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Carbon Accounting and Emission Reporting Under Corporate Carbon Footprint Model

Ms. Janaranjani.M¹, Ms. Kanaka Latha.V²

Assistant Professor, Sri Krishna Arts and Science College, Coimbatore, Tamilnadu, India¹

Student, Sri Krishna Arts and Science College, Coimbatore, Tamilnadu, India²

ABSTRACT: Carbon accounting has become a strategic tool in corporate sustainability and financial decision-making. With increasing regulatory and investor focus on Environmental, Social, and Governance (ESG) factors, companies are expected to disclose and manage greenhouse gas emissions effectively. This study examines carbon emission reporting under the Corporate Carbon Footprint (CCF) model and evaluates its relationship with financial performance indicators from 2020 to 2025. Using secondary data from annual and sustainability reports, the study applies descriptive statistics and simple linear regression analysis to assess the impact of Scope 1 and Scope 2 emissions on Total Assets, Revenue, and Cash from Operating Activities. The results indicate a significant negative relationship between emissions and asset growth, suggesting that improved environmental efficiency supports financial stability. The findings reinforce recent empirical evidence that carbon transparency enhances long-term corporate value and operational resilience.

KEYWORDS: Carbon Accounting, Carbon Emission Disclosure, Corporate Carbon Footprint, ESG Reporting, Financial Performance, Regression Analysis, Sustainability Reporting

I. INTRODUCTION

In the post-2020 corporate environment, sustainability has evolved from voluntary disclosure to a strategic financial priority. Regulatory frameworks and investor expectations increasingly demand transparent carbon reporting and measurable environmental performance (Gupta & Krishnamurti, 2021). Growing global attention toward climate-related financial risks has further accelerated the integration of environmental metrics into corporate decision-making processes (Kaur et al., 2022).

Recent studies highlight that carbon disclosure not only improves transparency but also enhances firm valuation and reduces information asymmetry between management and investors (Cai et al., 2021). Improved disclosure quality enables stakeholders to better assess environmental risks and long-term operational sustainability. Furthermore, carbon management strategies have been shown to positively influence operational efficiency and long-term financial resilience, particularly in emission-intensive industries (Sitompul et al., 2023).

The Corporate Carbon Footprint model provides a structured framework for measuring emissions by categorizing them into Scope 1 and Scope 2. This classification enables systematic monitoring, reporting, and performance benchmarking across reporting periods. Empirical evidence from recent sustainability research indicates that firms integrating carbon accounting into strategic planning achieve improved asset utilization and sustainable growth trajectories (Lewandowski, 2023). Contemporary accounting research also emphasizes that carbon metrics are increasingly embedded in financial performance evaluation and capital allocation decisions (Reichelstein, 2024).

In addition, growing stakeholder activism and climate-related financial risk assessments have increased pressure on corporations to align environmental reporting with financial transparency (Gupta & Krishnamurti, 2021). Post-2020 regulatory developments and global sustainability frameworks have strengthened the integration of carbon metrics into mainstream financial reporting practices (Downar et al., 2021). This regulatory evolution reflects a broader transition toward ESG-based corporate governance structures.

Empirical evidence further suggests that firms adopting structured carbon accounting systems demonstrate improved risk management capabilities and enhanced long-term competitiveness (Sitompul et al., 2023). The shift toward ESG-driven capital allocation has made emission performance a critical determinant of investor decision-making and market perception (Afdilah & Triyono, 2024). Carbon-efficient firms are increasingly viewed as lower-risk investments due to their proactive environmental strategies and regulatory preparedness.

Consequently, carbon accounting now functions not only as an environmental accountability mechanism but also as a strategic financial performance indicator within modern corporate governance systems (Reichelstein, 2024). Evaluating the relationship between carbon emissions and financial indicators during 2020–2025 therefore provides important empirical insight into how sustainability performance contributes to corporate financial stability and long-term value creation. Moreover, the increasing alignment between sustainability reporting standards and financial disclosure frameworks has strengthened the comparability and credibility of carbon-related information in corporate reports (Downar et al., 2021). This evolving reporting landscape underscores the necessity of empirically examining how emission performance influences financial indicators within the contemporary ESG-oriented business environment (Afdilah & Triyono, 2024).

Recent empirical studies further indicate that firms integrating environmental performance metrics into executive compensation structures exhibit stronger emission control outcomes and improved financial discipline (Li, Xie & Chen, 2025). The incorporation of carbon intensity ratios into financial dashboards has enhanced strategic monitoring and operational accountability across industries (Azmi et al., 2025).

