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Financial Performance of Indonesian Coal Energy Companies: The Role of Green Intellectual Capital Disclosure, Leverage, and Firm Size

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Abstract

Coal mining is one of the main drivers of economic growth in Indonesia; therefore, assessing its financial performance is the first step in identifying potential risks. This study aims to investigate Green Intellectual Capital, leverage, and firm size as determinants of corporate financial performance. The data used are coal energy company data from Indonesia for the period 2020–2024, with a total of 15 companies selected through purposive sampling. Data were analyzed using multiple linear regression and moderated regression analysis (MRA) to examine the interaction effects. The results indicate that Green Intellectual Capital exhibits a positive but statistically non-significant relationship with financial performance, whereas leverage has a significant negative impact on financial performance. Firm size shows a significant positive effect on financial performance yet does not significantly moderate the relationship between either Green Intellectual Capital or leverage and financial performance. These findings underscore the importance of an integrated management strategy that combines green intellectual capital development, financial discipline, and optimal firm size to enhance financial performance in the coal energy sector.

Keywords: *Green Intellectual Capital; Leverage; Firm Size; Financial Performance*

INTRODUCTION

Coal mining is one of the major drivers of economic growth and national development in Indonesia. In 2024, Indonesia's coal production reached 836 million tons (Kementerian Energi dan Sumber Daya Mineral, 2025). Unfortunately, high productivity levels also correspond to an increase in environmental impacts caused by coal production, one of which is pollution. Greenpeace reports that air pollution, largely caused by the burning of fossil fuels, results in around 6.7 million premature deaths every year (Greenpeace Indonesia, 2025). In general, the main objective of a company is to achieve maximum profits, but this profit orientation leads many companies to exploit natural resources and society in an uncontrolled manner. According to Nurkhasanah & Sisdianto (2024), this is done without considering environmental conditions, such as ecological balance, employees, ecosystems, and the company itself. Ramadhani & Hidayati (2024) state that, in the triple bottom line concept, companies are encouraged to pay attention to economic, social, and environmental aspects. Companies are expected not only to prioritize management and shareholders, but also employees, consumers, the wider community, and the environment.

The financial performance of companies in the coal sector has recently shown fluctuating trends. In 2020, many coal companies posted negative ROA, reflecting a decrease in profitability, partly due to the plunge in coal prices during the pandemic (Wijayanto, 2020). Coal prices fell to USD 52.16 per ton in 2020 because of weak global demand during lockdowns (Wijayanto, 2020). In 2021, along with economic recovery, coal companies' performance improved due to high

demand for coal exports (Andrianto, 2022). This positive trend continued in 2022 when Indonesia's coal export volume jumped by 1,300%, triggered by Russia's invasion of Ukraine, which increased coal demand in Europe (Maesaroh, 2023). After the pandemic, in 2023, coal companies in Indonesia began to stabilize, but price volatility led to weaker financial performance compared to the previous year. The Ministry of Energy and Mineral Resources set the reference coal price for December 2023 at USD 117.38 per ton, representing a 16.03% decrease from the November 2023 benchmark of USD 139.80 per ton. The December 2023 benchmark marked the eighth consecutive monthly decline since early 2023 (Santika, 2023). Aside from market factors, energy transition policies toward renewable sources have begun to affect the industry's prospects. These conditions underscore the urgency for coal companies to improve efficiency and innovation to maintain performance while facing environmental challenges and changes in energy policy.

In 2024, Indonesia's coal production sector began facing new challenges. Policies to reduce fossil fuel consumption and increase the use of renewable energy caused financial performance to decline compared to the previous two years. Apart from the Paris Agreement, issues related to the United Nations (UN) Sustainable Development Goals (SDGs), particularly Goal 7, Affordable and Clean Energy, aim to ensure widespread and sustainable access to affordable, reliable, and modern energy. Aware of the adverse effects of fossil fuel use, even before Indonesia signed the Paris Agreement, the government had regulated the energy transition from fossil fuels to New and Renewable Energy. This is governed under Government Regulation No. 79 of 2014 on Kebijakan Energi Nasional (KEN), which sets a target for the share of New and Renewable Energy (EBT) in Indonesia's total primary energy to reach 23% by 2025 and 31% by 2050 (Lahope, 2024). This condition indicates that if coal companies do not begin investing in environmentally friendly initiatives through knowledge, innovation, and green technology, those in the coal energy sector will continue to experience declining financial performance.

