

The Effect of Green Accounting and Carbon Disclosure to Profitability, Intervened By: Green Innovation

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Abstract

This study explores the intricate dynamics between Carbon Disclosure (CD), Green Accounting (GA), Green Innovation (GI), and Profitability within the corporate sector. Utilizing a robust dataset, we examined the empirical, model-implied saturated, and estimated correlation and covariance matrices to discern the relationships among these critical sustainability and financial performance metrics. Our findings indicate a consistently weak correlation between CD and GA, suggesting that higher carbon disclosure levels do not necessarily correspond to more rigorous green accounting practices. Similarly, an inverse relationship was identified between both CD and GI and GA and GI, implying a potential divergence between transparency, accounting practices, and innovative actions in environmental sustainability. Moreover, the weak to negligible correlations between GI and ROE across matrices highlight a disconnect between green innovation efforts and short-term financial performance. The covariance data reinforce these patterns, suggesting that while companies may be investing in sustainability, these efforts are not immediately reflected in profitability. These results underline the complex interplay between sustainability initiatives and corporate financial outcomes, suggesting that direct linear models may not fully capture the nuanced interactions at play. Our study prompts a reconsideration of the sustainability-financial performance nexus and calls for a more nuanced exploration of the mechanisms through which sustainability efforts translate into economic value. We recommend future research directions, including longitudinal studies, the investigation of mediating variables, industry-specific analyses, and international comparisons, to build a more comprehensive understanding of these vital relationships.

Keywords: Carbon Disclosure, Green Accounting, Green Innovation, Return on Equity, Sustainability, Corporate Finance, Environmental Strategy.

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INTRODUCTION

The global environmental crisis, particularly climate change, has taken center stage in recent decades, urging all sectors, including corporations, to take an active role in addressing these issues. This aligns with the research by Clarke & Klettner (2021), which depicts the significant role of corporations in responding to and mitigating climate change. Amidst this, the roles of Green Accounting and Carbon Disclosure have become more crucial than ever.

Green Accounting, an approach to record and report both financial and non-financial information related to environmental impact, has been recognized as an essential element in sustainable business practices (Wijethilake,

2020). Stakeholders' demands for corporate transparency and accountability regarding environmental issues have further bolstered the relevance of Green Accounting. However, there is still a research gap on how Green Accounting can influence corporate Profitability.

Moreover, Carbon Disclosure, which involves reporting corporate greenhouse gas emissions, has also emerged as a major issue in the discourse on corporate environmental responsibility (Suttipun & Stanton, 2022). Carbon Disclosure reflects a company's commitment to addressing climate change, yet studies on its impact on Profitability are sparse.

In this context, Green Innovation has the potential to be a crucial element in influencing the relationship between Green Accounting, Carbon Disclosure, and Profitability (Dangelico & Pujari, 2021). Green Innovation, designed to reduce environmental impact and enhance sustainability, should theoretically increase the company's market value. Nonetheless, there is a scarcity of research examining this phenomenon.

Prior research has touched on various aspects of this topic, but none have specifically addressed the influence of Green Accounting and Carbon Disclosure on Profitability with Green Innovation serving as an intervening variable. This creates a knowledge gap that this research aims to fill, offering a new opportunity to be explored. This study is motivated to bridge the gap in the existing literature and provide fresh insights into how Green Accounting, Carbon Disclosure, and Green Innovation interact and affect corporate Profitability. This research seeks to further our understanding of the role of Green Innovation in mediating the influence of Green Accounting and Carbon Disclosure on Profitability.

The objective of this study is to examine and elucidate the impact of Green Accounting and Carbon Disclosure on corporate Profitability, with a mediating role of Green Innovation. This study also aims to offer new perspectives to corporate management, investors, and other stakeholders on how they can leverage sustainable practices to enhance company value. It is anticipated that this research will yield strong empirical and theoretical evidence on how Green Accounting and Carbon Disclosure affect Profitability, as well as the significant role of Green Innovation in this relationship. This research is expected to make a substantial contribution to the literature on sustainable accounting and finance, as well as to business practices and public policy.

Green Accounting is an accounting system that integrates environmental factors into business decision-making. Hypothesis H1 suggests that companies that implement Green Accounting effectively and report their environmental impact to stakeholders will have a positive influence on Profitability, which is the financial value given by the market to the company.

Supporting this hypothesis is the study conducted by Ibrahim et al. (2020). Their research aimed to investigate the influence of Green Accounting on the market value of companies. The findings indicated a positive and significant relationship between the implementation of Green Accounting and Profitability. This suggests that Green Accounting can send positive signals to the market about a company's commitment to environmental sustainability, which in turn can enhance their market valuation.

