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The Impact of Green Intellectual Capital on Firm Performance: The Moderating Role of the ESG Governance Pillar

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Abstract

This study investigates the impact of green intellectual capital (GIC) on firm performance and the moderating role of the ESG governance pillar. Using an unbalanced panel of 183 firm-year observations from companies listed on the Indonesia Stock Exchange over 2020–2024, the study employs moderated regression analysis (MRA). Firm performance is proxied by return on assets (ROA), and governance quality is measured using Bloomberg ESG governance pillar scores. The findings reveal that aggregate GIC significantly enhances firm performance, supporting the resource-based view (RBV) that green intangible assets are critical drivers of competitive advantage. Supplementary analysis further confirms that green human, structural, and relational capital independently boost profitability. However, contrary to expectations, the governance pillar negatively moderates the GIC-performance nexus. This counterintuitive finding extends agency theory by suggesting that overly rigid monitoring mechanisms induce high compliance costs, bureaucratic friction, and managerial risk aversion, thereby temporarily dampening the financial benefits of green innovation. Ultimately, this study advises corporate executives and policymakers to design flexible, collaborative oversight frameworks that foster environmental proactivity without stifling strategic agility.

Keywords green intellectual capital, firm performance, governance pillar, resource-based view, agency theory.

1. Introduction

In recent decades, escalating global climate change and environmental degradation have fundamentally reshaped the strategic landscape of corporate operations (Astuti & Ahmar, 2025; Cek & Kalmaz, 2025). Modern enterprises are no longer evaluated solely on their capacity to generate financial returns; instead, they face mounting pressure from diverse stakeholders to integrate sustainable practices and green technology innovations into their core business models (Anser et al., 2024; Astuti & Ahmar, 2025). This shift is particularly critical for emerging economies undergoing rapid industrialization, where the pursuit of economic expansion frequently collides with severe ecological consequences (Anser et al., 2024; Cek & Kalmaz, 2025). In Indonesia, the urgency of this transition is underscored by the country's status as the eighth-largest global emitter of greenhouse gases, producing approximately 1.3 gigatons of CO_2 equivalent annually (Sumiati & Isnaini, 2024). Consequently, companies listed on the Indonesia Stock Exchange (IDX) are increasingly compelled to adopt eco-friendly technological innovations and sustainable corporate frameworks to ensure long-term resilience (Astuti & Ahmar, 2025; Sumiati & Isnaini, 2024).

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To navigate this environmental transition, organizations rely heavily on a specialized set of intangible assets known as green intellectual capital (GIC) (Chen, 2008; Sumiati & Isnaini, 2024). Unlike physical resources, GIC encapsulates the collective environmental knowledge, innovative capabilities, and sustainable practices embedded at both the individual and organizational levels (Chen, 2008; Xu et al., 2019). It comprises three interrelated dimensions: green human capital, which captures the environmental expertise and commitment of the workforce; green structural capital, which embodies the internal systems, databases, and technological infrastructure that facilitate sustainable initiatives; and green relational capital, which reflects collaborative networks with suppliers, consumers, and regulators aimed at shared environmental objectives (Chen, 2008; Sumiati & Isnaini, 2024; Xu et al., 2019). Collectively, these components drive a firm's capacity to initiate eco-friendly operations and sustain green technological advancement.

The theoretical foundation connecting these intangible assets to corporate outcomes is rooted in the resource-based view (RBV) of the firm (Barney, 1991; Wernerfelt, 1984), which holds that sustained competitive advantage stems from resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). GIC embodies such strategic assets, as the accumulation of specialized green knowledge, collaborative stakeholder networks, and eco-friendly infrastructure cannot be easily replicated by competitors (Chen, 2008; Yusliza et al., 2020). Leveraging this proprietary environmental knowledge enables organizations to optimize resource utilization, drive green process innovation, and differentiate their market offerings (Astuti & Ahmar, 2025; Kumar et al., 2025). Consequently, the strategic deployment of GIC should translate into superior firm performance (Sumiati & Isnaini, 2024; Yusliza et al., 2020).

