

Carbon emission disclosure and firm value of carbon-intensive firms: The moderating role of external assurance

Divulgação de emissões de carbono e valor empresarial de empresas intensivas em carbono: O papel moderador da garantia externa

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Received 18/08/2024 Accepted 12/12/2024.

ISSN: 2594-8040

To cite this paper: Issa, S.O., Ubandawaki, A.T., Akande, A. & Alabi, A.T. (2024). Carbon emission disclosure and firm value of carbon-intensive firms: The moderating role of external assurance. *Journal of Perspectives in Management – JPM*, 4, e263970. <https://doi.org/10.51359/2594-8040.2024.263970>

Abstract: *The expansion of global economic activities by firms has raised increasing concerns over unsustainable energy consumption, which is contributing to global carbon emissions and posing a significant threat to the planet's climate and environment. This has led to intensive growth in investor pressure for carbon emission mitigation and disclosure. The purpose of this study is to investigate the relationship between carbon disclosure and firm value as well as examining the moderating role of external assurance on both constructs. The data used were extracted from annual/stand-alone sustainability reports of carbon-intensive firms in Nigeria. Using Generalized Least Square regression analysis on 370 firm-year observations, this study finds that external assurance has a significant moderating role in increasing the effect of carbon disclosure on firm value. Carbon disclosure and external assurance also have a direct positive impact on firm value. The study*

recommends integrating carbon information into regulatory requirements and setting mandatory standards for sustainability assurance practices.

Keywords: *Carbon Emission Disclosure; Firm Value; External Assurance.*

Resumo: *A expansão das atividades econômicas globais por empresas tem levantado preocupações crescentes sobre o consumo insustentável de energia, que está contribuindo para as emissões globais de carbono e representando uma ameaça significativa ao clima e ao meio ambiente do planeta. Isso levou a um crescimento intensivo na pressão dos investidores para mitigação e divulgação de emissões de carbono. O objetivo deste estudo é investigar a relação entre a divulgação de carbono e o valor da empresa, bem como examinar o papel moderador da garantia externa em ambos os construtos. Os dados usados foram extraídos de relatórios de sustentabilidade anuais/independentes de empresas intensivas em carbono na Nigéria. Usando a análise de regressão de mínimos quadrados generalizados em 370 observações empresa/ano, este estudo conclui que a garantia externa tem um papel moderador significativo no aumento do efeito da divulgação de carbono no valor da empresa. A divulgação de carbono e a garantia externa também têm um impacto positivo direto no valor da empresa. O estudo recomenda integrar informações de carbono em requisitos regulatórios e definir padrões obrigatórios para práticas de garantia de sustentabilidade.*

Palavras-Chave: *Divulgação de Emissões de Carbono; Valor da Empresa; Garantia Externa*

1. Introduction

Corporations' expansion of global economic activities has raised concerns over unsustainable energy consumption worldwide, which has contributed to global carbon emissions and poses a significant threat to the planet's climate and other ecosystems. Greenhouse Gases (GHG), like Carbon dioxide (CO₂), have been generally linked to many of the climate change challenges and threats the world is facing.

In response to these pressures, companies around the world have started disclosing their carbon footprints and the intervention role in mitigating the adverse impact of their operations on the environment, which are reported to have grown in recent years, especially in developed countries (KPMG, 2022). Carbon emissions are key organizational activities birthed by energy consumption from unclean sources; therefore, carbon emission disclosure represents an essential pillar of sustainability reporting which further provides an insight into the efforts and strategies of an organization towards sustainable practices. Due to its importance, carbon emission reporting has been included the notable international sustainability reporting frameworks such as Global Reporting Initiative (GRI), and Carbon Disclosure Project (CDP).

The increasing attention given to climate change threats has made it one of the top global priorities today, leading to different adaptation and mitigation strategies being developed at country, corporate, and individual levels. In response, many initiatives and agendas have emerged to promote sustainable development goals and the transition to cleaner energy. International initiatives like the Kyoto Protocol and the Paris Agreement show that the world is greatly concerned about climate change risks.

