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The Effect of Carbon Emission Disclosure, Environmental Performance, and Firm Size on Profitability

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Abstract

Purpose: This study examines the effects of carbon emissions disclosure, environmental performance, and firm size on profitability.

Research Methodology: Nineteen companies were selected as samples using purposive sampling. The study used secondary data sourced from the annual reports and sustainability reports of each company and analyzed using a multiple linear regression approach with a fixed-effects model using Microsoft Excel and EViews 12 software.

Results: The results of the research analysis indicate that carbon emission disclosure has a negative effect, environmental performance has no significant effect, while firm size has a positive effect on profitability in Indonesian mining companies.

Conclusions: Regression analysis shows that carbon emissions disclosure (X_1) has a negative effect, environmental performance (X_2) has no significant effect, and firm size (X_3) has a positive effect on profitability.

Limitations: This study is limited to three independent variables, an observation period of 2021–2023, and a focus on the mining sector; therefore, the results cannot be generalized to other sectors.

Contributions: This research is expected to benefit companies in making strategic decisions related to sustainability, investors in evaluating financial and non-financial performance, academics in enriching the literature on factors that influence profitability, and further researchers in expanding the variables, sectors, and research periods.

Keywords: *Carbon Emission Disclosure, Environmental Performance, Firm Size, Profitability.*

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1. Introduction

Climate change has emerged as a major global concern because human activities have become the primary drivers of increasing Greenhouse Gas (GHG) emissions, which in turn contribute to the acceleration of global warming. This condition has led to various serious consequences, such as increased intensity of extreme weather events, rising sea levels, and disruptions to the balance of global ecosystems. According to the annual report of the United Nations Environment Programme, the energy sector and extractive industries, including mining, are among the largest contributors to global carbon emissions. Therefore, active corporate involvement is required to systematically implement sustainability principles within operational activities (Rodríguez-Olalla & Avilés-Palacios, 2017).

Indonesia has a substantial extractive industry base and thus faces a dualistic challenge between economic contributions and ecological impacts. From an economic perspective, the mining sector plays a strategic role in increasing foreign exchange earnings, driving Gross Domestic Product (GDP) growth, and expanding employment opportunities. From an environmental standpoint, mining-related activities

pose significant risks of environmental degradation, including water and air pollution, land damage, and increased carbon emissions (Prasetyo, Baderan, & Hamidu, 2025). These conditions position the mining sector as one of the main focal points in Indonesia's sustainable development agenda.

In response to growing demands for environmental accountability, companies are expected to enhance information transparency regarding their carbon footprint through carbon emission disclosure. Such transparency serves not only as an administrative obligation but also as a strategic effort to demonstrate corporate accountability and commitment to sustainability. Carbon emission disclosure reflects an entity's seriousness in managing environmental impacts and constitutes an important component of the implementation of Environmental, Social, and Governance (ESG) principles. The implementation of carbon emission disclosure may also affect a company's financial condition, as increased operational costs can have implications for profitability.

Environmental performance also affects profitability. In Indonesia, an environmental performance assessment program known as PROPER was established by the Ministry of Environment and Forestry to evaluate national environmental performance. Companies with strong environmental performance are generally able to reduce legal, reputational, and social risks while simultaneously enhancing investor and public trust. Higher PROPER ratings obtained by companies are associated with improved profitability, although the magnitude of this effect may vary across industries (Fitri & Suhendro, 2025).

Firm size also affects a company's ability to manage resources and implement sustainability strategies to achieve profitability (Chandra, Wijaya, Angelia, & Hayati, 2020). Larger entities typically have better access to capital, higher operational efficiency, and greater capacity to adapt to technological changes that support sustainability initiatives. Nevertheless, firm size does not always guarantee higher profitability. Based on this background, the profitability of mining companies is presumed to be influenced by three key factors: carbon emissions disclosure, environmental performance, and firm size. These factors are strategically relevant in explaining the extent to which business entities can integrate sustainability principles into their operational activities. However, empirical studies examining the simultaneous effects of these three characteristics particularly within the Indonesian mining sector remain limited.