Despite these theoretical assertions, empirical evidence on the impact of GIC on corporate financial outcomes remains fragmented and inconclusive (Pramesti et al., 2024; Sumiati & Isnaini, 2024). While some studies advocate a direct positive relationship, a growing body of literature indicates that investments in environmental knowledge and green assets do not consistently translate into financial success or enhanced corporate value (Sukirman & Dianawati, 2023; Sumiati & Isnaini, 2024). In the Indonesian capital market, for instance, GIC evaluated in isolation often fails to exert a significant influence on profitability or market valuation (Pramesti et al., 2024; Sumiati & Isnaini, 2024). This inconsistency exposes a critical gap in the literature, suggesting that the mere possession of green intellectual assets is insufficient to guarantee superior financial outcomes (Doni & Fiameni, 2024; Sukirman & Dianawati, 2023). Researchers therefore argue that robust execution and monitoring mechanisms are required to ensure that green investments are converted into economic benefits rather than becoming sunk costs (Pramesti et al., 2024; Sukirman & Dianawati, 2023).

This discrepancy can be understood through the lens of agency theory (Jensen & Meckling, 1976). The separation of ownership and managerial control generates conflicts of interest in which managers may prioritize personal agendas over shareholders' wealth maximization. In environmental initiatives, executives might allocate corporate resources to green technologies and intellectual assets primarily to build a positive personal reputation, pursue social perquisites, or engage in superficial greenwashing. Without stringent oversight, such

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opportunistic behavior gives rise to substantial agency costs, which erode the firm's financial health and nullify the potential economic benefits of GIC investments.

To mitigate these agency costs and align managerial actions with shareholder wealth, robust oversight mechanisms are imperative (Hamdan et al., 2017). This study therefore introduces the governance pillar, a critical component of the environmental, social, and governance (ESG) framework, as a moderating variable. Effective corporate governance acts as a monitoring tool that minimizes agency costs and ensures that capital allocated to green technologies is efficiently executed rather than squandered on opportunistic behavior (Hamdan et al., 2017; Pramesti et al., 2024). Consequently, a robust governance structure is hypothesized to strengthen the conversion of green intellectual assets into financial performance (Adiwardhana et al., 2025; Hamdan et al., 2017).

This moderated framework is tested on companies listed on the IDX during 2020–2024 (Pramesti et al., 2024; Sumiati & Isnaini, 2024). The Indonesian capital market is a relevant setting given the intensifying regulatory mandates for sustainability reporting and the urgent need to address high-emission industrial practices (Astuti & Ahmar, 2025; Sumiati & Isnaini, 2024). Furthermore, to provide granular managerial insights, this study disaggregates GIC into green human, structural, and relational capital to identify which specific green asset serves as the primary driver of performance (Kumar et al., 2025; Sun et al., 2025).

Accordingly, this research empirically examines the moderating effect of the governance pillar on the relationship between GIC and firm performance, while controlling for firm size and leverage. By combining the resource-based view with agency theory, this article offers a theoretical contribution toward resolving the prevailing empirical inconsistencies. From a practical standpoint, the findings provide strategic guidance for investors and corporate executives in emerging markets on how governance structures shape the value created by green intellectual assets (Cek & Kalmaz, 2025; Sumiati & Isnaini, 2024).

2. Literature Review

Resource-based view. The resource-based view (RBV) is a preeminent theoretical framework in strategic management for explaining how organizations achieve and sustain competitive advantage (Barney, 1991; Wernerfelt, 1984). The theory shifts the strategic focus from external market structures to the internal bundle of resources and capabilities controlled by a firm. According to Barney (1991), a sustainable competitive edge requires more than resource ownership: resources must be valuable, rare, inimitable, and non-substitutable (VRIN). When an enterprise successfully accumulates and orchestrates VRIN assets, it establishes a market position that rivals cannot easily duplicate or substitute, laying the groundwork for superior long-term performance (Barney, 1991). In the contemporary business landscape, tangible physical assets are increasingly insufficient to maintain market leadership, elevating the strategic importance of intangible assets (Chen, 2008; Yusliza et al., 2020). In the context of corporate sustainability, ecological knowledge and green innovation capabilities, collectively conceptualized as GIC, embody the VRIN characteristics (Chen, 2008). Unlike conventional machinery, specialized environmental expertise and a sustainable organizational culture are