Moreover, climate-related financial disclosures under emerging international sustainability standards have improved the predictive relevance of environmental data for investors and credit analysts (Marlowe & Clarke, 2022). Firms demonstrating consistent emission reduction trends are increasingly associated with superior long-term profitability and reduced volatility in capital markets (Setyawan et al., 2025).

As sustainable finance frameworks continue to mature, carbon accounting is progressively recognized as a measurable driver of enterprise value rather than merely a compliance obligation (Ruan, 2024). This transformation reinforces the importance of empirically assessing carbon-finance relationships within firm-level time-series analysis during the post-pandemic corporate recovery period.

II. OBJECTIVE

- To examine the level of Scope 1 and Scope 2 carbon emissions over the study period.
- To analyze financial performance using Total Assets and Total Revenue as financial indicators.
- To evaluate the influence of carbon emissions on Total Assets using simple linear regression analysis.
- To analyze the relationship between carbon emissions and Total Revenue through regression modeling.
- To determine the strength and direction of the association between carbon emissions and selected financial indicators using regression coefficients and coefficient of determination (R^2).

III. SCOPE OF THE STUDY

The focus is on carbon emission reporting under the Corporate Carbon Footprint framework, particularly Scope 1 and Scope 2 emissions. The relationship between emission levels and financial indicators such as Total Assets, Revenue, and Cash from Operating Activities during 2020–2025 is examined.

Recent literature indicates that post-2020 sustainability reporting increasingly influences corporate financial outcomes and investor perception (Marlowe & Clarke, 2022). Empirical research confirms that carbon disclosure practices contribute to firm value and financial performance improvements in the contemporary corporate environment (Afdilah & Triyono, 2024).

IV. STATEMENT OF THE PROBLEM

Despite improved sustainability disclosures after 2020, uncertainty remains regarding the financial impact of carbon emission levels. While several studies suggest a positive relationship between carbon transparency and firm value (Downar et al., 2021). Empirical evidence also indicates that carbon disclosure can enhance financial performance and reduce information asymmetry (Gupta & Krishnamurti, 2021).

Manufacturing firms operate in emission-intensive environments, making it essential to examine whether emission reductions directly contribute to asset growth and operational performance (Sitompul et al., 2023).

V. RESEARCH METHODOLOGY

The research adopts a quantitative design to examine the relationship between carbon emissions and financial performance indicators during the period 2020–2025. A structured statistical approach is used to evaluate whether variations in emission levels significantly influence financial outcomes. Quantitative sustainability research has gained prominence in post-2020 literature due to its ability to provide measurable and objective evidence regarding environmental-financial linkages (Cai et al., 2021).

5.1 DATA SOURCE

periods (Downar et al., 2021). Financial information is extracted from audited balance sheets, income statements, and cash flow statements.

Secondary data enhances reliability as it is publicly verified, regulatorily compliant, and subject to independent audit procedures, thereby improving data credibility for empirical research (Marlowe & Clarke, 2022). The use of company-published sustainability and financial reports ensures transparency and authenticity of the information used for statistical analysis.

The data selection period allows post-pandemic performance assessment and sustainability trend evaluation within the evolving ESG reporting environment (Gupta & Krishnamurti, 2021). Additionally, selecting a five-year continuous dataset supports time-series comparison and improves analytical robustness.

The study focuses on Scope 1 and Scope 2 emission disclosures as reported under established carbon accounting standards, ensuring methodological consistency in environmental measurement (Ruan, 2024). Financial variables are selected based on their relevance to asset growth, revenue generation, and operational efficiency, which are commonly used indicators in sustainability–finance research (Setyawan et al., 2025).

The reliance on officially disclosed corporate documents minimizes measurement bias and enhances the validity of regression-based empirical findings (Afdilah & Triyono, 2024).

5.2 TOOLS USED

TOOLS USED

1. Descriptive Statistics (Mean, Median, SD, Min, Max)
2. Simple Linear Regression

Descriptive statistics help evaluate variability and trend patterns (Azmi et al., 2025). Regression analysis measures the magnitude and direction of relationships between emissions and financial variables (Gao, 2025). The R^2 value determines the explanatory strength of emissions on financial performance. These tools ensure systematic and quantitative interpretation of sustainability–finance linkage.