Most prior studies have examined these variables in isolation and have not sufficiently considered post-COVID-19 pandemic conditions, which have affected business profitability and financial performance. Referring to the 2021–2023 period, this study aims to examine the impact of carbon emission disclosure, environmental performance, and firm size on the profitability of mining companies listed on the Indonesian Stock Exchange (IDX) during this period. Specifically, this research contributes to enriching the literature on the determinants of profitability within a sustainability framework in Indonesia's mining industry, which is characterized by high emission intensity and diverse sustainability disclosure practices.

2. Literature Review and Hypothesis Development

2.1 Legitimacy Theory

Dowling and Pfeffer (1975) argue that a company's sustainability depends on the alignment between its values and prevailing social norms. In this specific context, entities must effectively ensure that their operations and reporting processes are socially acceptable to gain public support. Environmental information disclosure can also serve as a strategic approach to demonstrate social responsibility and maintain a positive corporate image in the public eye, as such information originates from the surrounding environment itself. Yuliandhari and Ramadhanty (2024) reveal that corporate failure to comply with environmental standards can negatively affect both corporate legitimacy and financial performance.

Therefore, companies need to adjust their policies and reporting practices to remain consistent with the expectations of various parties, including stakeholders, to maintain corporate legitimacy and sustainability. Jubaedah and Setiawan (2023) also state that companies tend to increase environmental disclosure when facing social pressure to maintain public trust. This condition necessitates consistent

adjustments in operational policies and reporting patterns so that companies can meet societal expectations, preserve legitimacy, and support long-term business continuity (Mahrani & Soewarno, 2018). Accordingly, legitimacy theory serves as a conceptual foundation, suggesting that carbon emission disclosure and environmental performance function as mechanisms for companies to maintain social acceptance, which is reflected in improved profitability.

2.2 Signalling Theory

Bergh, Ketchen Jr, Orlandi, Heugens, and Boyd (2019) explains that information asymmetry arises because management possesses more comprehensive knowledge regarding the organization's condition and prospects than external parties. To minimize this information gap, companies provide credible signals through voluntary disclosures, financial reports, and strategic initiatives that reflect performance and long-term prospects. These signals aim to enhance transparency and build stakeholder trust in the company. Mardaningsih, Nurlaela, and Wijayanti (2021) reveal that market responses to a company are determined by the signals conveyed to stakeholders. The effectiveness of these signals depends on their credibility and the degree of difficulty for competitors to imitate them. Adequate information disclosure plays a role in strengthening corporate credibility and transparency, thereby reducing information asymmetry and the level of uncertainty perceived by investors.

By providing clear and accountable information, investors gain a more structured basis for evaluation and tend to develop a more positive perception of the company's prospects (Agustiningsih & Septiani, 2022). Larger companies are generally perceived as more credible because of higher levels of scrutiny and transparency, which helps reduce information asymmetry and attract investor confidence. Thus, signalling through information disclosure plays an important role in influencing corporate relationships with various stakeholders (Qasem et al., 2022). Signalling theory indicates that entities with larger scales or higher levels of information transparency are more likely to trigger favorable market reactions, thereby reinforcing the theoretical foundation related to firm size and carbon emission disclosure.

2.3 Carbon Emission Disclosure and Profitability

Business entities that disclose information regarding their carbon emissions demonstrate corporate transparency and reflect dedication and commitment to addressing environmental issues. This practice not only indicates awareness of sustainability-related concerns but also sends a positive signal to stakeholders regarding corporate accountability and governance quality (Budiman, Yadiati, & Abdul Hasyir, 2024). Such disclosures can strengthen legitimacy in the eyes of the public and regulators, particularly amid growing global attention to climate change mitigation.

Although implementation may incur additional costs, such as investments in green technology, reporting systems, and operational process adjustments, environmental information transparency can enhance investor confidence, improve corporate image, and expand strategic partnership opportunities. The long-term impact of these efforts is an improved reputation, which has the potential to create competitive advantages that support more stable and sustainable profitability. Xu, Su, Wang, and Liao (2025) oncluded that carbon emission disclosures have a positive impact on financial performance, as measured by return on assets.