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deeply embedded within the firm's structure, making them difficult for competitors to imitate or acquire from open markets (Yusliza et al., 2020). Hence, the RBV suggests that the continuous cultivation and strategic deployment of green intangible assets are critical for navigating stringent environmental regulations while driving long-term value creation (Chen, 2008; Yusliza et al., 2020).

Agency theory. Agency theory, established by the seminal work of Jensen and Meckling (1976), provides a critical lens for understanding conflicts of interest within modern corporate structures. The theory posits that the separation of ownership (principals) and control (agents) generates information asymmetry and divergent objectives (Jensen & Meckling, 1976). Because managers are rational utility maximizers, they may not consistently act in shareholders' best interests and might instead appropriate corporate resources for personal perquisites, prestige, or other self-serving strategies (Hamdan et al., 2017; Jensen & Meckling, 1976). This principal-agent divergence gives rise to agency costs, comprising monitoring expenditures, bonding costs, and residual losses, which can significantly erode firm value if left unmitigated (Jensen & Meckling, 1976). In pursuing environmental innovation, executives might overinvest in green intellectual assets or engage in superficial greenwashing primarily to cultivate a favourable personal reputation among external stakeholders rather than to improve operational efficiency. Such misallocation exacerbates agency costs, as the capital spent on these green agendas often fails to yield proportionate economic returns for shareholders (Jensen & Meckling, 1976). This perspective underscores the necessity of robust governance and monitoring mechanisms to ensure that the deployment of green assets is aligned with long-term wealth maximization rather than opportunistic managerial self-interest (Hamdan et al., 2017).

Firm performance. Firm performance is widely recognized as the central barometer of organizational success, reflecting management's efficacy in deploying strategic resources to generate economic value and maximize shareholder wealth (Pramesti et al., 2024). In the corporate finance and strategic management literature, this multidimensional construct is typically evaluated through accounting-based metrics and market-based valuations (Pramesti et al., 2024; Sumiati & Isnaini, 2024). Accounting measures such as return on assets (ROA) provide a retrospective assessment of how efficiently an enterprise converts its tangible and intangible asset base into net income, whereas market-based indicators capture investor expectations regarding future growth potential and competitive standing (Pramesti et al., 2024; Sumiati & Isnaini, 2024). However, the evaluation of firm performance has evolved beyond conventional short-term financial metrics (Sumiati & Isnaini, 2024). Investors and stakeholders increasingly assess corporate success through the lens of long-term resilience, scrutinizing a firm's capacity to integrate environmental and social sustainability initiatives into tangible economic returns (Sukirman & Dianawati, 2023; Sumiati & Isnaini, 2024). Superior performance is therefore characterized by an organization's ability to translate eco-friendly practices, technological adaptability, and responsible resource management into sustained financial health, linking enduring financial viability to a firm's proactive response to environmental demands (Sukirman & Dianawati, 2023; Sumiati & Isnaini, 2024).

Green intellectual capital. The concept of green intellectual capital (GIC), pioneered by Chen

