits that while higher levels of CEE are negatively associated with NIM, the effect is not constant and that beyond a definite point, higher levels of the CEE act to increase NIM.

In a nutshell there is some evidence to support the assertion of some researchers that IC has a complex relationship with performance of firms and that IC does not have an absolute positive effect on firms' performance, though they had not used quadratic models (see also Firer and Williams, 2003; Maditinos et al., 2011; Mehralian et al., 2012; Mosavi et al., 2012). These results support the hypothesis that there is a nonlinear relationship between VAIC and risk and return. There is evidence in respect of NIM and Z-SCORE.

The control variables yielded the following results: BSIZE has negative and significant association with NIM and Z-SCORE which are consistently similar to earlier findings in this study. CRL5 has significant positive relationship with only RAROA. GDPpcg also presents no significant positive or negative relations with any of the performance variables. Across the estimations presented there are mixed results in respect of these control variables.

6 Conclusions

Specifically, the study draws insights from the resource-based view to posit that, the relationship between IC and financial performance and stability is nonlinear. It explored the contextual frontiers of banks by employing firm, industry, and economy specific data of banks in Africa. After the assessments of the performance of banks, the study concludes that RAROA and NIM are quite normal for African banks with RAROA being more consistent. Z-SCORE, which signifies a universal measure of bank insolvency risk, is quite high and depicts that most African banks are perhaps gravitating towards insolvency.

Based on the relatively low average VAIC and its components, the study concludes that the efficiency of banks' IC investments is quite low in Africa. Thus, on average the value creation efficiency of African banks from the perspective of IC is quite low compared to firms on other continents. This perhaps explains the level of development of the financial system in Africa relative to other regions. Nevertheless, the banking sector of Africa seems efficient in human capital than structural capital and capital employed. HC is dominant in issues of IC in banks. The resource-based view thus portends that IC is a key factor in creating competitive advantages and thus, could results in variances in performance and stability across firms, countries and continents. Based on the theory, the results suggest that the IC of most banks is not good and will make it challenging for banks in Africa to compete and collaborate with their counterparts in other jurisdictions like Asia, Europe and America in international business and finance.

On the nonlinearity of the relationship between ICP and BP; this study can also conclude that the relationship between ICP and NIM is nonlinear, i.e., a quadratic relationship (u-shaped) but that of RAROA is linear. ICP also has nonlinear relationships with bank risk/stability which are also u-shaped, and inverted u-shaped. Based on these complex relationships, there is an indication that IC detracts and improves the financial performance and stability of banks concurrently depending on how it is managed.

6.1 Implications for policy and practice

By using the data of banks in Africa, the findings have essential implications for developing countries. Guidelines on accounting and economic decisions by bank boards and regulatory bodies concerning IC and its effects on BP and stability in Africa are aided with some directions, alongside contributing to the area of study through further research directions.

Managers of banks must improve ICP using IC investments through recruitment and development among top management and employees; improvement of overall working conditions and culture; institution of improved information systems and internal controls; building networks of important stakeholders, among others. Initiatives from the regulatory bodies in relation to these are necessary periodically to make the banking sector robust in Africa. The central banks should continue to take actions toward developing accounting for banks' resources including IC.

By extension, a key component of IC, i.e., the human capital and its efficiency has been noted to dominate ICP with a significant influence on bank intermediation spreads and returns on assets in Africa. African banks have relatively high HCE but then it is clear in the study that in most instances the components of IC taken separately, have no significant influence on dimensions of performance and stability. By this, banks must invest in human capital vis-a-vis the structural capital to get higher ICP. For instance, there is an indication that managers of banks should not suppress resources that are proposed for employee training and development (see Alipour, 2012). The idea that human capital is not strictly owned by banks must be cautiously replaced with the one that, if banks do not train, develop employees, give them the appropriate incentives and the enabling structures; they can also stay and offer poor services that may be detrimental to the banks' financial performance and insolvency. The banking sector customarily dwells largely on personal services entrenched in trust. Relationship and sales executives of the banks undertake various drives especially in getting people to patronise their products. Bank managers are to put in place strategic policies in IC to manage and grow the businesses of their clients as part of the value creation activities to ensure good returns at lower risks for the banks. For instance, customer loyalty and trust, customer satisfaction and segmentation metrics should be improved by the management of banks to include issues of intangibles in the metrics based on new ways of value creation.