Shareholders and other stakeholders have also realized that mere financials do not reveal the intrinsic performance of a company, and they are now interested in non-financial results more than ever before. Issues of global concern of this magnitude are not strange to evolve into strategies for competitive advantage. To address these concerns, corporate disclosure of carbon emissions has become increasingly encouraged. Since organizations are now making an effort to satisfy their stakeholders and communicate their carbon emissions, it is imperative to understand the impact of this communication on corporate value.

Nigeria, among others, has been identified as one of the countries with a high degree of environmental issues that contributes significantly to global environmental problems. According to the 2022 World Bank Global Gas Flaring Tracker Report, Nigeria is the world's ninth highest gas flaring nation. In addition, the IEA Global Methane Tracker 2022 ranked Nigeria ninth among the top ten emitters of methane in the world. In addition, total CO₂ emission in Nigeria has increase by 214.04% from 1990 to 2020 (EIA, 2020). Many of these environmental challenges arise because of companies' actions and activities aimed at meeting their financial obligations. These low scores have led to intensive growth in investors demand and agitations for carbon emission mitigation and disclosure. In 2021, Nigeria enacted The Climate Change Act, which also emphasize reporting of climate change action.

Several studies have been conducted to investigate the link between carbon disclosure and firm value. However, different results have been reported in the literature, and there is a lack of consensus on the relationship between the two constructs. Considering this, this study considered the need for moderation. To address the issue of inconsistent findings, this study used external assurance to moderate the relationship between carbon disclosure and firm value. External assurance is considered in this study because it has the potential to improve the confidence of diverse stakeholder's group in the environmental information disclosed, thereby facilitating informed decision making. (GRI, 2013). Baalouch (2019) also assert that assurance affects corporate environmental accountability. Similarly, GRI (2013) emphasizes the significance of assurance for environmental reporting, emphasizing its role in enhancing trust, and credibility among stakeholders.

Moreover, Sub-Saharan Africa, generally, needs more attention when investigating carbon disclosure and firm value. Our study focused on Nigeria, the largest economy in the region, providing an answer to how carbon disclosure by Nigerian firms affects their value. Furthermore, this study adds to the literature by investigating the capital market benefits associated with disclosing carbon-related information and its assurance practices by focusing on carbon intensive industries in an emerging nation. This study effectively addresses gaps in the current literature by providing novel insights and empirical evidence regarding the role of external assurance in the relationship between carbon disclosure and firm value which has not been empirically explored in previous literature.

On this note, this study raises the following questions.

- i. What is the relationship between carbon disclosure and firm value?
- ii. Does external assurance affect firm value?
- iii. How does external assurance moderate the relationship between carbon disclosure and firm value?

2. Literature Review

Legitimacy theory addresses the social relationship between an organization and its stakeholders, suggesting that the corporation's performance is a function of how well the organization can act according to the normative expectation of the society in which it operates. Based on the going-concern principle, the corporation would constantly strategize to ensure its continual existence and survival; thus, maintaining a legitimate status becomes crucial in ensuring its long-term survival and achieving other organizational objectives. On the other hand, companies that oppose societal norms and values might experience challenges and boycotts from members of the stakeholder community, making it difficult for the company to succeed (Coopers and Lybrand, 1993). Climate crises have become a global issue affecting different facets of lives, including economic, social, and environmental aspects of people and the planet. Stakeholders, especially investors, are much more interested than before in how corporations disclose information regarding their carbon activities. Legitimacy theory has been considered in the works of Hardiyansah and Agustini (2021), and Kurnia *et al.* (2020) have considered legitimacy theory while examining the link between carbon disclosure and firm value.

Edward Freeman postulated the stakeholder theory in 1984, which supports the idea that a sheer dependency and connectivity between the corporation and various stakeholders directly or indirectly related to the organization. The bedrock of the theory is that organizations should strive to operate in a way that delivers value to the entire stakeholders' group without focusing only on shareholders. The idea of what constitutes the stakeholders of a corporation have been classified from different perspectives, including internal vs external and primary vs silent. Sustainability has emerged as a hot topic and many of the stakeholders are now interested in it. The organization has the responsibility of maintaining transparency by reducing information asymmetry and disclosing the needed information required for stakeholders to make well-informed decisions. Hardiyansah and Agustini (2021), and Kurnia *et al.* (2020) have considered stakeholder theory while investigating the link between carbon disclosure and firm value.