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(2008), represents a specialized evolution of traditional intellectual capital tailored to modern environmental challenges. GIC is defined as the total stock of intangible assets, knowledge, capabilities, and relationships directed toward environmental protection and green innovation at both the individual and organizational levels (Chen, 2008; Xu et al., 2019). The construct is disaggregated into three dimensions (Chen, 2008; Xu et al., 2019): green human capital encompasses employees' environmental competencies, skills, and commitment; green structural capital involves the organizational capabilities, management systems, and technological infrastructure that support ecological initiatives; and green relational capital pertains to partnerships with external stakeholders, such as suppliers, customers, and regulators, that foster collaborative environmental management (Xu et al., 2019). In practice, GIC is a vital catalyst for technological innovation, particularly for enterprises in high-emission and heavily scrutinized industries (Sun et al., 2025; Xu et al., 2019). By leveraging accumulated green intangible assets, organizations can transition from resource-intensive operations toward advanced eco-friendly processes (Sun et al., 2025; Xu et al., 2019). This intellectual foundation facilitates the continuous development of green products and sustainable manufacturing techniques and equips firms with the agility to respond proactively to stringent environmental regulations and societal pressures (Sun et al., 2025). Robust green intellectual capabilities thus allow companies to satisfy the demands of an environmentally conscious market and transform ecological compliance into competitive advantage (Sun et al., 2025; Xu et al., 2019).

Governance pillar. The governance pillar is a fundamental component of the environmental, social, and governance (ESG) framework, functioning as the structural backbone that dictates how a corporate entity is directed and controlled (Cek & Kalmaz, 2025). ESG-based governance transcends traditional compliance by incorporating rigorous oversight mechanisms, high standards of transparency, board independence, and management accountability toward shareholders and other stakeholders (Adiwardhana et al., 2025; Cek & Kalmaz, 2025). This pillar establishes the ethical and operational protocols that guide executive decision-making, ensuring that strategic issues, including environmental stewardship and technological transformation, are addressed with integrity and a commitment to long-term sustainability (Adiwardhana et al., 2025). Functionally, the governance pillar serves as a risk-mitigation instrument designed to constrain managerial opportunism and safeguard corporate resources (Hamdan et al., 2017; Pramesti et al., 2024). By enforcing stringent monitoring systems, it ensures that strategic investments, particularly substantial capital allocations to green technologies and environmental initiatives, comply with evolving regulatory standards and align with shareholders' long-term wealth maximization (Doni & Fiameni, 2024; Hamdan et al., 2017). Resilient corporate governance thereby prevents the misuse of ecological agendas for superficial greenwashing and helps ensure that investments in green intellectual assets are translated into operational efficiency and sustained economic value (Pramesti et al., 2024).

Anchored in the RBV, this study postulates that GIC is a critical driver of corporate financial success (Barney, 1991; Chen, 2008). Enduring competitive advantage is achieved by accumulating resources that meet the VRIN criteria (Barney, 1991), and GIC epitomizes these characteristics because the combination of employees' environmental expertise, sustainable

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organizational infrastructure, and collaborative stakeholder networks cannot be readily replicated or acquired by competitors (Chen, 2008). By leveraging this proprietary ecological knowledge, firms can optimize resource consumption, stimulate green product innovation, and achieve superior process efficiency (Astuti & Ahmar, 2025; Sumiati & Isnaini, 2024). These operational enhancements translate into cost reductions and market differentiation, which ultimately improve financial performance (Barney, 1991; Sumiati & Isnaini, 2024).

Recent empirical studies corroborate this reasoning, reporting a positive nexus between green intangible assets and corporate valuation (Astuti & Ahmar, 2025; Kumar et al., 2025). Organizations that continuously develop their green human, structural, and relational capital are better positioned to capture emerging market opportunities and sustain long-term profitability (Kumar et al., 2025; Yusliza et al., 2020). In high-emission industries, the proactive accumulation of GIC not only mitigates environmental compliance risks but also signals a credible sustainability commitment to prospective investors, thereby elevating market valuation (Astuti & Ahmar, 2025). Accordingly, a higher accumulation of green intellectual assets is expected to yield superior financial outcomes, and the following hypothesis is proposed:

H1: Green intellectual capital has a positive and significant effect on firm performance.