H1: Green Accounting has a positive effect on Profitability

This hypothesis will be tested within the scope of the international journal paper to ascertain the empirical relationship between the adoption of Green Accounting practices and the profitability of a company, providing insights into the financial benefits of sustainable environmental practices in corporate management.

Hypothesis H2 posits that companies which conduct thorough disclosure of information regarding carbon emissions and carbon reduction strategies to stakeholders will have a positive impact on Profitability, the financial value given by the market to the company. By engaging in Carbon Disclosure, companies signal to the market that they are serious about managing environmental impacts and are committed to sustainability.

One recent study supporting this Hypothesis is the research conducted by Jamali et al. (2019). Their research aimed to examine the effect of environmental disclosures, including carbon disclosure, on a company's market value. The results showed a positive relationship between the level of carbon disclosure and the market value of the company. More specifically, the study found that companies that are more proactive in carbon disclosure have higher Profitability. This indicates that Carbon Disclosure can influence market perceptions about a company's commitment to carbon emissions management and environmental sustainability, which in turn contributes to an increase in their market value.

H2: Carbon Disclosure positively affects Profitability

Hypothesis H3 implies that Green Innovation, referring to the introduction or application of new ideas, goods, and processes that provide environmental benefits, can moderate the influence of Green Accounting on Profitability. In this context, Green Innovation acts as an intervening variable affecting the relationship between Green Accounting and Profitability.

One recent study supporting this Hypothesis is the research conducted by Panfilio et al. (2021). Their research involved a sample of manufacturing companies and aimed to test whether Green Innovation affects the relationship between Green Accounting and financial performance. The findings indicated that Green Innovation positively moderates the influence of Green Accounting on a company's financial performance, which may reflect Profitability. More specifically, the study suggests that companies that implement Green Accounting effectively and have high levels of Green Innovation tend to have better financial performance. This indicates that Green Innovation can strengthen the relationship between Green Accounting and Profitability by providing additional signals of a company's commitment to sustainability and green innovation.

H3: Green Innovation intervenes in the influence of Green Accounting on Profitability.

Hypothesis H4 suggests that Green Innovation, which refers to the introduction or application of new ideas, goods, and processes that provide environmental benefits, can moderate the influence of Carbon Disclosure on Profitability. In this context, Green Innovation serves as an intervening variable that affects the relationship between Carbon Disclosure and Profitability.

Research supporting this Hypothesis is the study conducted by Deng et al. (2020). This study aimed to explore the influence of Green Innovation on the relationship between Carbon Disclosure and a company's financial performance. The results showed that Green Innovation moderates the positive influence of Carbon Disclosure on financial performance, which can be reflected in Profitability. Companies that actively implement Carbon Disclosure and have high levels of Green Innovation tend to have better financial performance, which in turn can have a positive impact on Profitability.

H4: Green Innovation moderates the influence of Carbon Disclosure on Profitability

Green Innovation moderates the influence of Green Accounting and Carbon Disclosure on Profitability by strengthening that relationship. In this context, Green Innovation acts as an intervening variable affecting the influence of Green Accounting and Carbon Disclosure on Profitability by providing additional signals of a company's commitment to sustainability and green innovation.

One recent study supporting this concept is the research conducted by Wang et al. (2021). This study aimed to analyze the moderating effect of Green Innovation on the relationship between Green Accounting, Carbon Disclosure, and Profitability. The findings indicated that Green Innovation enhances the positive influence of Green Accounting and Carbon Disclosure on Profitability. Green Innovation acts as an augmenting factor that provides additional signals about a company's commitment to sustainability and green innovation, thus increasing the positive influence of Green Accounting and Carbon Disclosure on Profitability.

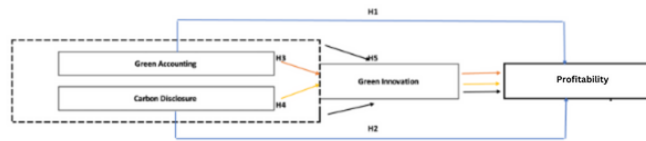
H5: Green Innovation moderates the influence of Green Accounting and Carbon Disclosure on Profitability.

