

The impact of sustainability disclosure on cost of capital: the role of intellectual capital as a moderator

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Abstract

This study investigates the impact of sustainability disclosure (measured by environmental disclosure, social disclosure and governance disclosure) on the cost of capital, proxied by cost of equity, cost of debt, and weighted average cost of capital (WACC), of listed manufacturing companies in Nigeria. It further explores the moderating role of intellectual capital within the agency and information asymmetry frameworks. Using a sample of 45 listed manufacturing firms over 2012–2025, the study employed descriptive statistics, correlation, and panel random effect regression analyses. Findings reveal that environmental disclosure has negative but significant effect on WACC of Nigerian manufacturing firms. This is the same relationship between environmental disclosure and cost of equity of Nigerian manufacturing firms. This implies that an increase in environmental disclosure, other independent variables remain constant there is decreases WACC and cost of equity. On the other hand, environmental disclosure is significant and positive with cost of debt in the listed Nigerian manufacturing firms. Indicating that any increase in the environmental disclosure will lead to increase in cost of debt of the listed Nigerian manufacturing firms. After moderation, Intellectual capital demonstrated a significant moderating effect on the link between sustainability disclosure and cost of capital. The study concludes that sustainability disclosure meaningfully impacts financing costs of Nigerian manufacturing companies and that intellectual capital further shapes this relationship. It recommends that firms should prioritize robust waste management and environmental risk disclosures in reports to capitalize on cost reductions. Collaborate with regulators for training on disclosure standards to sustain these benefits. Engage auditors for robust verification and seek green bonds to diversify funding away from traditional debt. Companies should also assess their intellectual capital.

Keywords: Sustainability Disclosure, Cost of Debt, Cost of equity, WACC

1. Introduction

Cost of capital is a fundamental concept in finance, representing the required return necessary to make an investment worthwhile. It is a critical determinant of capital budgeting decisions and, consequently, corporate valuation (Graham & Harvey, 2023). Firms must understand their cost of capital not only to assess investment opportunities but also to manage their performance and attract investors. Historically, the determinants of cost of capital have been largely financial metrics; however, in recent years, there has been a paradigm shift towards integrating sustainability into financial assessments. Sustainability, often defined through environmental, social, and governance (ESG) criteria, has gained

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traction among investors, prompting companies to disclose sustainability practices to build investor trust and alleviate perceived risks (Eccles et al., 2022).

As firms strategize to communicate their sustainability commitments, the question arises: does sustainability disclosure effectively influence a company's cost of capital? Furthermore, the influence of intellectual capital, encompassing knowledge, skills, and relationships, becomes vital as a moderating factor in this dynamic. This essay argues that sustainability disclosure can significantly lower a firm's cost of capital, and that intellectual capital plays a crucial moderating role in enhancing this relationship.

The integration of sustainability into corporate strategies is no longer optional but imperative. Research suggests that firms actively engaging in sustainability practices tend to attract a broader investor base due to decreased risk perceptions. For instance, a study by Grosse and Vafeas (2023) found that companies with high-quality sustainability disclosures tend to experience a reduction in their cost of equity capital by up to 112 basis points. This trend indicates that transparency regarding sustainability efforts effectively mitigates information asymmetries and perceived risks, resulting in a positive impact on capital costs.

Moreover, the rise of socially responsible investing (SRI) has further emphasized the relationship between sustainability disclosure and cost of capital. Investors are increasingly influenced by environmental, social, and governance considerations. According to a report by the Global Sustainable Investment Alliance (GSIA, 2023), sustainable investment strategies reached \$35.3 trillion in 2020, reflecting a 15% increase from 2018. This trend illustrates the shifting priorities of investors who are keen on ethical considerations alongside financial returns. Consequently, firms that emphasize sustainability and provide transparent disclosures are more likely to attract capital from these conscientiously driven investors, thus reducing their cost of capital.

Conversely, firms that downplay sustainability practices may face elevated costs of capital due to investor skepticism and heightened perceptions of risk. An empirical study by Dremptec et al. (2023) demonstrated that companies with poor sustainability disclosures often experience wider credit spreads, indicative of higher financing costs. This outcome suggests that inadequate transparency can damage credibility and deter investors, ultimately resulting in a more expensive cost of capital.

While the impact of sustainability disclosure on cost of capital is evident, the role of intellectual capital as a moderator deserves closer examination. Intellectual capital a blend of knowledge, innovative capabilities, and competencies—can enhance a firm's ability to effectively disclose and leverage sustainability practices, further driving investor engagement. This relationship is mediated through innovation, reputation, and stakeholder relations, which are intrinsic elements of intellectual capital.

Firstly, intellectual capital fosters innovation, enabling firms to develop sustainable practices that can lead to cost efficiency and reduce environmental impact (Deloitte, 2025). For example, technologies that emit fewer pollutants can lower regulatory compliance costs, translating into reduced capital expenditure. This innovation-driven approach enhances the sustainability narrative of a firm, reinforcing its market value and, consequently, decreasing the cost of capital.

Furthermore, firms with robust intellectual capital can craft compelling narratives around their sustainability initiatives, thereby enhancing their reputation. A strong brand reputation leads to increased customer loyalty and a more stable revenue base, which subsequently reduces perceptions of risk among investors (Chung et al., 2023). A reputation for sustainability efforts can directly influence investor behaviour, as many investors are inclined to lower the risk premium they demand for quality firms. Thus, through building a strong corporate reputation, firms can enjoy lower costs of capital, driven by both sustainability disclosures and intellectual capital.

Lastly, intellectual capital facilitates stakeholder engagement, a crucial aspect of sustainability. Firms that actively engage with their stakeholders—including investors, customers, and regulators—can better understand their expectations regarding sustainability practices. This insight enables companies to align their disclosures with stakeholder values, ultimately enhancing their credibility and trust (Edmans, 2023). By aligning with stakeholder expectations, firms can reduce perceived risks, leading to a more favourable cost of capital.