While the RBV provides a compelling rationale for the strategic benefits of green assets, agency theory elucidates the vulnerabilities inherent in their execution (Jensen & Meckling, 1976). Deploying GIC requires substantial financial investment and long-term commitment, creating fertile ground for principal-agent conflicts (Hamdan et al., 2017; Jensen & Meckling, 1976). Without stringent oversight, executives might exploit environmental initiatives to cultivate personal prestige or engage in superficial greenwashing rather than genuinely improving corporate efficiency (Jensen & Meckling, 1976). Such self-serving behavior inflates agency costs, neutralizing the economic advantages of green innovation and explaining why GIC does not universally guarantee profitability (Hamdan et al., 2017). A robust monitoring mechanism is therefore essential to align managerial actions with shareholder wealth maximization (Jensen & Meckling, 1976).

Within this framework, the governance pillar serves as the moderating mechanism that bridges green intellectual investments and tangible financial outcomes (Adiwardhana et al., 2025; Cek & Kalmaz, 2025). A resilient governance structure establishes rigorous transparency protocols, independent board oversight, and strict executive accountability, effectively constraining managerial opportunism (Pramesti et al., 2024). Under high governance standards, executive decisions on deploying green human, structural, and relational capital are scrutinized to ensure that they yield genuine operational efficiencies rather than serving as public relations expenditures (Hamdan et al., 2017; Pramesti et al., 2024). By suppressing agency costs, superior ESG-based governance should strengthen the conversion of intangible environmental assets into firm value (Adiwardhana et al., 2025). Hence, the following hypothesis is proposed:

H2: The governance pillar positively moderates the relationship between green intellectual capital and firm performance.

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The research model summarizing both hypotheses is presented in Figure 1.

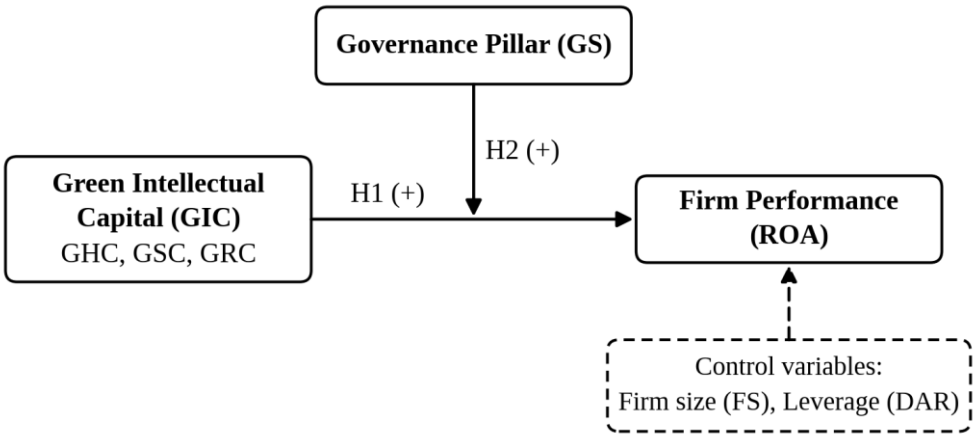

Figure 1. Research model

3. Research Method

Data and sample. This research uses secondary data extracted from the annual reports, sustainability reports, and financial databases of companies listed on the Indonesia Stock Exchange (IDX) over a five-year observation period from 2020 to 2024. A purposive sampling technique was employed to ensure the robustness and relevance of the dataset, with the following criteria: (1) the company was listed on the IDX throughout the observation period, and (2) its Bloomberg governance pillar score was available. Applying these criteria results in an unbalanced panel dataset of 183 firm-year observations, accommodating companies that meet the required disclosures in different years of observation.

Variable measurement. The variables are operationalized based on established empirical frameworks. The dependent variable, firm performance, is proxied by return on assets (ROA), a widely accepted accounting-based metric calculated as net income divided by total assets, which reflects management's efficiency in using corporate assets to generate profit. The primary independent variable, green intellectual capital (GIC), is operationalized as a multidimensional construct comprising three components: green human capital (GHC), green structural capital (GSC), and green relational capital (GRC). The governance pillar (GS) is used as the moderating variable to capture the effect of corporate oversight. It is measured using the annual governance pillar scores retrieved from the Bloomberg ESG database, which evaluate the strength of a firm's internal controls, board independence, and executive accountability. Finally, to control for intrinsic firm characteristics, this study includes two control variables: firm size (FS), calculated as the natural logarithm of total assets, and leverage (DAR), measured by the debt-to-asset ratio, i.e., total debt divided by total assets.