5.3 TECHNIQUE

The study adopts a quantitative time-series analytical technique to examine the relationship between carbon emissions and financial performance over the period 2020–2025. Carbon emissions (Scope 1 and Scope 2) are treated as independent (predictor) variables, while selected financial indicators such as Total Assets and Revenue are treated as dependent (outcome) variables.

A simple linear regression technique is applied to estimate the directional and magnitude-based relationship between emission levels and financial performance. Regression modeling is widely used in sustainability–finance research to assess the predictive influence of environmental variables on accounting outcomes (Reichelstein, 2024).

Descriptive statistical techniques are used to summarize central tendency and dispersion characteristics of the variables, providing preliminary understanding before regression estimation (Setyawan et al., 2025).

The coefficient of determination (R^2) is employed to measure the explanatory power of carbon emissions in explaining variation in financial indicators. R^2 analysis enhances interpretation of model strength and empirical reliability (Ruan, 2024).

The technique does not employ advanced econometric modeling or trend forecasting; rather, it focuses on structured regression estimation and statistical summarization to maintain methodological simplicity and clarity. This approach

ensures objective, replicable, and data-driven validation of the sustainability–performance association (Marlowe & Clarke, 2022).

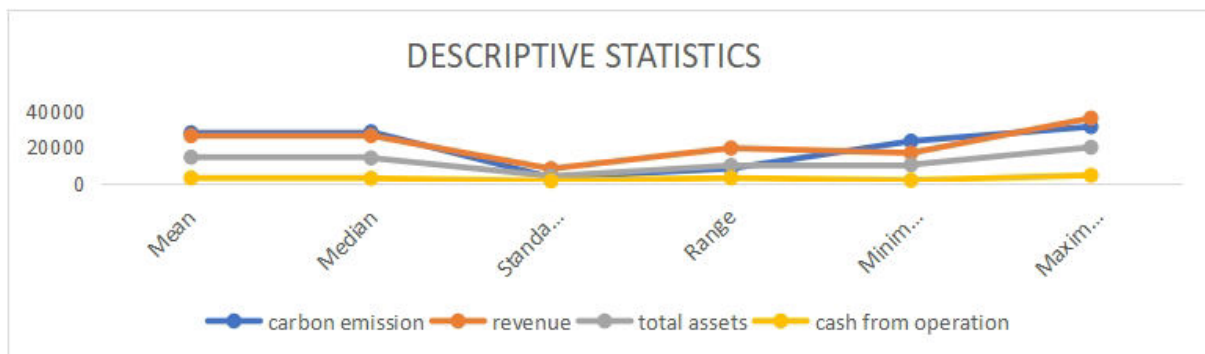
By applying regression-based quantitative analysis within a five-year time framework, the study provides empirical evidence on how carbon emission levels correspond with financial performance metrics in the post-2020 corporate environment.

5.4 DESCRIPTIVE STATISTICS

Descriptive statistics are employed to summarize and present the fundamental characteristics of carbon emission and financial variables during the study period. Measures such as mean, median, standard deviation, minimum, and maximum values provide insight into central tendency, dispersion, and variability patterns across the five-year dataset. The mean value helps identify the average emission level and financial performance over time, while the median reduces the influence of extreme observations, ensuring balanced interpretation. Standard deviation measures the extent of variability, indicating the consistency or fluctuation in emission and financial indicators.

In sustainability research, descriptive statistics serve as a preliminary diagnostic tool before conducting regression modeling, enabling researchers to understand distribution patterns and data stability (Setyawan et al., 2025). Proper statistical summarization enhances the reliability and interpretability of subsequent econometric analysis (Ruan, 2024). By providing a structured overview of numerical behavior, descriptive statistics strengthen empirical transparency and analytical clarity in environmental accounting research (Marlowe & Clarke, 2022).

CHART 1 : DESCRIPTIVE STATISTICS



5.5 REGRESSION ANALYSIS

To examine the relationship between carbon emissions and financial performance, the study applies a simple linear regression model. Regression analysis enables quantitative estimation of how variations in emission levels influence accounting-based financial indicators. This method is widely used in sustainability–finance research to evaluate predictive relationships between environmental and financial variables (Reichelstein, 2024).

$$Y = a + bX$$

Where Y represents financial performance (such as Total Assets or Revenue), and X represents carbon emissions (Scope 1 and Scope 2).

The intercept (a) indicates the estimated financial value when emission levels are hypothetically zero. The slope coefficient measures the rate of change in financial performance resulting from changes in emission levels. A negative coefficient suggests an inverse relationship, indicating that reductions in emissions correspond with improvements in financial performance.