Empirical research supports the argument that the interaction between sustainability disclosure and intellectual capital significantly impacts a firm's cost of capital. For instance, a study by Jiraporn et al. (2023) demonstrated that firms with high levels of intellectual capital experienced a more substantial reduction in their cost of equity capital when they engaged in comprehensive sustainability disclosure. The researchers concluded that intellectual capital amplifies the impact of sustainability transparency, enabling firms to cultivate investor confidence and secure preferential financing conditions.

Moreover, a meta-analysis conducted by Arjaliès and Mundy (2023) reinforced these findings by showcasing a consistent pattern across various industries: companies that effectively communicated their sustainability commitments and demonstrated strong intellectual capital profiles consistently enjoyed lower costs of capital. This convergence of evidence underscores the importance of integrating intellectual capital into sustainability strategies to optimize financing conditions.

However, it is also essential to note that the effectiveness of sustainability disclosure and intellectual capital moderation can vary across industries. For example, industries with higher environmental or social sensitivities, such as oil and gas, may observe a more pronounced impact of sustainability practices on cost of capital due to higher stakeholder scrutiny (Lins et al., 2023). Understanding these nuances is vital for firms seeking to leverage sustainability disclosure in managing their financial metrics effectively.

The roots of Nigeria's manufacturing sector can be traced back to the pre-colonial and colonial periods. Traditionally, local craftsmanship was integral to the economy, with artisans producing textiles, pottery, and metalwork. However, the advent of British colonialism in the late 19th and early 20th centuries significantly altered the production landscape. Colonial policies prioritized the extraction of raw materials for export, leading to the neglect of local industries. As noted by Adeyemi (2024), "The colonial economy was structured to benefit the metropole, and this severely hampered the growth of indigenous manufacturing capabilities" Adeyemi further elaborate that post-independence in 1960 marked a turning point for the Nigerian manufacturing sector. The government sought to promote industrialization as part of its development agenda, particularly during the 1970s oil boom. The influx of oil revenue provided an unprecedented opportunity for investment in various sectors, including manufacturing. The Nigerian Enterprises Promotion Decree of 1972 aimed to increase local participation in the economy by encouraging domestic investment in manufacturing. Consequently, the establishment of industrial development agencies and the provision of incentives led to a surge in manufacturing initiatives, particularly in food processing, textiles, and chemicals.

In recent years, the Nigerian government has renewed its focus on the manufacturing sector, recognizing it as a critical driver for economic diversification and job creation. As of 2024, manufacturing contributes approximately 10% to the nation's GDP. (Nigerian Bureau of Statistics (2025) Key sectors include cement, food and beverages, textiles, and pharmaceuticals. Importantly, the Nigerian Government has launched initiatives such as the National Industrial Revolution Plan (NIRP) and the Economic Recovery and Growth Plan (ERGP) to stimulate manufacturing growth.

However, despite these efforts, numerous challenges persist. The World Bank (2025) highlighted that high cost of capital is one of the primary problems in the sector, inadequate infrastructure, particularly in transportation and energy, remains a primary barrier to the growth of manufacturing in Nigeria. Manufacturers frequently face erratic power supply, which hampers production efficiency and inflates operational costs. Nigeria's energy sector has struggled for decades, and the reliance on generators for power adds significant expense to manufacturing processes.

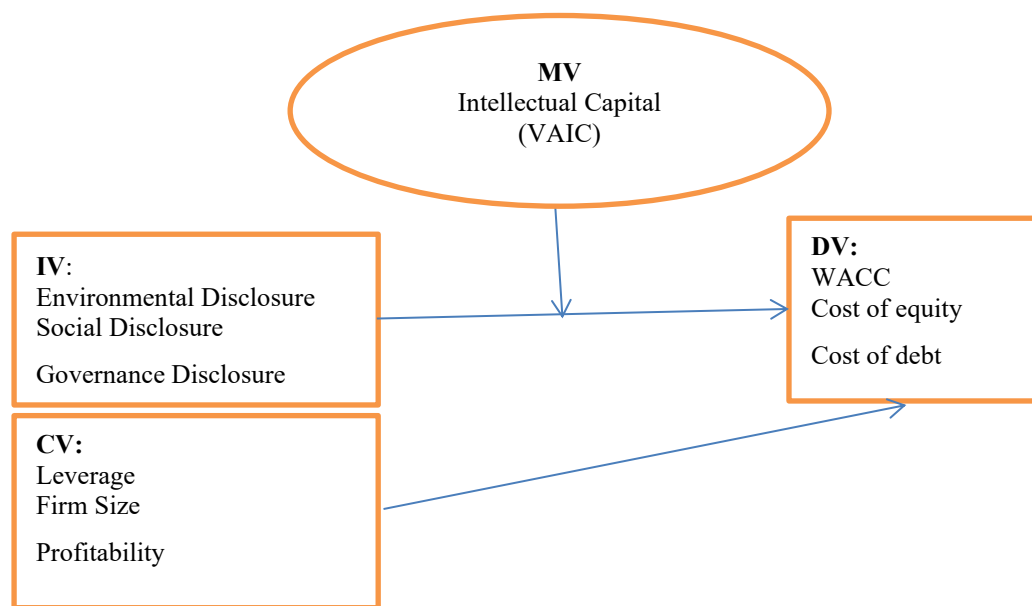
Therefore, this study seeks to examine the moderating effect of intellectual capital on the relationship between sustainability disclosure and the cost of capital of listed manufacturing firms in Nigeria. Specifically, it investigates (i) the impact environmental disclosure on the cost of capital (COE, COD, and WACC), (ii) the influence of social disclosure on the cost of capital, (iii) the impact of governance disclosure on cost of capital and (iii) the moderating role of intellectual capital cost of capital nexus. The study is anchored on agency theory and signalling theory, which provide insights into how governance mechanisms shape managerial incentives and external perceptions in the capital market (Fama & Jensen, 1983; Myers & Majluf, 1984).