RESEARCH METHOD

This study aims to explore the influence of Green Accounting and Carbon Disclosure on Profitability, intervened by Green Innovation, using a sample of Indonesian companies that have achieved the gold rating in 2021-2022 from PROPER (Public Disclosure Program for Environmental Compliance) by the Indonesian Ministry of Environment and have published a sustainability report. The sample consists of 102 companies from various sectors in Indonesia. The sample criteria include companies that meet the said requirements, namely receiving the PROPER gold rating, publishing a sustainability report, and operating within Indonesia

This study will use secondary data obtained from financial reports, sustainability reports, and market data to analyze the relationship between Green Accounting, Carbon Disclosure, Green Innovation, and Profitability. The analytical methods to be used include regression analysis to test the influence of independent variables (Green Accounting and Carbon Disclosure) on the dependent variable (Profitability), as well as moderation analysis to examine the influence of Green Innovation as an intervening variable in the relationship.

Figure 1.



The independent variable Green Accounting is measured using a proxy for Green Accounting, where the formula is depicted in the image. The formula for Green Accounting is as follows:

$$\text{Green Accounting} = \frac{\text{Number of Disclosed Items}}{\text{Total Items for Disclosure}} \times 100\%$$

- Number of Disclosed Items refers to:
 - Environmental Operational Costs
 - Product Recycling Costs
 - Environmental Research and Development Costs

Total Items for Disclosure: The number of items expected to be disclosed, which is 3 items in this case.

To measure the Green Accounting variable, the proportion of disclosed items to the total environmental disclosure items is calculated. This formula quantifies the extent of a company's environmental disclosures regarding operational costs, recycling processes, and research and development for environmental purposes. The result is multiplied by 100 to express it as a percentage, representing the degree to which a company engages in Green Accounting practices. This figure serves as an indicator of the company's transparency and commitment to incorporating environmental concerns into their financial reporting practices.

In the assessment of Carbon Disclosure as a variable in this study, a detailed scoring system is adopted based on multiple indicators related to carbon information disclosure. Each indicator within the dimensions of carbon information disclosure is allocated points based on qualitative or quantitative reporting. The indicators span various aspects of carbon management, from the strategic integration of carbon reduction goals to the technicalities of accounting standards, from employee involvement to the benefits and costs associated with carbon management.

For each indicator, a company can score points for disclosing specific, actionable strategies and metrics, reflecting the company's commitment and transparency in managing and reporting its carbon footprint. A qualitative description is valued, but a quantitative description is particularly encouraged and scored higher, given its specificity and measurability. Additionally, compliance with recognized standards such as the ISO14001 environmental management system certification is considered within the scoring system.

This point-based system provides a structured approach to evaluate the extent and depth of carbon disclosure practices among companies. It serves as a framework to quantify the level of disclosure and can be a valuable tool for comparing the carbon transparency of different organizations in a standardized way.

Table 1

Dimensions of Carbon Information Disclosure	Carbon Information Disclosure Indicators
Whether to integrate carbon emission reduction into enterprise development strategy	1 point for incorporating carbon emission reduction into enterprise development strategy; otherwise 0.
Whether to set carbon emission reduction targets	1 point for setting clear carbon emission reduction targets; otherwise 0.
Risks of carbon reduction	1 point for disclosing the business risks and economic benefit losses caused by the government's carbon emission regulation; otherwise 0.
Establish low carbon management organization or system	1 point for setting up a special low carbon management organization or establishing a low carbon management system; otherwise 0.
Enhance employees' low carbon awareness	1 point for carrying out low carbon environmental protection publicity for enterprise employees; otherwise 0.
Integrate carbon emission reduction into reward, punishment, and assessment mechanism	1 point for fully integrating employee rewards and punishments related to carbon emission reduction as clearly formulated in the enterprise rules and regulations; otherwise 0.
Annual carbon emissions of enterprises	1 point for qualitative description and 2 points for quantitative description; otherwise 0.
Carbon emission classification and accounting standards	1 point for qualitative description and 2 points for quantitative description; otherwise 0.
Energy consumption of the enterprise in the current year	1 point for qualitative description and 2 points for quantitative description; otherwise 0.
Whether the enterprise has passed ISO14001 environmental management system certification	1 point for passing, otherwise 0.
Carbon emission reduction of enterprises	1 point for qualitative description and 2 points for quantitative description; otherwise 0.
Whether enterprises invest in technology, capital, and labor for carbon reduction	1 point for actively investing in technology, capital, and labor specifically for carbon reduction; otherwise 0.
Cost of daily carbon emission reduction	1 point for the disclosure of specific charges, greening fees, and other expenses incurred in the process of carbon emission reduction management; otherwise 0.
Benefits from carbon emission reduction.	1 point for qualitative description and 2 points for quantitative description; otherwise 0.
Government support for carbon reduction	1 point for obtaining government financial subsidy support; otherwise 0.
Administrative penalties for environmental	1 point for not being penalized by

protection	environmental protection administration; otherwise 0.
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Green Innovation is quantified through multiple indicators that reflect the environmentally friendly initiatives of a company in terms of its patent activities. These indicators capture different dimensions of innovation, emphasizing not only the quantity but also the quality, diversity, and international reach of patents related to green products or services.

