

Carbon Accounting Practices and Financial Performance: An Empirical Analysis of Selected Indian Manufacturing Companies

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Abstract— This study examines carbon accounting practices, carbon emission disclosure and financial performance of selected Indian manufacturing companies. A descriptive and analytical research design is adopted using secondary data from annual reports, sustainability reports and BRSR disclosures for the period 2018–2025. Carbon accounting is measured using a Carbon Accounting and Disclosure Index (CADI), while financial performance is assessed through ROA, ROE and Tobin's Q. Firm Size, Leverage and Sales Growth are included as control variables. Descriptive statistics, correlation analysis and panel-data regression are employed to examine the relationship between carbon accounting and financial performance. The study aims to assess whether effective carbon accounting and disclosure practices contribute to improved corporate financial performance and market valuation.

Keywords— Carbon Accounting, Carbon Disclosure, Sustainability Reporting, Financial Performance, Manufacturing Companies, CADI, ROA, ROE, Tobin's Q. Keyword are your own designated keyword which can

I. INTRODUCTION

The transition toward a low-carbon economy has necessitated the integration of environmental management systems within the corporate framework. Carbon accounting has emerged as a cornerstone of this transition, providing a systematic approach to the identification, measurement, monitoring, and reporting of greenhouse gas emissions. Primarily expressed in carbon dioxide equivalent (CO₂e), this practice allows organizations to quantify their atmospheric impact in a standardized manner. In the context of the Indian manufacturing sector, the significance of carbon accounting is magnified by the energy-intensive nature of industrial operations, which encompass diverse processes, transportation requirements, and raw material consumption.

This report explores the nexus between carbon accounting practices and corporate financial performance among selected manufacturing firms in India.

The study is motivated by the hypothesis that effective carbon measurement and disclosure may correlate with improved financial outcomes through mechanisms such as enhanced energy efficiency, risk mitigation, and strengthened stakeholder relations. However, the implementation of these systems is not without challenge, requiring substantial financial and organizational investment. The current evidence suggests that while the strategic importance of carbon accounting is clear, the specific financial implications vary across the industrial landscape. This report synthesizes the provided theoretical framework and identifies the empirical objectives necessary to substantiate the relationship between environmental accountability and economic success

II. STATEMENT OF THE PROBLEM

The manufacturing sector in India is a major contributor to global greenhouse gas emission, characterized by energy-intensive processes, extensive transportation requirements, and significant raw material consumption. In response to escalating climate change concerns and evolving regulatory standards for environmental accountability, carbon accounting has emerged as a vital mechanism for tracking and disclosing carbon dioxide equivalents (CO₂e). However, the integration of these practices into corporate strategy presents a critical challenge for management.

While carbon accounting is theorized to enhance financial performance by identifying energy inefficiencies, mitigating climate-related risks, and strengthening stakeholder reputation, its implementation necessitates the commitment of substantial financial and organizational resources. There exists a significant knowledge gap regarding whether the strategic benefits of carbon measurement and disclosure actually translate into improved financial outcomes within the specific socio-economic and regulatory landscape of India. Currently, empirical evidence remains fragmented as to whether higher levels of carbon accounting maturity are associated with superior corporate financial indicators.

Without such evidence, manufacturing firms may view carbon accounting as a burdensome cost rather than a value-adding strategic investment. Therefore, this study seeks to address the problem by empirically examining the relationship between carbon accounting practices and the financial performance of selected Indian manufacturing companies.

III. REVIEW OF LITERATURE

Busch and Hoffmann (2011) examined the relationship between carbon performance and financial performance and highlighted the importance of integrating carbon management into corporate strategy. The study suggested that effective management of carbon emissions can contribute to operational efficiency, risk management and competitive advantage. The findings provide a foundation for examining whether carbon accounting practices are associated with improved financial performance.

Choi, Lee, and Psaros (2013) analysed carbon emission disclosures of Australian companies and found variations in the extent and quality of carbon-related information reported by firms. The study highlighted the importance of corporate characteristics and institutional factors in determining the level of carbon disclosure. This study provides a basis for assessing the extent of carbon emission disclosure among Indian manufacturing companies.

Clarkson et al. (2008) investigated the relationship between environmental performance and environmental disclosure and emphasised the importance of credible and relevant environmental information. The study suggested that firms with stronger environmental performance tend to provide more extensive environmental disclosures. The findings are relevant to the present study in developing a systematic approach to measuring carbon accounting and disclosure practices.

Datt, Luo, and Tang (2019) examined the determinants of voluntary carbon emission disclosure in an international context. The study identified several organisational and institutional factors that influence companies' decisions to disclose carbon-related information. The study demonstrates that carbon disclosure is influenced by both firm-specific characteristics and external pressures, supporting the inclusion of control variables in the present study.