2. Empirical literature

S/N	Authors	Country	Time period	Sample	Determinants	Sign	Sig. of Association
1	Patricial et al., (2025)	Brazil	2015 – 2021	19 G20 countries	Multivariate analysis, ordinary least square	+	Sig
2	Yunirieta (2025)	Indonesia	2019 – 2022	Non-financial companies	GMM	+ -	Sig, not sig
3	Ashfaq et al., (2025)	China	2014 – 2022	Energy industries	GMM	+	Sig
4	Bong & Jim (2025)	Korea	2015 – 2022	Korean listed companies	Ordinary least square	+ -	Sig
5	Darsono et al., (2025)	Indonesia	2020 – 2022	253 Indonesian firms	Partial least square	+ -	Sig
6	Ammar et al., (2024)	China	2010 – 2019	Chinese A listed companies	GMM	-	Sig
7	Luna (2024)	Italy	2015 – 2021	Banking sector	Ordinary least square	+ -	Sig
8	Yiming & Yufeng (2024)	China	2008 – 2019	Manufacturing sector	GGM	+ -	Sig
9	Pujiastuti et al., (2024)	Indonesia	2015 – 2022	Energy sector	GGM	-	Sig
10	Aliyu (2024)	Nigeria	2014 – 2023	Oil and gas sector	A pane-correlated standard errors regression	+	Sig
11	Amahulu et al., (2024)	Nigeria	2012-2022	Oil and gas sector	Panel least square	-	Sig
12	Diemtar & Florian (2024)	USA	2019-2021	Listed US 498 companies	Pearson correlation coefficient	- +	Sig
13	Ni Made et al., (2024)	Indonesia	2014-2021	Manufacturing companies	Multiple linear regression	+ -	Not sig, sig,
14	Pramesti et al., (2024)	Indonesia	2018-2022	Energy sector	Hierarch regression analysis	+ -	Not sig, sig,
15	Endar et al., (2024)	Indonesia and Malaysia	2015-2020	Registered Indonesian and Malaysian firms	GGM	+	Sig
16	Khayria et al., (2024)	Korea	2010-2019	1,659 listed European companies	Panae data least square	-	Sig
17	Tung et al., (2024)	Korea	2019 – 2021	Across the globe	GMM	+ -	Sig
18	ojaoYu & Qiang (2024)	China	2010-2020	Energy sector	GMM	-	Sig
19	Yizhou (2024)	China	2012-2022	A - listed companies	Ordinal least square	-	Sig
20	Yonglinan et al., (2024)	China	2015-2021	Energy sector	GMM	-	Sig

Source: Author draft.

Figure 1 Conceptual framework



Where: DV=Dependent Variables, IV= Independent Variables, MV= Moderating Variable and CV= Controlled Variables

3. Methodology

3.1. Research Design

This study adopts a descriptive and explanatory research design within the framework of the positivist paradigm. The descriptive design helps to provide a systematic and factual account of the sustainability disclosure, cost of capital, and intellectual capital among listed manufacturing firms in Nigeria. The explanatory aspect of the design enables the researcher to go beyond description and measure the relationships and interactions among variables. The positivist paradigm, which relies on an objective and empirical view of reality, aligns well with this quantitative research. It supports the use of observable data and systematic methodologies to explain the relationships under study.

3.2. Population of the Study

The population of the study consists of seventy-five (76) manufacturing companies listed on the Nigerian Exchange Group (NGX) as of December 31, 2025. These companies operate across eight sub-sectors of the Nigerian manufacturing industry: agriculture, conglomerates, construction, consumer goods, industrial goods, natural resources, oil and gas, and healthcare. These firms represent a broad base of the Nigerian industrial landscape, making the study's findings more generalizable across the manufacturing sector.

Table 3.1: Population of the Study as at 31st December 2024 (Manufacturing Firms)

S/No.	Sector	No of firms
1	Agricultural	6
2	Conglomerates	6
3	Consumer Goods	20
4	Construction	10
5	Industrial Goods	12
6	Healthcare	8
7	Oil and Gas	10
8	Natural Resources	4
9	Total	76

Source: Nigerian Exchange Group Website, December 2025

3.3. Sample Size and Sampling Technique

The study employed a purposive sampling technique, guided by a three-point filter to select firms that meet specific inclusion criteria. First, selected firms must have published financial statements for the entire study period (2012–2025). Second, only firms with complete data during the period are included. Third, the firm must have remained listed on the NGX throughout the study period without being delisted. As a result, 45 companies met the criteria and were retained in the final sample. This approach ensures the availability of reliable and consistent data over the study horizon.

Table 3.2: Working Population of the Study as at 31st December 2024 (Manufacturing Firms)

S/No.	Sector	No of firms
1	Agricultural	3
2	Conglomerates	5
3	Consumer Goods	17
4	Construction	1
4	Industrial Goods	6
5	Healthcare	4
6	Oil and Gas	5
7	Natural Resources	4
8	Total	45

Source: Generated from Table 1 by the Researcher 2026

3.4. Measurement of Variables

The study includes dependent, independent, moderating, and control variables. The dependent variable, cost of capital, is measured using three proxies: Cost of Debt (COD), Cost of Equity (COE), and Weighted Average Cost of Capital (WACC). COD is calculated as interest expense over average total debt; COE is derived using the Fama and French 3-factor model, and WACC is computed by averaging the costs of debt and equity capital. Sustainability disclosure checklist items were developed after a review of sustainability checklist used by previous disclosure studies. These includes the checklist used by: Yahaya (2025), in Nigeria; Patricial et al. (2025), in Brazil; Yuniricta (2025), in Indonesia; Ammar et al., (2024), in China; Luna (2024), in Italy; Diemtar & Florian (2024), in USA; and Okudo et al (2023), in Nigeria. The purpose of this review was to identify commonly used items in voluntary disclosure research. The check list developed was compared with the mandatory disclosure requirements in Nigeria in NGX sustainability guideline 2021 and S1 and S2 sustainability guideline 2023 including European sustainability guideline 2022 in order to ensure that sustainability disclosure items were not mistakenly included in the check list. Due to subjectivity inherent in weighted approach such as making a particular disclosure more important than the other, and on the assumption that all items are equally important and different users pay attention to different information, this study used unweighted approach in scoring the items i.e. scoring the item one if it is disclosed and zero if is not disclosed as used by (Yahaya 2025; Emmanuel & Ifeanyichukwu 2021; Ni Made 2024; and Libert et al

2021). The proxies for sustainability disclosure are Environmental Disclosure, Social Disclosure and Governance Disclosure. The moderating variable, intellectual capital, is captured through value added intellectual efficiency. In addition, the study controls for several firm-specific variables that may influence cost of capital, including firm size, leverage, and profitability.