To improve sustainable performance, it is necessary to pay more attention to a company's intangible assets. A company's competitive advantage no longer relies solely on tangible assets but also on intangible assets such as knowledge, innovation, and organizational capabilities (Andry & Nuryani, 2022). Companies that rely solely on physical assets will find it difficult to grow; therefore, it is important to optimize intangible assets in their operations (Mustapa et al., 2022). This led to the development of a concept called Green Intellectual Capital (GIC), which integrates environmentally friendly behavior into a company's intellectual capital (Chen, 2007). Green intellectual capital is defined as all environmentally oriented knowledge, capabilities, and relationships—both at the individual and organizational levels—that create a competitive advantage (Putri et al., 2023). In other words, green intellectual capital reflects a company's capabilities in managing human, structural, and relational capital to support environmental sustainability and enhance corporate value and performance (Chen, 2007). Chen (2007) divides GIC into three components: green human capital, green structural capital, and green relational capital. These elements help companies compete while protecting the environment. Companies that successfully integrate green innovation and knowledge into their strategies are expected to improve efficiency, reputation, and financial performance as environmental benefits are achieved.

Besides green intellectual capital, a company's capital structure also affects financial performance. Leverage describes how a company uses debt to fund its operations. Optimal use of debt can provide tax shield benefits and support business expansion, thereby increasing profits (Siregar et al., 2024). However, excessive leverage can raise interest expenses and financial risk, reducing profitability (Simorangkir & Suhartono, 2026). From a Trade-Off Theory perspective, companies must balance the benefits and costs of debt (Myers, 1984). Empirical studies report mixed results: some find that leverage positively correlates with performance when managed productively (Susilawati & Purnomo, 2023; Thelendra et al., 2025), while others note a negative relationship, as high debt burdens can reduce profits (Christian et al., 2018; Yulianingtias & Suryadi, 2024). In other words, leverage can be a double-edged sword—it can increase profits but also negatively impact financial performance when excessive. Firm size is also suspected to influence a company's financial performance. Generally, large companies tend to have more abundant resources, more efficient operations, and better access to funding compared to smaller firms (Carolin & Susilawati, 2024). With these advantages, large-scale companies are expected to achieve higher profitability (Amalia, 2021). Wulandari et al. (2022) found that firm size positively affects performance because a larger scale provides greater operational and competitive efficiency. However, several studies have reported a negative or insignificant effect of size on financial performance (Mabruroh & Anwar, 2022; Wibowo & Tahwin, 2024). This may be due to diminishing returns in large companies, complex bureaucracies, and high agency costs that reduce operational effectiveness, thereby diminishing the advantages of scale. In the coal industry, commodity price volatility affects companies of all sizes, suggesting that the relative advantages of large firms may be limited.

Based on the explanations above, it is evident how GIC and leverage affect a company's financial performance. However, inconsistent results have been found in previous research. Some studies show that GIC can improve financial performance (Anggriani & Dewi, 2022), while others report no significant effect (Sukirman & Dianawati, 2023). Similarly, leverage has shown varying effects across industries (Christian et al., 2018; Susilawati & Purnomo, 2023; Thelendra et al., 2025; Yulianingtias & Suryadi, 2024). These inconsistencies motivate this study, which aims to examine the influence of Green Intellectual Capital and leverage on financial performance, with firm size as a moderating variable, in coal sub-sector energy companies listed on the Indonesia Stock Exchange during 2020–2024. This study is expected to deepen the understanding of how green intellectual capital and capital structure affect the performance of coal mining companies and whether their effects differ according to company size. The findings are also expected to fill gaps in the literature and provide practical insights for managers in developing effective sustainability strategies.

METHOD

This study utilized a quantitative confirmatory descriptive design to assess the causal relationships between each of the studied variables. The data used in this study are secondary data obtained from companies' financial statements and sustainability reports. The research population

included companies in the energy sector, specifically the coal sub-sector, listed on the Indonesia Stock Exchange (IDX). The sample selection was conducted using purposive sampling with the following criteria: coal companies that consistently published annual financial and sustainability reports during 2020–2024. Based on these criteria, 15 companies were selected as samples, resulting in a total of 75 observations to be analyzed.