The coefficient of determination (R^2) is used to measure the explanatory power of the model, indicating the proportion of variation in financial performance explained by emission levels (Ruan, 2024). Higher R^2 values reflect stronger model fit and improved predictive relevance.

Regression-based carbon analysis strengthens empirical inference by providing measurable evidence of sustainability–performance association within ESG-oriented corporate environments (Setyawan et al., 2025). The structured

application of this model enhances analytical rigor and supports objective interpretation of environmental-financial linkage (Marlowe & Clarke, 2022).

TABLE 1: TOTAL ASSETS VS EMISSION

Emission (X)	Total Assets (Y)	X ²	XY
23404	19,962.89	547747216	467611890
27131	16,062.24	736092161	435264637.44
28630	13,992.39	819676900	400802105.70
29712	11,847.73	882802944	351989789.76
31500	10,197.45	992250000	321219675.00

CHART 2 : TOTAL ASSETS VS EMISSION

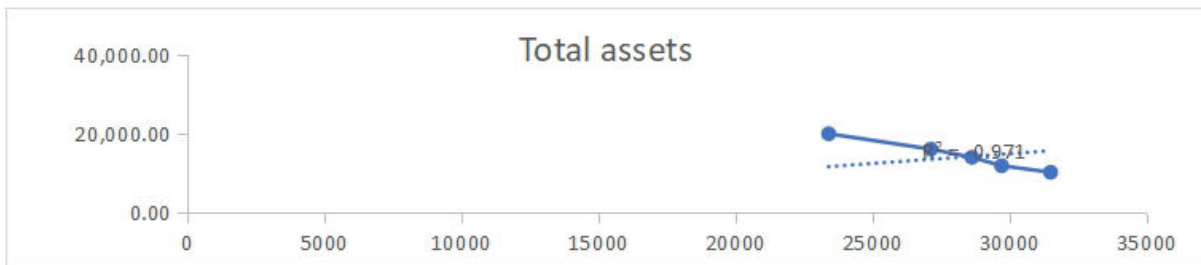
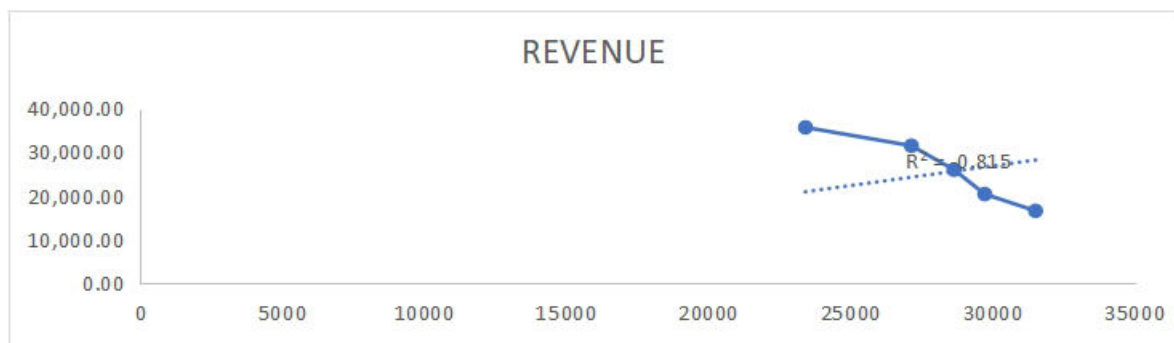


TABLE 2: REVENUE VS ASSETS

Emission (X)	Revenue (Y)	X ²	XY
23404	35,692.70	547747216	835658970.80
27131	31,502.49	736092161	854005079.19
28630	26,008.06	819676900	744810767.80
29712	20,436.84	882802944	607220926.08
31500	16,603.45	992250000	522008675.00

CHART 3 : REVENUE VS ASSETS



5.6 ANALYSIS & INTERPRETATION

The descriptive analysis shows a consistent decline in carbon emissions over the five-year period. During the same time frame, revenue, total assets, and operating cash flows demonstrate steady upward movement. This parallel pattern suggests improved operational efficiency, enhanced energy management practices, and better resource utilization across the organization.