Conversely, Siddique, Akhtaruzzaman, Rashid, and Hammami (2021) findings indicate that carbon emission disclosure has a significant negative impact on return on assets, which is a relative measure of a firm's financial success. These contrasting results suggest that the effect of carbon emission disclosure on profitability is highly dependent on industry characteristics and environmental compliance costs. Given the high emission intensity of Indonesia's mining sector, re-examining this relationship is relevant. Based on legitimacy and signalling theories, carbon emission disclosure is viewed as a signal of environmental accountability that can strengthen corporate legitimacy and is therefore theoretically assumed to contribute to increased profitability.

H_1: Carbon emission disclosure positively affects profitability.

2.4 Environmental Performance and Profitabilit

Environmental performance reflects a company's ability to manage environmental impacts through energy efficiency, pollution control, and the adoption of eco-friendly practices (Nelson, Junaidi, & Sentoso, 2025). Strong environmental performance demonstrates corporate commitment to sustainability principles and social responsibility, reinforcing legitimacy in the eyes of regulators, society, and other stakeholders. This commitment also serves as a positive signal of strong corporate governance and concern for long-term sustainability (Kodriyah, Kurnia, Sa'adah, & Kholiyah, 2023). With a positive reputation and high public trust, companies have the potential to gain competitive advantages, expand market opportunities, and increase investor support, which may ultimately support more stable and sustainable profitability growth.

Dohrmann, Martinez-Blasco, Moring, and Margarit (2024) show that environmental performance has a significant positive effect on financial performance, as measured by return on assets. In contrast, Anthoni and Cerya (2025), conclude that environmental performance does not have a significant impact on financial performance, contradicting the hypothesis developed in this study. These empirical variations suggest that the effect of environmental performance on profitability is influenced by the level of environmental risk within an industry, making the mining sector a relevant context for assessing the consistency of legitimacy theory. The theory argues that strong environmental performance enhances social acceptance and stakeholder trust, which is theoretically expected to strengthen profitability.

H_2: Environmental performance positively affects profitability.

2.5 Firm Size and Profitability

Firm size represents the scale of an entity and is typically measured by total assets, sales, or market value. Large-scale companies tend to manage resources more efficiently, have broader access to funding, and face higher demands for transparency to maintain public legitimacy. A larger scale can enhance profitability-generating capacity and strengthen stakeholder confidence (Ridhwan & Dwiati, 2022). In general, larger organizations exhibit greater operational stability and resilience to economic fluctuations, enabling them to sustain financial performance over longer periods. Consequently, large companies are positioned more strategically and competitively in terms of business expansion, innovation, and maintaining positive relationships with investors and creditors.

Shibutse, Kalunda, and Achoki (2019) findings reveal that firm size has a significant positive impact on financial success as measured by return on assets. Zavalii, Zhyhlei, Ivashko, and Kornatka (2025) research shows that firm size has a significant negative effect on return on assets, which is a statistical indicator of financial performance. These differing findings suggest that firm size may enhance efficiency and signal quality but can also generate negative effects as organizational complexity increases, thus requiring a re-examination in large-scale mining companies. In accordance with signalling theory, larger firm sizes are perceived as more credible and stable; therefore, firm size is expected to increase profitability.

H_3: Firm size positively affects profitability.