3.5. Model Specification

To analyze the relationships among the study variables, the research applies Baron and Kenny's moderation framework, which involves three paths. First, the direct effect of tax avoidance on cost of capital (Path a) is estimated using multiple regression models. Second, the direct effect of intellectual capital on cost of capital (Path b) is assessed. Third, the study introduces interaction terms to capture the moderating effect of intellectual capital on the relationship between sustainability disclosure and cost of capital (Path c). Each of these paths is examined using separate regression models for each proxy of cost of capital (COE, COD, and WACC), resulting in a total of nine models. Based on the functional relationship and building on the empirical models of Goh et al. (2016) and Ghelichi et al. (2017), this study adopts a structured regression approach to examine the effect of sustainability disclosure on cost of capital and the moderating role of intellectual capital. Three modelling stages are applied, consistent with Baron and Kenny's (1986) moderation framework.

Path a estimate the direct effect of sustainability disclosure on the cost of capital:

$$COCit = \beta_0 + \beta_1 ENVit + \beta_2 BSOCit + \beta_3 GOVIt + \beta_4 PROFit + \beta_5 LEVIt + \beta_6 SIZEit + \mu it \dots\dots(i)$$

Path b captures the direct effect of ownership structure on cost of capital:

$$COCit = \beta_0 + \beta_1 ICit + \beta_2 PROFit + \beta_3 LEVIt + \beta_4 SIZEit + \mu it \dots\dots (ii)$$

Path c introduces the interaction between tax avoidance and ownership structure, to assess moderation:

$$COCit = \beta_0 + \beta_1 ENVit + \beta_2 SOCit + \beta_3 GOVIt + \beta_4 ICit + \beta_5 ENVIC + \beta_6 SOCIC + \beta_7 GOVIC + \beta_8 PROFit + \beta_9 LEVIt + \beta_{10} SIZEit + \mu it \dots\dots (iii)$$

Where:

COCit = Cost of capital; ENV = Environmental disclosure; SOC = Social disclosure; GOV = Governance disclosure; IC = Intellectual Capital; PROF = Profitability; LEVIt = Leverage; SIZEit = Firm size; AGEit = Firm age; μit = Error term; β = Coefficients.

Given that cost of capital is proxied by COE, COD, and WACC, models (i)–(iii) are adapted into: Models 1–3 (Direct effect on sustainability disclosure):

$$COEit / CODit / WACCit = \beta_0 + \beta_1 ENVit + \beta_2 BSOCit + \beta_3 GOVIt + \beta_4 PROFit + \beta_5 LEVIt + \beta_6 SIZEit + \mu it \dots\dots (1-3)$$

Models 4–6 introduce intellectual capital (IC) to assess its effect on cost of capital:

$$COEit / CODit / WACCit = \beta_0 + \beta_1 ICit + \beta_2 PROFit + \beta_3 LEVIt + \beta_4 SIZEit + \text{controls} + \mu it \dots\dots (4-6)$$

Models 7–9 test for moderating effects by incorporating interaction terms between sustainability disclosure measure and each intellectual capital proxy:

Model 7 (IC moderation):

$$COE/COD/WACCit = \beta_0 + \beta_1 ENVit + \beta_2 BSOCit + \beta_3 GOVIt + \beta_4 PROFit + \beta_5 LEVIt + \beta_6 SIZEit + \text{controls} + \mu it$$

Each model includes firm-specific control variables (PROF, LEV, SIZE), and panel regression techniques are applied across 45 listed Nigerian manufacturing firms between 2012 and 2025.

3.6. Estimation Techniques

The study employs a variety of quantitative analysis techniques. First, descriptive statistics are used to summarize the variables using mean, median, standard deviation, minimum, and maximum values. Next, a correlation analysis is conducted to identify the nature and strength of relationships between variables and to detect potential multicollinearity. Finally, multiple regression analysis is employed using panel data methodology, which is suitable given the data's cross-sectional and time-series structure. This method allows for an in-depth examination of the direct, indirect, and moderating effects among the study's variables. The statistical significance of the regression coefficients is evaluated using t-statistics and p-values, which guide hypothesis testing and interpretation of results.

4. Result Analysis

4.1. Descriptive Statistics

The study adopts a structured empirical framework to examine the relationship between tax avoidance and cost of capital, and the moderating effect of ownership structure. The modeling approach draws on the work of Goh et al. (2016) and Ghelichi et al. (2017), using a three-step regression path to test direct and interaction effects. The models are structured following Baron and Kenny's (1986) approach to moderation analysis.

The first model (Path a) assesses the direct impact of sustainability disclosure on the cost of capital using three proxies: Environmental disclosure (ENV), Social disclosure (SOC), and Governance disclosure (GOV). The second model (Path b) evaluates the direct effect of intellectual capital on the cost of capital, while the third model (Path c) introduces interaction terms to determine whether intellectual capital moderates the relationship between sustainability disclosure and cost of capital. Key control variables across all models include firm profitability (ROA), leverage (LEV and size).