The discourse on sustainability disclosure, and firm performance has gained substantial attention from researchers across different climes. Carbon disclosure, which is a component of sustainability disclosure, is not excluded from the narrative that has emerged due to the climate crisis and associated risks. Climate change threats have affected different sectors of the global economy, the stock market has also been affected. With the rise of climate activism, investors tend to react to how organizations report their climate change-related activities.

However, different results have been reported in the literature, and there is a lack of consensus on the relationship between the two constructs. Some studies have reported a positive relationship between carbon disclosure and firm value. For example, Astuti *et al.*, (2023) conducted an empirical study on the effect of external assurance and carbon disclosure on the firm value of quoted banks in Indonesia, the findings showed that carbon disclosure significantly and positively impact firm value of the sampled banks. Along this background, Sanctis (2023) studied the impact of carbon disclosure on firm value among S&P companies. This study's results also support that carbon disclosure positivity impacts firm value.

Using 495 samples comprising 99 manufacturing firms in Indonesia, Rahmianingsih and Malau, (2022) reported that carbon emission disclosure positively impacts firm value measured by Tobin's Q. Noor and Ginting (2022) conducted research to examine how disclosing carbon emissions affects the value of 50 industrial firms listed in Indonesia. The result shows that carbon disclosure positively influence firm value. A study conducted in Malaysia by Rahman *et al.* (2018) found that firms that disclose higher-quality voluntary carbon information can gain a competitive advantage in the market, which will translate to enhanced firm value.

Dissimilar to this finding, Alsaifi *et al.*, 2020 studied the relationship between carbon emission disclosure and performance of quoted firms on the FTSE 350 index. The finding reveals that investors respond negatively to carbon disclosure announcements. Similarly, Mahmudah *et al.*, (2023) investigated the impact of CSR disclosure and carbon disclosure on the value of Indonesian firms, the study found that CSR and carbon disclosure negatively impact firm value. Suggesting a form of trade-off, Sun *et al.*, (2022) find that an increase in carbon disclosure affects firms' value negatively. The study used firms in the Shanghai and Shenzhen 300 (CSI 300) Index.

A few studies have also suggested narratives different from those discussed above. An empirical study conducted by Agustia and Wijaya (2021) finds that greenhouse gas emission disclosure does not have a relationship with firm value. Sudibyo (2018), also reported in a study of sampled listed Indonesian firms that carbon disclosure does not relate to firm value.

Findings on this discourse can be categorized into three different schools of thought. The school of thought reported a positive relationship, another that reported a negative relationship, and a third group that finds no relationship. A summary of some of the empirical works related to all the schools of thought has been provided below. Supporting the legitimacy theory, these studies found a positive relationship between carbon disclosure and firm value (Astuti *et al.*, 2023; Sanctis, 2023; Kurnia *et al.*, 2021; Nazwa and Fitri, 2022; Noor and Ginting, 2022; Rahmianingsih and Malau, 2022;

Meyliana and Sudibyo, 2022; Jiang *et al.*, 2021; Hardiyansan *et al.*, 2021; Rahman *et al.*, 2018). Contradictorily, other studies have reported that the nature of the relationship between carbon disclosure and firm value is negative (Mahmudah *et al.*, 2023; Sun *et al.*, 2022; Muhammad and Aryani, 2021; Kurnia *et al.*, 2020; Alsaifi *et al.*, 2020; Lee *et al.*, 2015).

Other studies have also maintained a neutral position by reporting that firm value is independent of carbon disclosure and no relationship exists between them (Ramadhan *et al.*, 2023; Anggita and Nugroho, 2022; Asyifa and Burhany, 2022; Rachmawati, 2021; Agustia and Wijaya, 2021; Sudibyo, 2018). To address the issue of inconsistent findings found in the literature, this study used external assurance to moderate the relationship between carbon disclosure and firm value. The justification for this attempt is to apply the moderation approach to the research variables due to the mixed results of other studies.