The conceptual framework of this study is as follows (Figure 1):

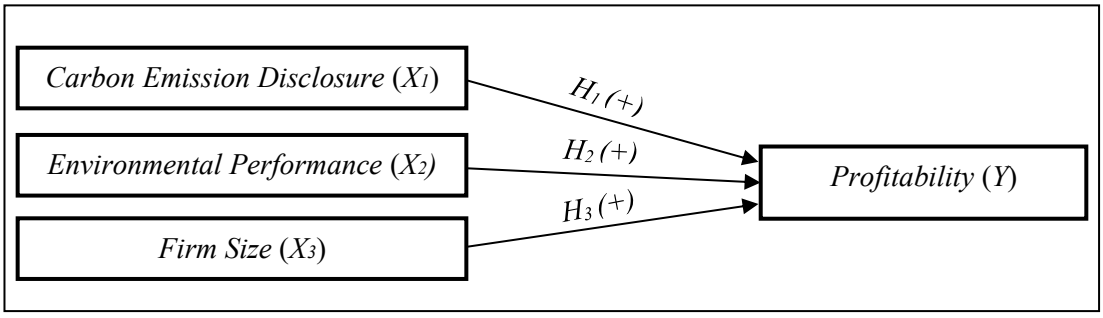

Figure 1. Conceptual framework

3. Methodology

3.1 Research Design

The objective of this study was to provide an unbiased description of corporate conditions without making broad generalizations about the overall population. Therefore, this research employed a descriptive design combined with a quantitative methodology. The findings of this study are based on secondary data; particularly numerical data obtained from sustainability and annual reports of mining companies that served as the research subjects. These reports are publicly accessible to the general public, including the authors, through the Indonesia Stock Exchange (www.idx.co.id), as well as through the official websites of the respective mining companies, which are displayed on each company's homepage.

In quantitative research methodology, three types of data structures are commonly used: time series, cross-sectional, and panel data. In accordance with the objectives of this study, panel data were used because they allow for the incorporation of a time dimension as well as comparisons across different organizations. This structure enables the observation of performance fluctuations from one period to another, thereby facilitating a more comprehensive analysis. The independent variables were firm size, corporate environmental performance, and the level of corporate carbon emission disclosure. The dependent variable was corporate profitability. Each of these variables was measured using indicators that are commonly employed in empirical research studies.

3.2 Research Subjects

Mining business entities listed on the Indonesia Stock Exchange (IDX) consistently from the beginning to the end of the period 2021–2023 constitute the research subjects of this study. The primary focus of the analysis is on data available in sustainability and annual reports published on the official company websites during the specified period. During the same period, there were 67 mining business entities listed on the Indonesia Stock Exchange (IDX), which formed the population of this study. In the sample selection process, non-probability sampling combined with purposive sampling was employed.

This method is consistent with the research objectives and involves selecting samples based on predetermined criteria. 1) Mining companies that were continuously listed on the Indonesia Stock Exchange for three consecutive years, from 2021 to 2023; 2) Mining companies that published sustainability reports and annual reports during the period and made them publicly accessible; and 3) Mining companies that consistently obtained PROPER ratings from the Ministry of Environment and Forestry throughout the period. Based on these criteria, 19 companies were selected as the research sample, resulting in 57 observations over the three-year period. The sample selection process of the research variables is presented as follows Table 1:

Table 1. Sample selection process

Sample Selection Criteria	Number of Companies
Mining companies listed on the Indonesia Stock Exchange for three consecutive years (2021–2023)	67
Mining companies that did not publish annual or sustainability reports during 2021–2023	(12)
Mining companies that did not consistently obtain PROPER ratings from the Ministry of Environment and Forestry (KLHK) during 2021–2023.	(36)
Total sample	19
Total observations over three years	57

3.3 Variable Operationalization

3.3.1. Profitability (Corporate Profitability Performance)

Profitability reflects a company's ability to generate profits through efficient resource management. Chudy-Laskowska and Rokita (2024) state that both internal and external factors influence business profitability, some of which can be controlled by organizations through the implementation of appropriate policies and operational strategies. In this study, profitability is proxied using the Return-on-Assets (ROA) metric. Return on Assets (ROA) measures how effectively a company's assets are utilized to generate profits. ROA is considered a relevant measure of profitability because it reflects the overall efficiency of total asset utilization in operational activities.