Table 4.1 Descriptive Statistics

Variables	Obs	Mean	Std dev	Min	Max
WACC	630	.1409075	.034716	.0713	.2023
COE	630	.0709214	.0252121	.021	.107
COD	630	.0701197	.0253783	.0152	.121
ENV	630	.0694079	.075914	.0023	.439
SOC	630	.7559524	.1334701	.5	.1
GOV	630	.7084127	.0999635	.6	.9
LEV	630	.738215	.3011612	.00238	1.45
PROF	630	-.0446575	.2497258	-.804	.199
SIZE	630	15.31804	.6121165	13.99403	16.39949

Source: STATA Outputs Based on Data Generated (2026)

Table 4.1 shows the mean of cost of equity of the sample manufacturing firms as 0.071 meaning that on the average 7% of the cost of equity. The minimum is 0.1 which represent 1% with 11% maximum. This indicate that the cost of equity finance in the manufacturing firms is moderately disperse around the mean with standard deviation of 7%. On the cost of debt, the mean is 0.071 which represent 7% of the cost of debt finance in the manufacturing firms with minimum of 0.015 and maximum of .12 representing 2% and 12% respectively. The standard deviation is 3% indicating no diverse cost of debt in the Nigerian manufacturing firms. With minimum of 0.02% and maximum of 44%, environmental disclosure, mean of 0.7% and standard deviation of 8% there is no substantial variation of environmental disclosure of samples companies. Social disclosure accounted for a mean of .75 indicating and average of 75% social disclosure. The minimum is 50% with a maximum of 100% with standard deviation of 13% indicating a high means suggest robust social transparency in the sampled Nigerian manufacturing firms. The mean of 70% represent governance disclosure with a minimum of 60% and maximum of 90% governance disclosure with standard deviation of 10% indicating that governance disclosure has a substantial variation in sampled manufacturing firms the high minimum of 60% reflects no weak

performers, and the maximum (90%) highlighted strong but not perfect compliance across sampled firms. On the leverage, the mean accounted for 73% indicates firms fund most assets via debt, typical for capital intensive manufacturing firms, with a minimum and maximum of 0.02 % and 100% respectively with a 30% standard deviation. This is an indication of variability in financing strategies with over 100% maximum showing some over leverage cases exceeding assets. Profitability was represented by a mean of -4% with minimum and maximum of -80% and 20% respectively having a standard deviation of 25%. The negative means signals overall losses across sampled firms. The minimum -80% highlights deep underperformer while the maximum of 20% show modest profit. This is an indication that there is substantial variation of profitability of the sampled firms. Size, measured by the natural logarithm of total assets has a mean of 15.31, with minimum and maximum of 13.99 and 16.39 respectively but the standard deviation of 0.61 suggests a considerable level of dispersion in size during the sampled period.

Table 4.2 Correlation Analysis

Variable	wacc	Coe	cod	Env	Soc	gov	Lev	prof	Size	Vif
Wacc	1									
Coe	-0.3211	1								
cod	0.3421	-0.0641	1							
Env	-0.1212	-0.2310	0.1190	1						1.04
Soc	-0.4321	0.1269	-0.0744	0.1469	1					1.12
Gov	0.1232	-0.2576	-0.1228	-0.0722	-0.1586	1				1.69
Lev	0.2143	0.0715	-0.1015	-0.0828	0.0677	0.1853	1			1.20
Prof	-0.2131	0.4594	-0.1415	-0.0426	-0.1128	-0.5392	-0.0462	1		2.15
Size	-0.4211	-0.4519	0.1187	0.0136	0.1661	0.1426	0.2607	-0.5136	1	1.60

Source: Generated by the Author from the Annual Report and Account of Manufacturing Firms

Table 4.2 shows the correlation coefficients on the relationship between the dependent variables (WACC, COE and COD) and independent variables (environment, social, governance, leverage, profitability and firm size). The values of the correlation coefficient range from -1 to 1. The sign of the correlation coefficient indicates the direction of the relationship (positive or negative), the absolute values of the correlation coefficient indicate the strength, with larger values indicating stronger relationships. The correlation coefficients on the main diagonal are 1.0, because each variable has a perfect positive linear relationship with itself. The correlation between WACC and coe, environmental disclosure, social disclosure, profitability and size were all negative and weak having -0.321, -0.1212, -0.4321, -0.2131 and -0.4211 respectively but the relationship between WACC and other variables were positive. As shown in table 4.2, the correlation coefficient for cost of equity and cost debt, environmental disclosure, governance disclosure, and firm size were negatives and weak with -0.0641, -0.2310, -0.2357 and -0.4519 respectively. But the remaining variables with cost of equity were positive and moderate. On the cost of debt, there were negative and weak relationship between it and social disclosure, governance disclosure, leverage and profitability with -0.07441, -0.1228, and -0.1015. Similarly, environmental disclosure with social disclosure, governance and leverage were negative and weak with -0.0722, 0.0828 and -0.0426 respectively. The reaming correlation coefficients between environmental disclosure and other variables were positive. The coefficient between social disclosure with governance disclosure and profitability were -0.1585, and -0.1128 respectively indicating negative and week. The correlation results presented in table 4.2 also indicate that all the explanatory variables correlated with the explained variable. Thus, there is a negative but strong relationship between governance disclosure and profitability with -0.5392, profitability and size with -0.5136 both are strong in the Nigerian manufacturing. All the explanatory variables are positively related to the explained variable except cod with social disclosure, governance disclosure, leverage and profitability were all negative and weak with coefficients of -0.0744, -0.1228, -0.1015, and -0.1455 respectively. Similarly, all the other explanatory variables are positively related between themselves. Collinearity which is a situation where two of the independent variables are related, and multicollinearity an instance where more than two of the independent variables or predictors are correlated implies interdependence among

the predictors or independent variables and if high in magnitude, adversely affects the predictive ability of the independent variables. To determine the presence of collinearity problem, a Variance Inflation Factor (VIF) test was carried out, the results of which provide evidence of the absence of collinearity. This is because the results of the VIF test ranges from a minimum of 1.04 to a maximum of 2.15. VIF of 5.00 can still be a proof of absence of collinearity (Baba et al., 2025; Yahaya 2025; and Hamida & Zahrah 2025). Hence, the predictive ability of the independent variables is not adversely affected by the relationship.

Similarly, Table 4.3 presents the correlation between the dependent (cost of debt) and independent variables. The correlation matrix and the VIF is presented below.