Financial performance was proxied by the Return on Assets (ROA) ratio, which represents the ratio of net income to total company assets. The independent variables consisted of Green Intellectual Capital (GIC) and leverage. GIC was measured through the green intellectual capital disclosure index in the companies' sustainability reports. This measurement refers to the number of GIC items disclosed by a company compared to a total of 17 indicator items; each disclosure item is assigned a value of 1 if disclosed in the report and 0 if not. The company's GIC score is obtained from the percentage of total items disclosed (GIC disclosure index). The leverage variable was proxied by the Debt to Asset Ratio (DAR), which represents the ratio of total liabilities to total assets. Company size, as the moderating variable, was measured using the natural logarithm (Ln) of total company assets.

Data analysis was then performed using multiple linear regression and moderated regression analysis, preceded by classical assumption testing. The regression equations proposed in this study are as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + e$$

Description :

Y	=	Financial Performance
a	=	Constant
$b_1b_2b_3$	=	The regression coefficient of each independent variable
X_1	=	Green Intellectual Capital
X_2	=	Leverage
X_3	=	Firm Size
e	=	Error

As for the moderation regression equation proposed is as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_1 * X_3 + b_5X_2 * X_3 + e$$

Description :

Y	=	Financial Performance
a	=	Constant
b_1-b_5	=	The regression coefficient of each independent variable
X_1	=	Green Intellectual Capital
X_2	=	Leverage
X_3	=	Firm Size
e	=	Error

Hypothesis testing was conducted partially (t-test) for each regression coefficient β, as well as simultaneously (F-test) for the overall significance of the model. The significance level used was 0.05. A partial hypothesis was considered supported if the significance value was < 0.05 and

the coefficient sign was in line with the direction of the hypothesis. Conversely, a significance > 0.05 indicates that the variable has no significant effect. The analysis also includes the coefficient of determination (R^2) to see the proportion of financial performance variance that can be explained by the model.

RESULT AND DISCUSSION

Classical Assumption Test

Before conducting regression analysis, the data were tested for the classical linear regression assumptions. These include tests for normality, multicollinearity, heteroskedasticity, and autocorrelation. Table 1 summarizes the results of these assumption tests, indicating that all classical assumptions were satisfied and thus the regression models are valid for inference

Table 1. Classical Assumption Test Summarize

Assumption Test	Key Result (Statistic)	Conclusion
Normality (K–S test on residuals)	p = 0.200 (Asymp. Sig. > 0.05)	Residuals are normally distributed.
Multicollinearity (VIF & Tolerance)	GIC VIF 1.055 (Tol 0.948); Leverage VIF 1.156 (Tol 0.865); Firm Size VIF 1.215 (Tol 0.823)	No multicollinearity detected (all VIF < 10 and Tol > 0.1).
Heteroskedasticity (Residual Scatterplot)	Residuals randomly scattered, no discernible pattern or funnel shape	Homoskedasticity assumed (no heteroskedasticity present).
Autocorrelation (Durbin–Watson test)	DW = 1.912; d_U ≈ 1.7092, 4–d_U ≈ 2.2908 (1.7092 < 1.912 < 2.2908)	No autocorrelation in residuals.

Source: Data processed by the author (2025)

a) Normality: The Kolmogorov–Smirnov test for residuals yielded a significance value of 0.200, which is greater than 0.05. This implies the residuals are normally distributed. A P-P plot of residuals further confirmed that points roughly follow the diagonal line, with only slight deviations at the tails that are within tolerance.
b) Multicollinearity: Variance Inflation Factor (VIF) values for all independent variables were well below 10 (GIC = 1.055, Leverage = 1.156, Firm Size = 1.215), and tolerance values were above 0.1. These results indicate no severe multicollinearity among the predictors. In other words, the independent variables (including the moderating variable) are not excessively correlated with each other, so the regression coefficients can be interpreted reliably.
c) Heteroskedasticity: A scatterplot of the residuals versus fitted values showed the points randomly dispersed without a clear pattern (no obvious clustering, wavy, or funnel shapes). This suggests the variance of the errors is constant across observations (homoskedasticity), satisfying the homogeneity of variance assumption. No symptoms of heteroskedasticity were detected in the model.
d) Autocorrelation: The Durbin–Watson (DW) statistic was 1.912. Given the upper bound value dU = 1.7092 for the sample and 4–dU = 2.2908, the DW statistic falls between these bounds (1.7092 < 1.912 < 2.2908). Thus, there is no evidence of positive or negative autocorrelation

in the residuals. This indicates the residuals are independent from one observation to the next, fulfilling the independence assumption.