3. Methods

The study adopted an expo-facto research design, as it is the design that explains research on the cause relationship between two or more variables (Cohen, 2017). The study focused on the top six carbon-intensive industries listed on the Nigerian stock exchange (oil and gas, industrial goods, natural resources, agriculture, healthcare, and consumer goods) from 2012 to 2021. Using the purposive sampling technique, thirty-seven (37) listed firms were selected based on the availability of their annual reports and the necessary information at the time of the study. The study focuses on carbon intensive firms because their operational activities are potentially more damaging to the environment (Zhou *et al.*, 2021). Data used was extracted from the annual and standalone sustainability reports of the sampled firms, supplemented by entity-specific archival data from other sources. Table 1 shows the distribution of the sample firms considered in the study.

Table 1. Sample distribution

(A) Sample selection		
Carbon intensive firms		57
Less: Firms with missing annual reports/stand-alone reports or incomplete data		20
Total final sample		37
(B) Industry composition		
Industry	Number of firms	%
Agricultural firms	4	11%
Consumer goods	16	43%
Healthcare	4	11%
Industrial goods firms	6	16%
Natural resources	1	3%
Oil and gas	6	16%
Total	37	100%

Source: Author's Compilation (2024).

3.1. Variable Measurement

The study measures firm value (FV) using Tobin's Q based on Ramadhan *et al.* (2023) and external assurance (EA) using a dummy variable that equals 1 when a company's sustainability reports are verified by an external assurer, and 0 otherwise (Girón *et al.*, 2021). Firm profitability (PROF), measured by return asset, serves as a control variable to enhance internal validity. Carbon disclosure (CD) is measured using content analysis (Muhammad and Aryani, 2021; Sudibyo, 2018). Unlike previous studies such as Matsumura *et al.* (2014) that used the CDP questionnaire, this study uses the

GRI Standards 305: Emission to compile a scoring index for carbon disclosure. The GRI Standards 305 index is more appropriate for assessing carbon disclosure in Nigeria, as most firms in the country use it to disclose their carbon activities compared to the CDP Questionnaire.

The measurement of carbon disclosure in this study involved three steps: First, a structured checklist was developed based on the GRI Standards 305: Emission indicators. Second, a coding system was used, with '0' indicating the absence of disclosed information and '1' indicating its presence. Third, the carbon information disclosure was calculated using a content analysis approach, with a simple unweighted average formula (Eq.1). Consequently, an index was created using the above three steps to measure carbon disclosure in this study (Muhammad and Aryani, 2021).

$$CD = \sum \frac{CQ}{MX CQ} \quad (1)$$

Where:

CD = Carbon Disclosure;

CQ = Carbon Information Scores;

MX CQ = Maximum disclosure scores for this study is 10.

3.2. Model Specification

According to Gujarati (2004), it is suggested that a regression model can be constructed to estimate relationship between variables in a general context. The formulated regression model is as in Eq.(2).

$$FV_{it} = \beta_0 + \beta_1 CD_{it} + \beta_2 EA_{it} + \beta_3 CD*EA_{it} + \beta_4 PROF_{it} + \epsilon_{it} \quad (2)$$

Where:

FV = Firm Value;

β_0 = Intercept.

β_1 to β_2 = Parameter β of the Independent Variables.

β_3 = Parameter β of the Moderating Variable.

β_4 = Parameter β of the Control Variable.

ϵ = Error term.

it = Indicator for Panel Data

CD = Carbon Disclosure.

EA = External Assurance.

$CD*EA$ = Carbon Disclosure* External Assurance

$PROF$ = Profitability.

4. Results and Discussion

The study used descriptive and inferential statistics on a longitudinal sample of 370 firm year observations of carbon-intensive firms. Table 2 presents the descriptive statistics.

Table 2 Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
CD	370	0.082	0.197	0	0.90
TBQ	370	1.736	1.555	0.42	11.76
EXTASS	370	0.062	0.242	0	1
FSIZE (millions)	370	115,760	268,072	261	2,392,019

Source: Author's Compilation (2024).