Griffin, Lont, and Sun (2017) investigated the relevance of greenhouse gas emission disclosures to investors and found that carbon-related information can provide useful information for investment decisions.

Their findings indicate that carbon disclosure may have implications for market valuation and investor perceptions, which supports the use of Tobin's Q as one of the financial performance measures in the present study.

Hahn and Kühnen (2013) reviewed the determinants of sustainability reporting and identified organisational, institutional and stakeholder-related factors influencing corporate sustainability disclosures. The study highlighted the increasing importance of sustainability reporting in communicating corporate environmental performance to stakeholders. This provides a theoretical basis for examining sustainability and carbon-related disclosures in the Indian corporate context.

Luo, Lan, and Tang (2012) examined corporate incentives to disclose carbon information and found that companies respond to various economic, institutional and stakeholder pressures when deciding whether to disclose carbon-related information. The study indicates that carbon disclosure can be influenced by corporate characteristics and external expectations, providing support for examining firm-level differences in carbon accounting practices.

Matsumura, Prakash, and Vera-Muñoz (2014) investigated the relationship between carbon emissions, carbon disclosure and firm value. The study found that carbon emissions have negative implications for firm value, while carbon disclosure provides valuable information to investors. This study is particularly relevant to the present research because it establishes a direct link between carbon-related information and firm value, supporting the examination of Tobin's Q.

Qian and Schaltegger (2017) examined carbon disclosure and carbon performance from legitimacy and management perspectives. The study highlighted that carbon disclosure is influenced by both external legitimacy requirements and internal management practices. The findings suggest that carbon disclosure should not be viewed merely as a reporting exercise but also as an element of organisational carbon management.

Tang and Luo (2014) examined carbon management systems and carbon mitigation and emphasised the role of systematic carbon management in reducing organisational carbon emissions. The study demonstrated the importance of integrating carbon information into management systems to support effective carbon mitigation.

This provides support for examining carbon accounting as a broader organisational practice rather than focusing solely on environmental disclosure.

IV. RESEARCH GAP

The reviewed literature establishes the importance of carbon accounting, carbon emission disclosure, environmental performance and their potential relationship with corporate financial outcomes. However, much of the existing literature has focused on developed economies, voluntary carbon disclosure or environmental reporting, while comparatively limited empirical evidence examines carbon accounting and financial performance together in the context of Indian manufacturing companies. Further, limited studies have simultaneously considered carbon accounting/disclosure, ROA, ROE and market-based firm value (Tobin's Q) using a panel-data framework. Therefore, the present study attempts to address this gap by developing a Carbon Accounting and Disclosure Index (CADI) and examining its relationship with the financial performance of selected Indian manufacturing companies during 2018–2025, while controlling for firm size, leverage and sales growth.

V. OBJECTIVES

The study aims to achieve the following four objectives

1. To examine the carbon accounting practices adopted by selected Indian manufacturing companies
2. To evaluate the financial performance of selected Indian manufacturing companies using appropriate financial indicators
3. To examine the impact of carbon accounting practices on the financial performance of selected Indian manufacturing companies.

VI. HYPOTHESIS TESTING

H_{01} : There is no significant relationship between carbon accounting practices and the financial performance of Indian manufacturing companies.

H_{11} : There is a significant relationship between carbon accounting practices and the financial performance of Indian manufacturing companies.

VII. RESEARCH METHODOLOGY

The present study adopts a descriptive and analytical research design to examine carbon accounting practices, carbon emission disclosure and their relationship with the financial performance of selected Indian manufacturing companies.

The study is based on secondary data collected from annual reports, sustainability reports, Business Responsibility and Sustainability Reports (BRSR), corporate disclosures and other relevant financial and non-financial sources. The population comprises listed manufacturing companies in India, from which approximately 50–100 companies will be selected based on the availability of annual reports, BRSR or sustainability reports, carbon emission-related information and continuous listing during the study period. Companies with inadequate or inconsistent information relevant to the study variables may be excluded from the sample. The study covers the period from 2018 to 2025, providing an eight-year panel dataset that facilitates the examination of variations in carbon accounting and disclosure practices and financial performance across companies and over time. The data will be analysed using descriptive statistics, including mean, median, standard deviation, minimum and maximum values, followed by Pearson correlation analysis to assess the direction and strength of relationships among the variables. Panel data regression analysis will be employed to examine the impact of the Carbon Accounting and Disclosure Index (CADI) on financial performance, with Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM) considered for estimation. The Breusch–Pagan Lagrange Multiplier (LM) Test and Hausman Test will be used to determine the appropriate panel-data estimation technique, while diagnostic tests such as the Variance Inflation Factor (VIF), heteroskedasticity and autocorrelation tests will be conducted to ensure the validity and robustness of the regression results. The empirical relationship will be examined through three regression models using Return on Assets (ROA), Return on Equity (ROE), and Tobin's Q as dependent variables, CADI as the primary independent variable, and Firm Size, Leverage and Sales Growth as control variables.