Table 4.3 Diagnostic Test Results

Test		p – value	p - value	p – value
Mean vif	1.47			
Pesaran’s Test		.121321	.10432	.112134
Hottest		.13111	12111	.10123
Hausman Test		0.2314	0.0765	0.0896
Brausch Pagan LM Test		0.000	0.000	0.000

Source: STATA 14.0 outputs based on data generated (2012-2025)

The diagnostic and specification test results provide insights into the reliability and suitability of the regression models used in the study. Firstly, the Mean Variance Inflation Factor (VIF) of 1.47 suggests there is no multicollinearity problem among the independent variables, as it falls well below the threshold of 5. This indicates that the variables used in the models are not highly correlated and the estimations are stable.

The Heteroskedasticity Test (Hetttest) shows results across the models. Model 1 has a p-value of 0.13111, suggesting the absence of heteroskedasticity (constant variance of error terms). Likewise, Models 2 and 3 have p-values of .12111, and .10123 indicating the absence of heteroskedasticity. The Pesaran’s Test for cross-sectional dependence shows p-values of 0.12132, .10432, and .112134 across the models, all of which are above the conventional significance level of 0.05. This indicates that there is no significant cross-sectional dependence in the panels, meaning the residuals are not correlated across entities. The Hausman Test, used to determine whether to use fixed or random effects, returns a significant p-value (0.2314) for Model 1, indicating that the random effects model is more appropriate. In the same vein, for Models 2 and 3, the p-values are 0.0765 and 0.0896, which suggest that the random effects model may be preferable in these cases, especially for Model 3. Lastly, the Breusch-Pagan Lagrange Multiplier (LM) Test, used to decide between pooled OLS and random effects, gives significant p-values (0.0000) for Models 1, 2 and 3. This confirms that the random effects model is more suitable than pooled OLS for these models.

$$COE_{it} / COD_{it} / WACC_{it} = \beta_0 + \beta_1 ENV_{it} + \beta_2 BSOC_{it} + \beta_3 GOV_{it} + \beta_4 PROF_{it} + \beta_5 LEV_{it} + \beta_6 SIZE_{it} + \mu_{it} \dots\dots (1-3)$$

Table 4.4 Regression for part A

variables	Model 1 (WACC)		Model 2 (COE)		Model 3 (COD)	
	z- value	Std Error	z- value	Std Error	z- value	Std Error
Constant	9.26***	.0445	11.63***	.02666	3.08***	.033129
Env	-2.91**	.01729	-7.75***	.010361	2.20***	.012873
Soc	0.99	.01027	6.96***	.006154	-4.23***	.007646
Gov	-6.00***	.01676	-2.58***	.01004	-5.91***	.012476
lev	1.92**	.00469	4.88***	.002813	-1.22	.003495
Prof	-0.81	.00756	5.08***	.004531	-5.15***	.005630
Size	-5.16***	.00267	-10.44	.00160	1.47	.001989
R Squared	14		43		11	
Wald chi2 (6)	101.34		441.33		75.58	
Prob>chi2	0.000		0.000		0.000	

Source: Generated by the Author from Annual Reports and Accounts Data of Manufacturing firms ***, ** and * indicate 1% and 5% and 10% significant levels respectively

Table 4.4 presents the regression results of the dependent variables (WACC), (COE), (COD) and the independent variables of the study (environmental disclosure, social disclosure, governance disclosure, leverage, profitability, and firm size) in direct relationship. In order to examine whether endogeneity exist, which could potentially lead to biased coefficient, a Hausman specification test to make the choice between Fixed Effect (FE) and Random Effect (RE) regression was performed. This test is necessary considering that there is a trade-off between the efficiency of the random effect and the consistency of the fixed approach. The test also determines whether the estimates of the coefficients, taken as a group, are significantly different in the two regressions. If any variables are dropped in the fixed effects regression, they are excluded from the test. Table 4.4 presents the regression results of model 1, 2 and model 3, discussion is done on RE in model 1, 2 and 3 RE in estimations. This is due to the fact that the Hausman test reveal that the RE is more efficient in model three models respectively

The regression results reveal the cumulative R2 (0.14) in model 1, (0.43) in model 2 and (0.11) in model 3, which is the multiple coefficient of determination gives the proportion or percentage of the total variation in the dependent variable explained by the explanatory variables jointly. Hence, it signifies 14%, 43% and 11% of total variation in WACC, cost of equity and cost of debt in the Nigerian listed manufacturing firms is caused by their environmental disclosure, social disclosure, governance disclosure, leverage, profitability, and firm size of the firms. This indicates that the models are fit and the explanatory variable are properly selected, combined and used as substantial value cost of capital is accounted for by the explanatory variables. This can be confirmed by the value of F- statistics of 0.00% at 5% and 0.00% at 5% levels of significance. Hence, the finding of the study is relied upon.

In RE estimations, the regression result in table 4.3 for model 1 reveals that environmental disclosure has negative but significant effect at 1% level, on WACC of Nigerian manufacturing firms. This is the same relationship between environmental disclosure and cost of equity of Nigerian manufacturing firms. This implies that an increase in environmental disclosure, other independent variables remain constant there is decreases WACC and cost of equity. This is consistent with the results of Alissa & Jaber (2021), Harrison et al., (2023), Mohd et.al. (2023), Chen at al. (2023), Almeida et al. (2025), Li et al (2023), Bassen et al. (2023) and Mordy's (2023) who found that firms with comprehensive environmental disclosures can expect reduced costs of capital. In addition, the findings support Linus et al., (2025) who documented a negative but significant relationship between environmental disclosure and cost of capital role in the Nigerian manufacturing firms. This means that environmental disclosure has an impact on the WACC and on the cost of equity. Expectedly, the findings suggest that increased environmental disclosure reduces the implied WACC and cost of equity capital by providing comprehensive insight into strategy, risks, and oversight practices, which eases risk estimation for capital providers. The result is not in tandem with the results of Huu and Hien (2025); Hmidah & Zahroh (2025); Chenxin (2025); and Dorathy et al (2024), who argued that higher environmental disclosure may not necessary reduces the level of information between the capital providers and the firms and

lower the risk that fund providers need to bear, thereby increasing the cost of capital. The study also aligned with signaling theory, where more information signals lower firm risk, prompting investors to accept lower returns. On the other hand, in model 3, environmental disclosure is significant and positive with cost of debt in the listed Nigerian manufacturing firms. Indicating that any increase in the environmental disclosure will lead to increase in cost of debt of the listed Nigerian manufacturing firms. This is line with the result of Yen et al. (2023), Jesan and Mio (2022), El Ghoul et al. (2022) and Musa and Mamman (2023). This finding suggests creators perceived increased environmental disclosure as a signal of higher underlying environmental risks, liabilities, or compliance costs, prompting creditors to demand higher interest rates to compensate for perceived default risks