Carbon disclosure (CD) is a ratio that ranges from 0 to 1 and can also be expressed as a percentage. Based on the mean CD value of 0.082 presented in Table 2, the average CD during the study period was found to be low, at 8.2%. Additionally, the highest average disclosure rate was 90%,

while the lowest was 0%, indicating a wide variation of among the sample firms. Tobin's Q has an average value of 1.736 and a standard deviation of 1.555 which is close to the average value. This implies a low deviation in the Tobin's Q of the sampled firms. The min and max value of Tobin's Q is 0.42 and 11.76 respectively.

Table 2 also shows informative figures for the dummy variables. On average, only 6.2% of the sample corporations assured their carbon emission information disclosed. The minimum of 0 implies there are some sampled firms that did not assured their carbon emission information throughout the period covered in the study. Finally, with respect to firm size, it has a mean value of 115.7 billion naira. The minimum asset value among the firms sampled is N261 billion, while the maximum value is N2.39 trillion.

4.1. Residuals Test

Several diagnostic tests such as multicollinearity, linearity, auto and serial correlation, heteroscedasticity, normality, and Hausman specification tests were conducted. Based on the results presented in Table 4, it can be inferred that there are no multicollinearity issues because Mean VIF value is below 10, as suggested by Hair *et al.* (2006). The Hausman test was performed to choose the appropriate model between random and fixed effect. The probability value is insignificant which indicate that the random effect model is supported. As the test was insignificant, the Lagrange Multiplier test was conducted to choose the best model to interpret between the random effect model and the pooled OLS. The result obtained showed that the random effect model is the most appropriate as the result is significant.

However, the result also shows the presence of auto correlation and heteroscedasticity because the p-value of both tests is significant. These findings indicate that using random effect regression in this investigation may be inappropriate, since it has the potential to contribute bias to the estimations of panel regression (Hausman and Kuersteiner, 2008). Therefore, the outcomes derived from this method may lack reliability and have the potential to be misleading, as emphasised by Bentes and Menezes (2013). Based on Westerlund and Naraya (2012) recommendation, this current study used the Generalised Least Squares (GLS) model to address this inefficiency. Cameron and Trivedi (2009) and Bentes and Menezes (2013) argue that GLS provides more efficient estimators than ordinary least squares. The GLS regression result is shown in Table 3.

Table 3: GLS Regression Result

ETR	Coef.	St.Err.	z-value	p-value
CD	2.429	0.858	2.93	0.005
EA	0.211	0.500	0.42	0.672
CD*EA	4.691	2.152	2.18	0.029
PROF	-0.657	0.184	-3.58	0.000
Constant	-0.489	2.098	-2.33	0.020
Number of obs	370	Mean VIF	4.77	
Wald-chi	21.45	Auto correlation test	0.0019	
Prob > chi2	0.0003	Hetttest	0.0000	

Source: Authors' Compilation (2024).

4.1.2 Interpretation of the model and discussion of finding

The Wald chi-square value of 21.45 for the model presented in Table 4 exceeds 2, indicating that the model is appropriate. Additionally, all the explanatory variables in the model are statistically significant based on the prob-value of the Wald chi-square, which is significant at the 1% level. Therefore, the model is well-suited for examining the moderating impact of external assurance on the

relationship between carbon disclosure and firm value. From the findings, the model of the study is in Eq.(3).

$$FV_{it} = -0.489 + 2.429 CD_{it} + 0.211 EA_{it} + 4.691 CD*EA_{it} - 0.657 PROF_{it} \quad (3)$$

Carbon disclosure has a significant positive impact on firm value disclosure evidenced by the 2.429 coefficient and the P-value of 0.005. The coefficient of 2.429 indicates that for every unit increase in carbon disclosure, firm value rises proportionally, reflecting a strong relationship between carbon disclosure and value creation of the listed sampled firms. Furthermore, the statistical significance of the p-value (0.005) confirms and means that an increase in the disclosure of carbon disclosure of listed carbon intensive firms enhances their value. The findings are in study (Astuti *et al.*, 2023; Han *et al.*, 2023; Kurnia *et al.*, 2021; Sun *et al.*, 2022; Jiang *et al.*, 2021) that carbon emission disclosure improves firm value. But dissimilar to those of (Alsaifi *et al.*, 2020; Lee *et al.*, 2015; Mahmudah *et al.*, 2023; Muhammad and Aryani, 2021). Given that the prob-value is below 5%, this study accepts the hypothesis that carbon disclosure has significant impact on firm value of the listed carbon-intensive firms. This relationship carries particular weight as these industries often face heightened environmental scrutiny and regulatory risks. Proactively disclosing carbon-related information demonstrates a firm's commitment to addressing these risks, which can alleviate investor concerns and improve stakeholder trust. From an investor's perspective, enhanced carbon disclosure reduces information asymmetry, providing clarity about a firm's preparedness for a low-carbon future (Sun *et al.*, 2022). This transparency fosters positive market reactions and attracts long-term investors who prioritize sustainability in their decision-making processes. The integration of carbon disclosure into investment strategies of firms with robust carbon reporting frameworks are often better positioned to attract capital, meet regulatory expectations, and ultimately improve their market valuation (Han *et al.*, 2023).