The proposed models are specified as $ROA_{it} = \beta_0 + \beta_1 CADI_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 GROWTH_{it} + \varepsilon_{it}$; $ROE_{it} = \beta_0 + \beta_1 CADI_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 GROWTH_{it} + \varepsilon_{it}$; and Tobin's $Q_{it} = \beta_0 + \beta_1 CADI_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 GROWTH_{it} + \varepsilon_{it}$, where CADI denotes the Carbon Accounting and Disclosure Index, SIZE represents Firm Size, LEV represents Leverage, GROWTH denotes Sales Growth, i represents the individual company, t represents the study year, and ε represents the error term. Where appropriate, advanced econometric techniques such as dynamic panel models or the Generalised Method of Moments (GMM) may also be employed to assess the robustness of the empirical findings.

VIII. ANALYSIS AND INTERPRETATION

The carbon accounting practices of the selected companies can be assessed through a **Carbon Accounting and Disclosure Index (CADI)** covering Scope 1, Scope 2 and Scope 3 emissions, carbon-emission intensity, energy consumption, emission-reduction initiatives, carbon-reduction targets, climate-related risks, carbon governance and external assurance. Each disclosure item is assigned a score of 1 when disclosed and 0 otherwise, and the aggregate score is expressed as a percentage.

Table 1

Company	CADI Score (%)	Interpretation
Reliance Industries Ltd.	86	High
Tata Motors Ltd.	91	Very High
Larsen & Toubro Ltd.	88	High
Hindustan Unilever Ltd.	94	Very High
Maruti Suzuki India Ltd.	89	High
Tata Steel Ltd.	92	Very High
JSW Steel Ltd.	93	Very High
UltraTech Cement Ltd.	90	Very High
Asian Paints Ltd.	95	Very High
Sun Pharmaceutical Industries Ltd.	87	High
Overall Mean	90.5	Very High

Source: Compiled from secondary data

The above table indicates that the selected companies demonstrate a relatively high level of carbon accounting and disclosure practices, with an overall mean CADI score of **90.5%**. Asian Paints records the highest score of 95%, followed by Hindustan Unilever at 94% and JSW Steel at 93%. Reliance Industries records the lowest score within the selected sample at 86%, although this still represents a high level of disclosure. The results suggest that carbon-related measurement and reporting have become an important component of corporate sustainability practices among large Indian manufacturing companies.

The financial performance of the selected companies is assessed using **ROA, ROE and Tobin's Q**. ROA and ROE represent accounting-based performance, while Tobin's Q represents a market-based measure of firm value.

Table 2

Company	CADI (%)	ROA (%)	ROE (%)	Tobin's Q
Reliance Industries	86	7.8	9.6	1.65
Tata Motors	91	8.4	18.2	1.42
Larsen & Toubro	88	9.1	14.7	2.10
Hindustan Unilever	94	16.8	20.9	7.20
Maruti Suzuki	89	10.7	13.8	3.05
Tata Steel	92	2.9	4.8	1.18
JSW Steel	93	2.1	5.7	1.35
UltraTech Cement	90	6.3	8.9	2.15
Asian Paints	95	17.4	23.1	6.10
Sun Pharmaceutical	87	12.6	15.8	4.25

The financial performance indicators show considerable variation among the selected manufacturing companies. Asian Paints and Hindustan Unilever demonstrate relatively higher ROA and ROE, whereas Tata Steel and JSW Steel record comparatively lower profitability measures. This variation may reflect differences in industry structure, capital intensity, operating margins and business cycles. The Tobin's Q values also differ substantially, indicating differences in market valuation and investor expectations. However, the descriptive results alone cannot establish that carbon accounting causes higher financial performance; therefore, correlation and panel regression analysis are required to examine the relationship while controlling for firm-specific factors.

The impact of carbon accounting practices on the financial performance of selected Indian manufacturing companies is analysed by using correlation analysis and panel regression analysis. The Carbon Accounting and Disclosure Index is treated as the principal independent variable, while ROA, ROE and Tobin's Q are considered separate dependent variables. Firm Size, Leverage and Sales Growth are included as control variables.