3.3.2. Carbon Emission Disclosure

Carbon emission disclosure presents data related to carbon emissions resulting from operational activities in response to climate change issues and serves as an illustration of corporate transparency. In this study, the level of transparency related to carbon emissions is assessed using the Carbon Emission Disclosure Project Index developed (Bae Choi, Lee, & Psaros, 2013). This index consists of five categories of variables: disclosure related to climate change issues, greenhouse gas emission calculations, energy usage, costs, and initiatives aimed at emission reduction, and accountability procedures for generated emissions. In total, these five categories comprise 18 disclosure items used to evaluate the extent to which companies provide information on carbon emission management. For example, when a company reports quantitative data on year-to-year changes in total carbon emissions measured in metric tons of CO_2-equivalent, the disclosure is assigned a score of one out of the 18 assessment indicators.

3.3.3. Environmental Performance

Environmental performance describes the extent to which a company can manage its operational activities in a manner that minimizes negative environmental impacts while supporting efforts to preserve environmental quality. Handoyo, Akram, and Nurabiah (2022) argue that environmental performance can be assessed through scores or ratings that indicate a company's level of compliance and responsibility toward environmental aspects. Various efforts have been undertaken to reduce environmental degradation, including the formulation and implementation of regulations at both national and international levels (Aulia & Hadinata, 2019). In Indonesia, environmental performance assessment is conducted through the PROPER program administered by the Ministry of Environment and Forestry, which uses a color-based rating system: gold and green for excellent performance, blue for compliance, red for non-compliance, and black for serious violations of environmental regulations.

3.3.4. Firm Size

Firm size in this study is measured based on total assets, as total assets reflect a company's operational capacity and scale of activities (Abeyrathna & Priyadarshana, 2019; Maulana & Rahayu, 2022). The larger the total assets, the broader the scope of business activities, the greater the level of resource management, and the stronger the company's ability to expand and finance operational activities. Therefore, total assets serve as a relevant indicator for assessing firm size and the strategic position of a business entity in the industrial market.

A summary of the operationalization of the research variables is presented as follows Table 2:

Table 2. Summary of variable operationalization

No	Variable	Measurement	Scale
1.	Profitability	$ROA = \frac{Net\ Income}{Total\ Assets}$	Ratio
2.	Carbon Emission Disclosure	$CED = \frac{\Sigma di}{18}$	Ratio
3.	Environmental Performance	$EP = PROPER\ Rating$	Ratio
4.	Firm Size	$FS = Ln\ (total\ asset)$	Ratio

4. Results and Discussion

4.1 Classical Assumption Tests

4.1.1. Normality Test

As a component of this study, a normality test was conducted to determine whether the data contained in the regression model followed a normal distribution. The Jarque–Bera test, which is included in the EViews software, was used to test the following hypotheses: Hypothesis H0 states that the data follow a normal distribution, in contrast to hypothesis H_a, which states that the data do not follow a normal distribution. The evaluation was carried out using the probability value, better known as the p-value. The significance level for the evaluation was set at 0.05. If the p-value is greater than 0.05, null hypothesis (H_0) is accepted.

This hypothesis states that the data are considered normally distributed and the regression model can be used. If the opposite result applies, that is, the p-value is less than or equal to 0.05, null hypothesis (H_0) is rejected without further consideration. This indicates that the data do not follow a normal distribution, which must be considered when performing regression analysis. The results of the normality test show that the probability value of 0.1298 (12.98%) is greater than the significance level of 0.05. This indicates that there is no significant deviation between the data and the normal distribution. Regression analysis can therefore be performed on the data because null hypothesis (H_0) has been accepted.

4.1.2. Multicollinearity Test

The multicollinearity test in the context of regression model analysis is used to determine whether the variables considered independent have a significant relationship with other independent variables. The hypotheses used include H_0, which states that there is no relationship between the independent variables, and H_a, which states that there is a correlation between the independent variables. The obtained correlation coefficient values serve as the main reference in conducting this test, where the correlation coefficients among variables are examined with the criterion that the correlation coefficient value is less than 0.80. There is no evidence of multicollinearity in the regression model; therefore, the null hypothesis (H_0) is accepted if this condition is met.