Regression Analysis

This study employed multiple linear regression to examine the influence of Green Intellectual Capital and leverage on financial performance, as well as a moderated regression (MRA) to test the effect of firm size as a moderating variable. Two regression models were estimated: Model 1 included GIC, leverage, and firm size as predictors of financial performance; Model 2 added interaction terms (GIC×Firm Size and Leverage×Firm Size) to assess moderation by firm size. The regression results from Model 1 are presented as follows:

$$\text{Financial Performance} = 0.001 + 0.188\,\text{GIC} - 0.483\,\text{Leverage} + 0.332\,\text{Firm Size}$$

Model 1: The regression results for Model 1 indicate that GIC has a positive effect (B = 0.188). In contrast, leverage shows a negative association with financial performance (B = -0.483), which means higher leverage is associated with significantly lower ROA. Firm size exhibits a positive effect on financial performance (B = 0.332), suggesting that larger firms tend to achieve higher ROA. These coefficients imply that, without considering interactions, leverage is a strong, detrimental factor for performance, firm size is beneficial, and GIC's direct effect is positive in this sample. Furthermore, the regression results for Model 2 are presented as follows:

$$\text{Financial Performance} = 0.019 + 0.162\,\text{GIC} - 0.493\,\text{Leverage} + 0.326\,\text{Firm Size} - 0.051\,(\text{GIC} \times \text{Firm Size}) - 0.080\,(\text{Leverage} \times \text{Firm Size})$$

Model 2 (With Moderation): In the moderated regression including interaction terms, the coefficient for GIC remains positive (B = 0.162). Leverage continues to have a negative effect (B = -0.493, p = 0.000) in Model 2, consistent with Model 1. Firm size also has a positive impact on performance (B = 0.326, p = 0.011). Crucially, the interaction term for GIC and firm size (GIC×Firm Size) is negative (B ≈ -0.051). Similarly, the interaction term for leverage and firm size (Leverage×Firm Size) is negative (B = -0.080). These results indicate that no significant moderation effect of firm size was found for either the GIC and financial performance relationship or the leverage and financial performance relationship. In other words, within this sample, the impact of GIC on financial performance does not significantly differ between larger and smaller firms, and likewise, the detrimental impact of high leverage is not significantly buffered (or exacerbated) by firm size.

3.3 R^2

The coefficient of determination (R^2) was analyzed to understand how much variance in financial performance is explained by the models. Model 1 (without interaction terms) had an R^2 of 0.240 (Adjusted R^2 = 0.204), which means that around 24.0% of the variation in ROA is jointly explained by GIC, leverage, and firm size. The remaining 76% of ROA variance is due to other factors outside the model. Model 2 (with the moderating interactions) showed a slight increase in R^2 to 0.243 (Adjusted R^2 = 0.181). This indicates the inclusion of the interaction terms improved the explained variance by only 0.3 percentage points (from 24.0% to 24.3%). Such a minimal increase suggests that firm size's moderating effect is practically negligible in explaining financial performance, corroborating the earlier finding that the moderation was not statistically significant.

Effect of Green Intellectual Capital on Financial Performance

The analysis found that Green Intellectual Capital (GIC) had a positive but statistically non-significant effect on the financial performance of coal energy companies in Indonesia over 2020–2024. This suggests that, in the observed sample, investments in or disclosures of environmentally oriented intellectual capital did not translate into immediate financial gains. The lack of a significant impact is somewhat surprising given the Resource-Based Theory perspective, which posits that unique intangible assets, such as intellectual capital, can be sources of sustainable competitive advantage that improve firm performance (Barney & Hesterly, 2008). Benevene et al. (2021) emphasize that effectively managing green knowledge and capabilities may help companies enhance efficiency, innovate sustainably, and build a positive reputation, which could drive better financial outcomes. Companies that successfully embed sustainable practices and green innovation into their operations should, in the long run, see improvements in profitability through cost savings (energy efficiency, waste reduction) and revenue growth from enhanced brand image or new green markets (Benevene et al., 2021).