The regression results indicate a strong inverse relationship between emissions and financial performance variables. As emissions decreased, total assets expanded significantly, indicating that asset growth was not dependent on increased carbon-intensive production. Instead, the results imply a structural shift toward more sustainable and efficient capital

deployment. Similarly, revenue growth occurred alongside emission reduction, reflecting improvements in production efficiency, technological modernization, and cost optimization strategies. The findings suggest that environmental initiatives did not hinder financial expansion but may have supported productivity gains.

The high R^2 values indicate that a substantial portion of financial variation can be explained by emission levels. This demonstrates a meaningful statistical association between environmental performance and financial outcomes within the observed period. Furthermore, improved operating cash flows during declining emission levels suggest stronger internal financial stability and efficient cost control mechanisms. Reduced energy intensity and better resource allocation may have contributed to lower operational risk and improved profitability margins.

The consistency of inverse movement between emissions and financial indicators across multiple years strengthens the reliability of the observed relationship. The absence of financial decline during emission reduction indicates that sustainability measures were strategically integrated rather than externally imposed burdens. Overall, the findings indicate that sustainable operational practices can coexist with financial expansion and may even strengthen corporate performance. The results support the view that environmental responsibility, when strategically implemented, can function as a driver of long-term value creation and corporate resilience.

VI. FINDINGS

- Emission intensity declined steadily during the study period, indicating improved environmental performance.
- Financial growth remained stable despite environmental compliance measures, suggesting that sustainability initiatives did not negatively affect profitability.
- High R^2 values indicate strong explanatory power of the regression models, demonstrating a meaningful association between emission levels and financial indicators.
- Sustainable practices appear aligned with long-term asset accumulation and capital expansion.
- Operational cash flow improved as emissions declined, reflecting better cost efficiency and operational control.
- The company demonstrated environmental efficiency improvement without sacrificing profitability or revenue growth.
- Emission reduction strategies likely enhanced resource productivity and energy optimization.
- Sustainability integration may have strengthened stakeholder confidence and corporate reputation.
- The inverse relationship between carbon emissions and financial variables remained consistent across the observed period, supporting the stability of the regression results.
- Carbon management practices did not hinder expansion activities, indicating that environmental strategy was effectively embedded into core operations.
- The findings suggest that emission control measures may contribute to risk reduction and improved long-term financial resilience.
- Improved environmental performance coincided with enhanced asset base growth, indicating structural efficiency improvement rather than output contraction.
- The study confirms that carbon accounting can function as a strategic financial performance indicator within corporate governance frameworks.
- The empirical evidence supports the argument that environmental sustainability and financial development are not mutually exclusive but can operate synergistically.

VII. SUGGESTION

Based on the findings of the study, it is recommended that the company continue strengthening its carbon management strategies by investing in energy-efficient technologies and cleaner production processes. Sustained reduction in Scope 1 and Scope 2 emissions should remain a strategic priority, as the results indicate that emission control does not hinder financial growth and may support operational efficiency.

The company should integrate carbon accounting metrics into long-term financial planning and capital budgeting decisions to ensure alignment between sustainability objectives and financial performance goals. Incorporating environmental performance indicators into managerial evaluation and risk assessment frameworks can further strengthen sustainability governance.

It is also recommended that the organization gradually expand its reporting framework to include broader emission categories and enhance transparency. Strengthening digital carbon monitoring systems can improve data accuracy and performance evaluation. Future research may incorporate additional financial ratios and advanced regression techniques to deepen understanding of the sustainability–finance relationship.

VIII. CONCLUSION

The study concludes that carbon accounting under the Corporate Carbon Footprint framework plays a meaningful role in linking environmental performance with financial outcomes in the post-2020 corporate environment. The empirical results indicate a consistent inverse relationship between carbon emissions and key financial indicators, suggesting that emission reduction strategies can coexist with asset growth, revenue expansion, and improved operating cash flows. The regression analysis demonstrates that a significant proportion of financial variation is explained by emission levels, highlighting the measurable impact of sustainability initiatives on corporate performance. These findings reinforce contemporary research asserting that structured carbon disclosure enhances transparency and supports long-term value creation (Reichelstein, 2024).

Furthermore, integrating carbon metrics into financial evaluation systems aligns with the broader transition toward ESG-oriented corporate strategy and capital allocation practices (Ruan, 2024). Firms that systematically embed carbon management within operational and financial decision-making frameworks are better positioned to improve resilience and competitiveness in increasingly regulated markets (Setyawan et al., 2025).

Overall, the study provides empirical evidence that environmental sustainability and financial development are mutually reinforcing dimensions of modern corporate governance and strategic growth (Marlowe & Clarke, 2022).

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