Looking at the relationship between social disclosure and cost of capital, this study documented a positive relationship with WACC and cost of equity but negatively inclined with cost of debt. The relationship is significant at 1% level of significance estimate. This implies that an increase in the social disclosure will leads to increase in WACC and cost of equity. The result is in support of the work of Bon & Jim (2025) Singh et al. (2024), Ofori & Mensah (2024) who documented positive and significant relationship between social disclosure and cost of capital. The findings extend to that of Muttakin et al. (2021) who documented a positive interaction between social disclosure score and cost of capital in Malaysian firms. Further concludes that investors could view greater social disclosure as revealing higher business risks or future cash flow volatility from social commitments, prompting demands for higher returns. On the relationship between social disclosure and cost debt which was documented as significant but negative inclined at 1%. This indicates that higher levels of social disclosure are associated with lower debt financing costs for listed Nigerian manufacturing firms. The result supports the study of Afonsi (2021), Gendron et al. (2023), Gursoy et al. (2022), Martines-Sanchez (2024), and Guah et al. (2022) whose studies align with information asymmetry and signaling theories, where detailed social disclosures (e.g., on labour practices, community enjoyment, human rights) reduce lenders' perceived risks by providing transparency into non-financial performance. The result is not in line with the study of Kim et al. (2023), Liu and Zhao (2023), and Ramirez (2022) who documented insignificant results in their studies.

The relationship between governance disclosure and WACCC, cost of equity and cost of debt is negative and significant at 1% significance levels respectively. This suggests as governance disclosure increases, (e.g., board independence, audit details, or ownership transparency), WACCC, cost of equity and cost of debt decreases. This reflects reduced information asymmetry and agency risks, where disclosures signal oversight, lowering perceived default or operational risk. The finding is in support of results by Alissa and Jaber (2021), Harrison et al. (2023), Mutakin et al. (2021), Rahaman et al. (2023), Chen et al. (2025) and Lins et al. (2025).

On the control variables, leverage is positive and significant with cost of equity while it is negative with cost of debt but insignificant. This finding aligns with financial theory, particularly Modigliani-Miller Proposition II (with or without taxes), where leverage amplifies equity risk due to fixed debt obligations, rising the equity beta and thus the cost of equity. Empirically, it suggests investors perceive levered to compensate for potential financial distress or volatility in earnings available to shareholders. On the profitability, the relationships between cost of equity and cost of debt, they are significantly positive and negative at 1% significance levels. This is an indication that any unit increase in the profitability by 1% cost of equity will rise confirming a reliable direct relationship. According to Yahaya (2025) in finance research, such study in Nigerian manufacturing firms, it suggests profitable companies face or demand higher equity costs, possibly due to growth opportunities or risk premiums investors require. On the side of negative relationship with cost of debt, the negative sign indicates the more profitable firms pay lower interest rates on their debt, conditional on all other control variables in the regression. This statically significance implies that this inverse relationship is robust enough in the study sample to treat it as systematic pattern, not just sampling noise. Finally, on the control variable firm size significant but negative with cost of equity but positively incline with cost of debt but insignificant. A negative and significant coefficient on firm size in a cost of equity regression indicates that larger firm have lower required equity returns, aligning with established finance theory like the premium in assets pricing models. This relationship suggests larger firms' benefits from lower perceived risks due to greater

diversification, economies of scale, and better access to information, reducing investors' required returns.

$$\text{COEit} / \text{CODit} / \text{WACCit} = \beta_0 + \beta_1 \text{ICit} + \beta_2 \text{PROFit} + \beta_3 \text{LEVit} + \beta_4 \text{SIZEit} + \text{controls} + \mu_{it} \dots (4-6)$$

Table 4.5 Regression for part B

variables	Model 4 (WACC)		Model 5 (COE)		Model 6 (COD)	
	z- value	Std Error	z- value	Std Error	z- value	Std Error
Constant	9.84***	.04461	12.43***	.026558	3.22***	.033552
Ic	-3.77***	.01942	-4.74***	.011565	-1.16	.014611
Env	-3.38***	.01724	-8.40***	.010262	2.05***	.01296
Soc	1.30	.01014	7.44***	.00607	-4.12***	.007669
Gov	-3.87***	.01834	-0.45	.010918	-4.85***	.013793
lev	2.09***	.00461	5.14***	.00276	-1.18	.003496
Prof	-0.48	.007514	5.56***	.004473	-5.03***	.00565
Size	-5.00***	.00264	-10.33	.001576	1.53	.00199
R Squared	16		45		12	
Wald chi2 (7)	117.68		478.99		76.97	
Prob>chi2	0.000		0.000		0.000	

Source: Generated by the Author from Annual Reports and Accounts Data of Manufacturing firms ***, ** and * indicate 1% and 5% and 10% significant levels respectively

Table 4.4 presents the direct effect of the moderator, intellectual capital (IC) on cost of capital (WACC, COE and COD) of listed manufacturing firms in Nigeria using Panel random effect regression.