Table 3. Results of the multicollinearity test

	PROF	**CED**	**EP**	**FS**
PROF	1,000000	-0,386887	0,025023	-0,175326
CED	-0,386887	1,000000	0,349164	0,655076
EP	0,025023	0,349164	1,000000	0,619204
FS	-0,175326	0,655076	0,619204	1,000000

Table 3 presents the results of the multicollinearity test, which show that the correlation coefficient between carbon emission disclosure and environmental performance is 0.35, between carbon emission disclosure and firm size is 0.66, and between environmental performance and firm size is 0.62. All coefficient values are below the 0.8 threshold, indicating that the relationships among the independent variables are relatively weak and not significant. Thus, H_0 can be accepted; therefore, it can be concluded that the regression model is free from multicollinearity problems.

4.1.3. Heteroskedasticity Test

The heteroscedasticity test determines whether the variance of residuals among the data in the regression model is consistent (homoscedasticity) or significantly different (heteroscedasticity); therefore, a heteroscedasticity test is required in conducting research. A regression model that meets the homoscedasticity requirement shows residual stability and reliable and unbiased estimates (Ghozali & Ratmono, 2017). The following hypotheses are relevant to this test: H_0 indicates that heteroscedasticity does not exist, while H_a indicates that it does. This evaluation, with a threshold of 0.05, is based on the significance value, which serves as the basis for the assessment.

If the significance value is greater than 0.05, the null hypothesis (H_0) is accepted, and the model is considered free from heteroscedasticity. The possibility of determining whether heteroscedasticity exists or not is by determining whether the null hypothesis (H_0) is rejected or not when the significance value is less than or equal to 0.05. The findings from the heteroscedasticity test reveal that the average chi-square probability value (obs*R-squared) for this investigation is 0.6643, which is equivalent to 66.43%. This result is greater than the 0.05 threshold for statistical significance. The results of the study can conclude from this result that the data related to the independent variables do not show any heteroscedasticity. The resulting implication is that the residual variance is maintained at the same level across all observations, and the regression model can be used without problems.

4.1.3. Autocorrelation Test

An autocorrelation test was conducted to determine whether the residuals in period t are related to the residuals in the previous period (t−1), which indicates the presence of dependence among observations. If the residuals do not remain independent over time, this problem will arise. One method for conducting this test is the Lagrange Multiplier (LM) test, developed by Yuan and Liu (2021). The following assumption can be used for this test: the study assumes no autocorrelation, with the null hypothesis being H_0. With a significance level of 0.05, the decision regarding this autocorrelation test is based on the chi-square probability value (obs*R-squared).*

If the probability value is greater than 0.05, then the null hypothesis (H_0) is accepted, and the regression model does not contain autocorrelation. If the probability value ultimately proves to be less than or equal to 0.05, indicating that there is still a relationship between periods, then the null hypothesis (H_0) is rejected. This is because the null hypothesis is not supported by the data. Based on the results of the autocorrelation test, the chi-square probability value (obsR-squared) was 0.1157, which is greater than the significance level of 0.05. Given this, it indicates that the regression model does not contain autocorrelation; therefore, the null hypothesis (H_0) was accepted.

4.2 Data Analysis Assumption Tests

Panel data regression analysis assesses the relationship between independent and dependent variables using panel data, a combination of cross-sectional and time-series data. Three main models are used: the Fixed-Effects Model (FEM), which captures individual fixed characteristics through dummy variables; the Random-Effects Model (REM), which treats differences among individuals as random variables with Generalized Least Squares (GLS) estimation; and the Common-Effects Model (CEM), which ignores individual and time differences using Ordinary Least Squares (OLS). The appropriate model is selected through the Chow test (FEM vs. CEM), the Hausman test (FEM vs. REM), and the Breusch–Pagan LM test (REM vs. CEM), with a p-value of 0.05 as the reference, thus enabling the identification of the most representative model according to the characteristics of the panel data.