External assurance, however, has a positive but insignificant impact on firm value as shown by the 0.211 coefficient and P-value of 0.672. This suggests that while there may be a slight positive association between external assurance and firm value, it is not statistically meaningful. Since the prob-value is above 5%, this study rejects the hypothesis that external assurance has a significant impact on the firm value. This indicates that external assurance, in its current form or practice among carbon-intensive firms, does not play a significant role in influencing market valuation. A plausible explanation for this result lies in the low degree of external assurance adoption among the sampled, which can dilute its overall effect. External assurance is intended to enhance the credibility and reliability of disclosed information, particularly in areas like sustainability reporting. When properly implemented, it can bolster stakeholder confidence by verifying the accuracy and completeness of reported data. However, in the case of the sampled firms, the low prevalence or quality of external assurance may limit its potential impact. If firms only minimally engage in assurance activities or if the assurance is perceived as superficial or inconsistent, its value to stakeholders, including investors and regulators may be undermined.

The study also shows that external assurance plays a significant moderating role in increasing the effect of carbon disclosure on firm value as shown by the 4.69 coefficient and P-value of 0.029. The moderation effect (4.691) is greater than the direct relationship (2.429) indicating that external assurance reinforces the value relevance of carbon disclosure for firms. Given that the prob-value is below 5%, this study accepts the hypothesis that external assurance has a significant moderating effect on the relationship between carbon disclosure and firm value. This means that external assurance not only validates carbon disclosure but also amplifies its influence by increasing stakeholder confidence and aligning with global standards. Firms that adopt external assurance as part of their disclosure strategy can better realize the financial and reputational benefits of their sustainability initiatives.

5. Conclusions

There is a growing demand for carbon emission mitigation and disclosure from investors and other stakeholders due to the negative environmental impact of a company's operations. This study investigated whether external assurance moderates the relationship between carbon disclosure and the firm value of carbon intensive firms in an emerging economy context. Using Generalised Least Square regression analysis on 370 firm-year observations, the study finds that external assurance significantly increases the impact of carbon disclosure on firm value. The research demonstrates that the act of disclosing carbon emission information has a significant and beneficial effect on a company's value. Additionally, the results indicate that external assurance has a significant moderating role in increasing the impact of carbon disclosure on firm value. This suggests that external assurance enhances the value relevance of carbon disclosure for firms.

This study enhances the empirical value of carbon disclosure and firm value by highlighting the potential value of external assurance in their relationship. The findings could contribute to the implementation of improved monitoring regulations for carbon-sensitive industries. The study recommends integrating carbon information into regulatory requirements and setting mandatory standards for sustainability assurance practices. It also enhances managers' understanding of the economic impact of carbon disclosure, particularly in an unregulated economy.

Similar to previous empirical investigations, this research also has some limitations despite its valuable contributions. The study suffered some limitations, among which only 37 carbon-intensive listed companies were considered due to the availability of data at the time of this study. Secondly, the data used was sourced from information presented in annual reports and stand-alone sustainability reports. Other alternative channels, such as magazines, newspapers, or corporate websites, were not considered in this study. Future research may consider using these other ways to collect information other than annual reports. The study concludes that while the limitations exist, they do not undermine the validity of the study due to its rigorous measurement methodology, well-established findings, and comprehensive observations. Instead, the study suggests that future improvements can be made by addressing and considering these limitations.

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