Table 4.4 reveals that incorporating intellectual capital into the model improves its explanatory power. The R² values increased from 14 to 16 (WACC), 43 to 45 for cost of equity (COE), and from 11 to 12 for cost of debt (COD). This indicates that intellectual capital enhances the model's ability to predict changes in cost of capital. Further IC introduction improved the direction of relationship between governance disclosure and COE and COD to negative and significant at 1%. Regarding intellectual capital variable, (IC) has a negative and significant relationship with WACC, COE and COD at 1%, 1% and 14% level of significance. This shows a strong positive and significant effect on WACC, COE and COD (0.00, and 0.88 p = 0.000 and 0.38). This suggests that intellectual capital reduced both cost of equity and cost of debt in the Nigerian listed manufacturing firm. This is in consistent with signalling and information asymmetry theories in finance. The introduction of IC strengthens all the results obtained from models 1, 2 and model 3.

$$\text{COE/COD/WACCit} = \beta_0 + \beta_1 \text{ENVit} + \beta_2 \text{BSOCit} + \beta_3 \text{GOVit} + \beta_4 \text{PROFit} + \beta_5 \text{LEVit} + \beta_6 \text{SIZEit} + \text{controls} + \mu_{it}$$

Table 4.6 Regression for part C

variables	Model 7 (WACC)		Model 8 (COE)		Model 9 (COD)	
	z- value	Std Error	z- value	Std Error	z- value	Std Error
Constant	0.25	.13268	1.07	.07991	-0.45	.10178
Ic	3.04***	.17808	2.90***	.10729	1.62*	.13661
Env	1.88*	.39943	0.37	.24066	2.48***	.306417
Soc	-4.24***	.13403	-2.58***	.08075	-3.72***	.102818
Gov	6.03***	.20886	5.65***	.12584	3.46***	.160227
Envic	-2.03***	.53046	-0.74	.31960	-2.48***	.406936
Socic	4.44***	.17520	3.22***	.10556	3.48***	.134403
Govic	-6.42***	.25533	-5.73***	.15384	-3.90***	.195876
lev	2.07***	.00454	5.06***	.00273	-1.14	.00348
Prof	-3.03	.00794	2.94***	.00478	-6.27***	.00609
Size	-7.35***	.00288	-11.86***	.00171	-0.27	.002212
R Squared	23		48		15	
Wald chi2 (10)	179.16		540.65		105.80	
Prob>chi2	0.000		0.000		0.000	

Source: Generated by the Author from Annual Reports and Accounts Data of Manufacturing firms ***, ** and * indicate 1% and 5% and 10% significant levels respectively

From model 4.6 it shows the moderating variable with other variables on how it influences the result.

In research, a moderator variable affects the strength, direction or existence of relationship between an independent variables and the dependent variable. The possible results of a moderator effect are strengthening, weakening or reversing/changing that relationship. (Sudduth et al.,2022)

The moderator enhances the independent and dependent variables, making the association stronger at certain levels of the moderator. The moderator reduces the relationship's strength, diminishing the impact of the independent variable on the under specific moderator conditions. The moderator reverses or alters the direction of the relationship, potentially turning a positive association negative or vice versa.

The panel data regression results in Table 4.6 show that the models for WACC, COE, and COD are statistically significant at 1%, with Prob > F and Wald Chi² values of 0.000, and 114.83 respectively confirming model fitness. The interaction between environmental disclosure (ENV) reveals a positive but insignificant impact on COE, and a positive and significant impact on COD This suggests that intellectual capital significantly moderate the relationship between sustainability disclosure and cost of capital (COD) in listed Nigerian manufacturing firms. The interaction between social disclosure and cost of equity is negative but significant and 1% likewise its relationship with COD. The governance disclosure with cost of equity is significant and positively incline, the same applies to governance disclosure and COD. The interaction term (ENV*.IC) shows a negative and significant effect on COE and EOD reversing the direction of the relationship with EOD in model 2 but strengthening the result of COE in model 1 This effect aligns with Fairchild and Mackinnon (2009), who noted that moderation may alter strength or direction of relationships. Similarly, SOC*.IC is statistically significance and positively inclined with COE and COD and 1% significant, but GOV*.IC is negative but significant at 1% on both COE and COD. This is an indication that intellectual capital moderates the relationship between sustainability disclosure and cost of capital in the Nigerian listed manufacturing sector which is in line with the work of Asrifa and Arbawal, (2025) therefore, the study refused to accept the hypothesis four (Ho4) Therefore, intellectual capital significantly moderate cost capital in the listed manufacturing firms in Nigeria.

5. Conclusions

This study explored the relationship between sustainability disclosure and the cost of capital, with a focus on how intellectual capital moderates this relationship in listed Nigerian manufacturing firms between 2012 and 2025. The cost of capital was assessed through three key proxies: cost of equity (COE), cost of debt (COD), and weighted average cost of capital (WACC), while sustainability disclosure was measured using environmental disclosure index, social disclosure index and governance disclosure index. Intellectual structure was examined through value added intellectual efficiency. The findings indicate that sustainability disclosure significantly affects the cost of capital. Specifically, environmental disclosure negatively and significantly influences COE and WACC, suggesting that firms with lower cost of capital was influence by environmental disclosure. However, environmental disclosure positively affects COD, implying that debt providers respond to environmental issues with higher interest demands due to increased risk perception.

Regarding the direct influence intellectual capital shows a significant effect on COE, COD, or WACC. implying that higher intellectual capital may reduce borrowing costs, potentially due to information asymmetric from creditors. In terms of moderating effects, intellectual capital institutional does significantly moderate the relationship sustainability disclosure and cost of capital. This suggests that intellectual capital in the Nigerian exercise sufficient oversight to influence capital market responses to cost of capital.

Based on these findings, several recommendations are proposed. First, listed manufacturing firms should prioritize robust waste management and environmental risk disclosures in reports to capitalize on cost reductions. Collaborate with regulators for training on disclosure standards to sustain these benefits. Engage auditors for robust verification and seek green bonds to diversify funding away from traditional debt.

Listed manufacturing firms should strategically disclose social achievements like employee welfare successes while minimizing cost-heavy details, using integrated reporting for balanced narratives. Pursue hybrid financing, such as green equity funds, and invest in disclosure training to optimize reporting efficacy. Listed manufacturing firms should expand social disclosures on employee training and philanthropy in annual reports, quantifying impacts to maximize debt cost savings.

Listed manufacturing firms should prioritize detailed disclosures on board composition, independence, and audit effectiveness in annual reports to sustain cost advantages Invoke upper echelons theory by ensuring top executives drive governance narratives, aligning them with capital market expectations. Manufacturing managers could prioritize intellectual capital alongside sustainability reporting to optimize capital costs.

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