Table 4. Results of the Chow test and Hausman test

Method	Test	Value	Result
Chow Test	FEM vs CEM	Prob.: 0,0000	Fixed Effect Model
Hausman Test	FEM vs REM	Prob.: 0,0160	Fixed Effect Model

Based on the results of the Chow and Hausman tests, as presented in Table 4., it can be concluded that the Fixed-Effects Model (FEM) is the most appropriate regression model for this study. Therefore, the Lagrange multiplier test was considered irrelevant to this study. These findings confirm that the FEM is the model that best fits the characteristics of the panel data and meets the required statistical assumptions; therefore, it can be relied upon for the regression analysis in this study.

Table 5. Results of multiple linear regression analysis

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	-6,668591	2,449209	-2,722753	0,0100
CED	-0,313557	0,140770	-2,227436	0,0324
EP	4,79E-05	0,031945	0,001500	0,9988
FS	0,233710	0,082367	2,837417	0,0075

Based on the results of the multiple linear regression analysis, the form of the multiple linear equation used in this study can be expressed as follows:

$$PROF = -6{,}668591 - 0{,}313557 * CED + 0{,}0000479 * EP + 0{,}233710 * FS + \varepsilon \quad (1)$$

The t-test was used to test the partial hypotheses to confirm the impact of each independent variable on the dependent variable being tested. The examination findings in the study illustrate that the probability value of the carbon emission disclosure variable is 0.0324, which is lower than the significance level of 0.05. It was determined that the coefficient value of −0.313557 indicates a significant and negative impact of carbon emissions disclosure on profitability, which rejects Hypothesis 1 (H_1).

The next probability value for the environmental performance variable is found to be 0.9988. This result is found to be significantly higher than the significance level of 0.05, with a coefficient value of 0.0000479 (4.79E-05). This result rejects Hypothesis 2 (H_2) because it was proven that environmental performance does not have a significant effect on profitability. The last variable, firm size, had a coefficient value of 0.233710 and a probability value of 0.0075, which is less than 0.05, indicating that firm size has a positive impact on profitability and supports Hypothesis 3 (H_3).

The implementation of the F-test aims and functions to determine whether all independent factors used simultaneously affect the dependent variable; therefore, the F-test is conducted. The probability value, also known as the F-statistic, is 0.000000 based on the results of the F-test. This result is below the significance level of 0.05. This result indicates that firm size, environmental performance, and carbon emission disclosure simultaneously affect profitability. The result of the adjusted R-squared (adj. R^2) test for the multiple linear regression model is 0.777665, which is equivalent to 78%. The remaining 22% of the variation in profitability is influenced by variables not included in the research model. The remaining 22% of the variation in profitability is influenced by variables not included in the research model.

5. Conclusions

5.1 Conclusion

The results of this study indicate that carbon emission disclosure has a negative and significant effect on profitability. This suggests that increased disclosure may lead to additional costs related to emission control programs and environmental reporting. Environmental performance, however, does not have a significant effect on profitability, possibly because environmental initiatives require substantial investment and their benefits tend to appear in the long term.

Firm size has a positive and significant effect on profitability, indicating that larger companies tend to achieve higher profitability due to stronger resources and more efficient operational management. This study contributes to understanding the relationship between carbon emission disclosure, environmental performance, and firm size in influencing profitability in extractive industry companies. The findings also provide practical implications for regulators, companies, and investors in considering sustainability and ESG aspects in decision-making.

5.2 Research Limitations

This study is limited to companies in the extractive industry and only examines three main variables: carbon emission disclosure, environmental performance, and firm size. In addition, the research period may not fully capture the long-term impact of environmental initiatives on profitability.

5.3 Suggestions and Directions for Future Research

Future research is recommended to include additional variables such as intellectual capital, cost of capital, environmental costs, social responsibility disclosure, and good corporate governance. Researchers are also encouraged to extend the research period and expand the scope of study to other sectors such as transportation, manufacturing, and logistics to obtain more comprehensive results.

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Author Contributions

PCL Conceptualization, research design, data collection, data analysis, manuscript drafting, and final approval. RS Supervision, methodological guidance, manuscript revision, and final approval.

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