Additionally, beyond the linearity arguments espoused between IC and risk and return, the relationships between some risk and return and IC variables are nonlinear and bank boards should note that the relationship are not perennially linear. For instance, the results indicate that ICP and CEEs have nonlinear relationships with financial performance. The nonlinearity of the relationship between ICP and NIM indicates that initial levels of ICP (high) result in low NIM emphasising a decrease in interest income relative to interest paid. However, beyond a certain point of investment and performance in IC, increasing ICP also results in high performance in NIM.

Similarly, ICP and financial stability also have u-shaped and inverted u-shaped relationships. The latter implies that at initial levels of ICP, the insolvency risk of banks increases (i.e., good stability) but beyond a point, higher ICP may result in poor bank stability. Continuous investment and performance of IC lead to low financial performance and good stability but beyond a certain level of investments in ICP financial performance improves with stability gradually deteriorating. In other words, within a certain range, ICP may lead to low performance and good stability and beyond that, it may result in high performance and poor stability. Practitioners must thus understand that the relationship between IC and BP can be complex and nonlinear; and invests and control IC to achieve optimum financial performance and stability.

This research's contributions to the extant literature are in many dimensions as already enumerated though subject to some latent limitations. The findings of this research are generalisable but limited to the financial sector. Subsequently, there exists a need to undertake a cross-industry study comparing the regions or countries in Africa or the countries or a cross-continent study comparing banks in Africa to others in other continents. The data of several countries in Africa were collected. The political and economic systems in the countries may differ. Subsequently, corporate governance and financial reporting frameworks are generally different across the countries as used in this study a result of legislation/regulations by regulatory/supervisory bodies. As much as this study has recognised some differences, there could be inherent to combining the data of these countries in one analysis. Forthcoming research could introduce other variables and other robust estimation techniques that could iron out the differences in regulatory and macroeconomic environments across the regions and countries.

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Notes

1 With the lag of the dependent variable as part of the regressors in the estimations, it lessens considerably the problem of autocorrelation typically linked with time-series regression analysis (Busse and Hefeker, 2007).

2 In the estimation of the inflection points, this study adopts the formula of Lind and Mehlum (2010) which is specified as $x^{min} = -\theta_1 / 2\theta_2$.

3 A rule of thumb is that correlations among the independent variables between -0.80 and 0.80 do not distort the standard error of estimate and may not lead to inaccurate conclusions (see Gujarati, 1995; Hair et al., 1995).

4 With U-shaped relationship, a positive coefficient is expected for linear term while a negative is expected for the quadratic term. A reverse of the coefficients for both the linear and quadratic terms will result in an inverted U-shape. As a rule of thumb, negative values of the point of inflection reflect minimum function and a U-shaped relationship between variables of interest; while positive values reflect a maximum function and an inverted U-shaped relationship (Alhassan and Biekpe, 2017; Lind and Mehlum, 2010).

Appendix

Table A1 List of countries in Africa by regions and number of banks selected from each country (see online version for colours)

	Western	*Number of banks*		*Central*	*Number of banks*		*Eastern*	*Number of banks*		*Northern*	*Number of banks*		*Southern*	*Number of banks*
1	Benin	7	1	Cameroon	8	1	Burundi		1	Algeria	16	1	Angola	
2	Burkina Faso	9	2	Central African Republic		2	Comoros		2	Egypt		2	Botswana	12
3	Cape Verde		3	Chad		3	Djibouti		3	Libya		3	Lesotho	
4	Côte d'Ivoire	13	4	Congo		4	Eritrea		4	Mauritania	8	4	Malawi	13
5	Gambia		5	Democratic Republic of Congo		5	Ethiopia		5	Morocco	15	5	Mauritius	16
6	Ghana	25	6	Equatorial Guinea		6	Kenya		6	Tunisia	19	6	Mozambique	9
7	Guinea		7	Gabon		7	Rwanda	7				7	Namibia	7
8	Guinea-Bissau		8	Madagascar		8	Seychelles					8	São Tomé and Príncipe	
9	Liberia					9	Somalia					9	South Africa	23
10	Mali	9				10	Sudan	13				10	Swaziland	5
11	Niger					11	South Sudan					11	Zambia	21
12	Nigeria	26				12	Tanzania	31				12	Zimbabwe	14
13	Senegal	11				13	Uganda	15						
14	Sierra Leone	13												
15	Togo													
	Total	*113*			*8*			*67*			*58*			*120*