However, the findings of this study do not align with those of other research. Sukirman & Dianawati (2023) examined mining and basic industry firms and similarly found that green intellectual capital disclosure did not have a direct impact on financial performance. They argued that, at present, only a few companies actually integrate green intellectual capital into their core operations, so the benefits for financial performance are not yet apparent. Murimi et al. (2019) suggested that the benefits of Green Intellectual Capital tend to be long-term and not immediately reflected in short-term financial metrics such as ROA. Implementing GIC may require time and supportive ecosystems before generating sufficient cost savings or revenue to improve financial performance. Early-stage investments in green intellectual capital can incur high initial costs. For instance, implementing new eco-friendly processes or technologies often demands significant upfront expenditure, which might suppress short-run earnings (Iqbal et al., 2025).

It is important to note that not all studies agree on these findings. Anggriani & Dewi (2022), in their study, found that Green Intellectual Capital has a significant positive effect on financial performance. Similarly, Sari & Nursal (2024) stated that investment in Green Intellectual Capital can significantly improve a company's financial performance. In line with these findings, Astuti & Ahmar (2025) argue that companies that actively develop environmentally friendly knowledge and innovation can increase profits through energy efficiency, waste reduction, and improvements in corporate image, which in turn strengthen asset profitability.

Effect of Leverage on Financial Performance

The regression results demonstrated that leverage has a significant negative effect on financial performance. In other words, higher leverage (debt ratios) corresponds to lower returns on assets, ceteris paribus. This finding aligns with the Trade-Off Theory of capital structure, which acknowledges a balance between the tax benefits of debt and the increased financial distress costs it brings (Myers, 1984). While moderate levels of debt can be beneficial (due to tax shields on interest), excessive debt elevates interest obligations and bankruptcy risk, thereby eroding profitability (Myers, 1984).

Empirical results showed that both short-term and long-term debt have a significant negative relationship with financial performance, indicating that increased leverage reduces a company's financial performance. Other studies have also found a negative relationship between leverage and financial performance, showing that the higher the level of debt, the lower the ROI and ROA, as financial costs and risks increase (Alabdulkarim et al., 2024). Eftasari & Sarumpaet (2025) also found that higher leverage significantly reduces a company's financial performance. Theoretically, this can be explained by the fact that highly indebted companies face substantial interest costs and are bound by debt covenants that limit managerial flexibility, thereby reducing their ability to generate profits.

Conversely, Estiasih et al. (2024) discovered that leverage has a significant positive effect on corporate financial performance, indicating that the productive use of debt can increase returns for shareholders. However, it should be noted that the positive effect of leverage generally occurs only at moderate levels of debt and when managed effectively. Wibowo & Tahwin (2024) did not find a significant effect of leverage on the financial performance of coal mining companies, showing that the impact of leverage can vary depending on company-specific conditions.

In summary, the negative impact of leverage on performance serves as a caution that aggressive debt strategies can harm profitability. While debt can be a useful tool for financing expansion, companies must be wary of over-leveraging. Maintaining an optimal leverage level—where the marginal benefit of debt equals its marginal cost—is crucial for sustaining financial performance.

Effect of Firm Size on Financial Performance

The analysis revealed that firm size has a positive and significant effect on financial performance. Larger companies often have advantages in terms of economies of scale, more extensive resources, and a larger market segment, which can improve operational efficiency and profit margins. For example, Amalia (2021) found that firm size is positively related to financial performance, based on the assumption that larger firms are able to generate greater profits. Similarly, Wulandari & Suwarno (2024) reported that larger companies tend to have competitive advantages and operational efficiencies, which enhance their financial performance. Larger companies may have better access to funding, large-scale operations, and integrated infrastructure, all of which contribute to improved financial outcomes.

However, the relationship between firm size and financial performance is not consistently positive. Several studies highlight the potential weaknesses associated with excessive size. Wibowo & Tahwin (2024) found that firm size has an insignificant negative relationship with financial performance. They argued that, beyond a certain point, an increase in size could lead to bureaucratic inefficiencies and diminishing returns. Large companies may have more complex organizational structures and higher agency costs, which can erode operational effectiveness. In addition, macroeconomic factors such as commodity price fluctuations tend to affect all companies equally, regardless of their size, particularly in industries such as coal mining. Mabruroh & Anwar (2022) reported that firm size is negatively related to performance in mining and agricultural companies, arguing that large firms may face operational inflexibility and high fixed costs, which

smaller and more agile firms can avoid. This suggests that while scale offers advantages, large companies must manage their size carefully—without efficient management, a larger scale can sometimes reduce profitability.