Efficiency is defined as the normalized number of patents related to green products/services published in the last five years. It reflects a company's focus on developing sustainable solutions and is given by the formula:

$$E_{i,t} = \frac{\sum_{t=0}^T n_i(t)}{N_i}$$

where N_i is the total number of employees of firm i . In the case of a region or a country i , the efficiency is evaluated according to Eq. (1), where $n_i(t)$ is the number of patents published in region i at time t and N_i is the total number of employees of region or country i .

The diversification indicator is defined as the number of IPC classes (4 digit) of each patent. Given a company i , the diversification $D_{i,t}$ is given by:

$$D_{i,t} = \frac{\sum_{t=0}^T \sum_{n=1}^{n_i(t)} c_{p,i}(t)}{\sum_{t=0}^T n_i(t)}$$

This indicator is important because it has been proven that small incremental innovations do not enhance firms innovation performance, see for example (Moaniba et al., 2018), whereas the kind and not the number of technical domains selected by the company are significant.

The quality indicator is defined as the number of backward citations. Given a company i , the quality indicator is given by:

$$Q_{i,t} = \frac{\sum_{t=0}^T \sum_{n=1}^{n_i(t)} b_{p,i}(t)}{\sum_{t=0}^T n_i(t)}$$

Backward citations play a main role in predicting IC, so companies must be aware that their capacity to absorb previous knowledge and make use of it will strongly affect future innovation and the ability to be competitive (Harhoff et al., 2003; Hall et al., 2007).

The internationalization indicator is defined as the number of geographical extensions of a patent. Given a company i , the internationalization $I_{i,t}$ indicator is given by:

$$I_{i,t} = \frac{\sum_{t=0}^T \sum_{n=1}^{n_i(t)} e_{p,i}(t)}{\sum_{t=0}^T n_i(t)}$$

Given the five previously defined indicators, an index that summarizes the five values is defined. The Innovation Patent Index (IPI) is defined by five dimensions, which are the five indicators just described: efficiency, time, diversification, quality and internationalization, as shown in

Figure 2. The IPI is evaluated as a weighted average of the normalized five indicators, in formula,

$$IPI_{i,t} = \alpha_1 E_{i,t} + \alpha_2 D_{i,t} + \alpha_3 Q_{i,t} + \alpha_4 I_{i,t} + \alpha_5 M_{i,t}$$

where α_1 , α_2 , α_3 , α_4 and α_5 are real numbers. So far, the α coefficients are positive and all equal. Thus, IPI is a real number that ranges between 0 and 10. Moreover, it is important to underline that in order to evaluate the IPI for a firm or a region it is necessary to define the period of observation T, i.e. the number of years.

RESULTS AND DISCUSSION

The consistently low correlation coefficients between CD and GA (0.043) across all three correlation matrices indicate a negligible linear association, suggesting that practices of carbon disclosure are not strongly related to the implementation of green accounting procedures within the firms analyzed. A notable negative correlation is observed between CD and GI (-0.321), implying that higher levels of carbon disclosure may not necessarily align with greater green innovation initiatives. This may reflect differing strategic priorities or potential trade-offs between transparency in carbon reporting and investment in green innovation.

The negative correlations between GA and GI (-0.207), and between GA and ROE (-0.249), suggest a weak inverse relationship, which could indicate that while companies are engaging in green accounting practices, these do not strongly translate into innovation or immediate financial performance gains. The near-zero correlation between GI and ROE (-0.005) implies that, within the sample, green innovation efforts have a negligible direct short-term impact on companies' profitability as measured by ROE.

Turning to the Empirical Covariance Matrix, the values are notably large, with a significant range across the variables. The covariance between CD and GA is positive, whereas it is negative between CD and GI, and between GA and GI. This reinforces the patterns observed in the correlation matrices, albeit the magnitudes are substantially more pronounced due to the nature of covariance measurement, which does not standardize by the variability of individual variables.

CONCLUSION

In summary, the data suggest that in the context of the sampled firms, carbon disclosure, and green accounting practices are not substantial predictors of green innovation or immediate financial returns. The disconnection between green innovation and ROE indicates that other factors may mediate the relationship between environmental initiatives and financial performance. These findings underscore the complexity of the sustainability-performance nexus and call for a deeper exploration of how companies can harmonize environmental strategies with financial objectives for long-term sustainability and value creation.

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