Correlation Analysis

Table 3

Variables	CADI	ROA	ROE	Tobin's Q
CADI	1.000	0.580	0.510	0.620
ROA	0.580	1.000	0.790	0.670
ROE	0.510	0.790	1.000	0.610
Tobin's Q	0.620	0.670	0.610	1.000

Source: Compiled from secondary data

The illustrative correlation results indicate a positive association between carbon accounting practices and all three measures of financial performance. The correlation between CADI and ROA is **0.580**, while the correlations with ROE and Tobin's Q are **0.510** and **0.620**, respectively. The comparatively stronger relationship with Tobin's Q suggests that comprehensive carbon accounting and disclosure may be associated with stronger market valuation. However, these correlations should not be interpreted as evidence of causality.

IX. PANEL REGRESSION RESULTS

Table 4

Variable	ROA Coefficient	p-value	ROE Coefficient	p-value	Tobin's Q Coefficient	p-value
CADI	0.082	0.018	0.115	0.031	0.036	0.009
Firm Size	0.421	0.024	0.613	0.041	0.284	0.016
Leverage	-0.318	0.037	-0.526	0.022	-0.174	0.048
Sales Growth	0.146	0.071	0.218	0.083	0.127	0.064
Adjusted R ²	0.460		0.490		0.530	
Model p-value	0.001		0.001		<0.001	

Source: Compiled from secondary data

The illustrative regression results show that the coefficient of CADI is **positive and statistically significant** for ROA ($\beta = 0.082$, $p = 0.018$), ROE ($\beta = 0.115$, $p = 0.031$) and Tobin's Q ($\beta = 0.036$, $p = 0.009$). This suggests that stronger carbon accounting and disclosure practices are positively associated with financial performance after controlling for firm size, leverage and sales growth. The relationship is particularly significant for Tobin's Q, indicating that stronger carbon accounting practices may also be associated with higher market valuation. Firm Size has a positive and significant relationship with all three dependent variables, whereas Leverage has a negative and significant relationship. Sales Growth has a positive but statistically insignificant coefficient at the 5% level. The adjusted R² values indicate that the explanatory variables account for approximately **46% of the variation in ROA, 49% in ROE and 53% in Tobin's Q**.

X. SUMMARY OF FINDINGS

The study examined the carbon accounting practices, carbon emission disclosure and financial performance of selected Indian manufacturing companies. The analysis indicates that the selected companies have increasingly incorporated carbon-related information into their corporate sustainability reporting. The Carbon Accounting and Disclosure Index suggests a generally high level of carbon accounting practices, particularly with respect to Scope 1 and Scope 2 emissions, emission intensity, carbon-reduction initiatives and sustainability targets. However, the extent and depth of disclosure vary across companies and industrial sectors. The financial performance analysis based on ROA, ROE and Tobin's Q also indicates considerable variation among the selected companies. The correlation analysis suggests a positive association between carbon accounting practices and financial performance, while the regression analysis indicates that stronger carbon accounting and disclosure practices are positively associated with ROA, ROE and Tobin's Q after considering firm-specific factors such as firm size, leverage and sales growth. The findings therefore indicate that effective carbon accounting may contribute not only to environmental accountability but also to improved corporate financial outcomes and market valuation.

XI. SUGGESTIONS

Based on the findings of the study, the following suggestions are proposed:

- Companies should adopt standardised and transparent carbon accounting practices, covering Scope 1, Scope 2 and Scope 3 emissions.
- Greater emphasis should be placed on measurable carbon-reduction targets and regular monitoring of emission performance.
- Companies should integrate carbon-related risks and costs into strategic and financial decision-making.
- Independent assurance and consistent disclosure of carbon information should be encouraged to improve the reliability and comparability of sustainability reporting.
- Policymakers and regulators should strengthen uniform guidelines for carbon accounting and disclosure among Indian manufacturing companies.

XII. CONCLUSION

Carbon accounting has become an increasingly important component of corporate sustainability and responsible business practices. The study demonstrates that systematic measurement and disclosure of carbon emissions can provide companies with valuable information for managing environmental risks, improving resource efficiency and strengthening stakeholder confidence. The empirical framework suggests a positive relationship between carbon accounting practices and financial performance, indicating that environmental responsibility and financial performance need not be conflicting objectives. Companies that integrate carbon management into their strategic and operational decisions may be better positioned to manage climate-related risks and respond to changing investor and regulatory expectations. However, the findings should be interpreted in the context of the selected companies and study period. Wider adoption of standardised carbon accounting practices, improved Scope 3 disclosure and stronger external assurance can further enhance the quality and usefulness of corporate carbon reporting.

Overall, carbon accounting can serve as a strategic mechanism for integrating environmental sustainability with long-term corporate financial performance.

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