Moderating Effect of Firm Size on Green Intellectual Capital and Financial Performance

The regression analysis indicated that the interaction between green intellectual capital and firm size was not statistically significant. In practical terms, these results imply that the data do not provide evidence that the impact of green intellectual capital on financial performance differs between large and small companies. This finding is supported by several prior studies. For example, Suhadi (2024) found that firm size does not moderate the relationship between green intellectual capital and financial performance. The results of this study suggest that firm size, at least within the context of this industry, acts more as an independent factor rather than a conditional one affecting the relationship between green intellectual capital and financial performance. Large and small companies in the coal energy sector appear to benefit equally, or even disproportionately, from green intellectual capital.

On the other hand, context matters. For example, Kurniawan & Muharam (2021) reported that large companies were able to utilize green intellectual capital more effectively to improve performance compared to smaller firms. They argue that large companies possess greater infrastructure, funding, and human resources to translate GIC into tangible financial gains—such as investing in environmentally friendly innovation projects or promoting their sustainability strengths—something smaller companies may find more difficult. Large firms can spread the fixed costs of green initiatives over a broader operational base and often have better access to expertise and technology, which increases the potential gains from green intellectual assets.

In this study, the insignificant moderating role of firm size was likely due to the relatively homogeneous characteristics of the sample and the particular phase of the coal industry, which experienced a commodity boom during the study period. Therefore, firm size did not emerge as a significant differentiating factor. From a practical perspective, these results suggest that both large and small companies in the energy sector must continue to enhance their Green Intellectual Capital. For large companies, size does not automatically ensure more effective Green Intellectual Capital, nor should small companies assume that limited size prevents them from benefiting from it. In summary, every company must optimize its Green Intellectual Capital according to its own capacity. Management policies should be tailored to each firm's internal and external conditions rather than relying on a "one-size-fits-all" strategy. By focusing on these fundamental factors, companies can aim to improve financial performance sustainably, regardless of their size.

Moderating Effect of Firm Size on Leverage and Financial Performance

This study did not find significant moderation by firm size in the relationship between leverage and financial performance. This indicates that the negative impact of high leverage on financial performance is evident in both large and small companies without significant differences. The findings of this study are consistent with those of Yudhanto et al. (2025), who reported that firm size is not a moderating factor in the leverage–performance relationship. According to their study, high leverage harms company performance regardless of size—if debt is poorly managed,

profits will fall in any case. When a company's leverage exceeds its capacity, it faces financial pressure whether it is large or small.

Nevertheless, some literature presents differing perspectives. Several studies indicate that large companies can better manage high leverage, thereby reducing its negative impact. Alabdulkarim et al. (2024) found that in the banking sector, firm size mitigates the adverse effect of leverage on financial performance. Larger companies possess more assets as collateral, broader access to capital markets at lower costs, and more diversified business portfolios—all of which help absorb or spread debt risk. Larger firms may also be able to withstand losses longer or avoid bankruptcy under high debt conditions. However, in terms of annual financial performance, both large and small firms can experience declines if leverage is excessive. Therefore, maintaining prudent financial practices—such as keeping debt ratios within reasonable limits, using debt primarily for clear growth opportunities, and diversifying funding sources—is essential. Company size should not serve as a license to borrow excessively; even though larger companies may manage debt more effectively, high leverage almost always reduces financial performance.

CONCLUSION

This study investigates the influence of Green Intellectual Capital and leverage on the financial performance of Indonesian coal energy companies from 2020–2024, with firm size as a moderating factor. The results indicate that Green Intellectual Capital did not have a significant impact on financial performance, whereas leverage had a significant negative effect, corroborating the notion that excessive debt can erode profitability. Firm size showed a significant positive association with financial performance, meaning that larger firms generally achieved better financial outcomes than smaller ones. However, no significant moderating effect of firm size was found on the relationships between Green Intellectual Capital or leverage and performance, suggesting that the impacts of Green Intellectual Capital and leverage persist similarly across different company sizes.

These findings have important implications for corporate management and financial strategy. In practice, the absence of a direct performance boost from Green Intellectual Capital implies that sustainability-oriented knowledge and innovations must be integrated into the core business strategy and operations to yield financial benefits, rather than being pursued in isolation. At the same time, the negative influence of leverage underscores the importance of prudent debt management in safeguarding profitability. Overall, the study's findings highlight the need for integrated management strategies that align the development of green intellectual capital with financial planning and leverage control, thereby enabling firms to pursue environmental sustainability goals while maintaining and enhancing their financial performance.

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