Data analysis. To test the hypotheses, this study employs moderated regression analysis (MRA) within a panel data framework. MRA investigates whether the governance pillar alters the strength or direction of the relationship between GIC and firm performance. By incorporating

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an interaction term, this method identifies the moderating effect while controlling for the potential confounding influences of firm size and leverage. The empirical model is specified as follows:

$$ROA_{it} = \alpha + \beta_1 GIC_{it} + \beta_2 GS_{it} + \beta_3 (GIC_{it} \times GS_{it}) + \beta_4 FS_{it} + \beta_5 DAR_{it} + \varepsilon_{it}$$

where ROA_{it} represents the performance of firm i in year t, GIC_{it} denotes aggregate green intellectual capital, GS_{it} is the governance pillar score, and the product term ($GIC_{it} \times GS_{it}$) captures the interaction between GIC and governance quality. FS_{it} and DAR_{it} are control variables for firm-specific characteristics, and ε_{it} is the error term. The coefficient β_3 is the primary parameter of interest; a statistically significant β_3 confirms the moderating role of the governance pillar in the GIC-performance nexus. All estimations are conducted using panel regression analysis to account for both cross-sectional and temporal variation in the dataset.

4. Finding and Discussion

Descriptive statistics. Table 1 outlines the descriptive statistics for all variables, encompassing 183 firm-year observations from companies listed on the IDX. The dependent variable, firm performance (ROA), exhibits a mean value of 0.064, indicating that, on average, the sampled companies generated a return of 6.4% on their total assets. ROA ranges from a minimum of -0.171 to a maximum of 0.310. This considerable spread, including negative profitability, reflects the highly competitive and volatile operating environment in emerging markets, where some firms face financial distress while others achieve significant wealth creation. The moderating variable, the governance pillar (GS), demonstrates a strong average score of 80.625 with a standard deviation of 10.370. Ranging from 48.374 to 96.809, this relatively high mean suggests that most of the sampled Indonesian firms have begun adopting robust ESG governance frameworks and internal monitoring mechanisms, driven by increasing regulatory and stakeholder demands for corporate transparency (Cek & Kalmaz, 2025). Furthermore, the control variables indicate that the sample consists of relatively large enterprises (mean FS of 31.433) operating with moderate financial leverage, as evidenced by the mean DAR of 0.482, meaning that approximately 48.2% of their assets are financed through debt.

The aggregate GIC exhibits a mean of 42,724.976 with a very large standard deviation of 28,930.985. The wide gap between the minimum (236.660) and maximum (166,495.297) values confirms that environmental knowledge and green capabilities are highly heterogeneous and not uniformly distributed across organizations (Barney, 1991; Chen, 2008). Some firms act as aggressive pioneers in accumulating green assets, while others lag significantly. Disaggregating GIC reveals that green relational capital (GRC) is the most dominant dimension, with the highest mean of 16,803.404. This indicates that Indonesian companies primarily prioritize building external green networks, such as sustainable supplier partnerships and community relations, to secure institutional legitimacy and fulfill immediate stakeholder expectations. In contrast, green structural capital (GSC) and green human capital (GHC) record lower means of 13,328.476 and 12,593.098, respectively. This disparity suggests that while firms are rapidly expanding their external green relations, the internal development of green technological infrastructure and specialized employee environmental competencies is still in a

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developing, yet critical, phase (Xu et al., 2019).

Table 1. Descriptive statistics

Variable	Obs	Mean	STD	Median	Minimum	Maximum
ROA	183	0.064	0.078	0.052	-0.171	0.310
GIC	183	42724.976	28930.985	36105.648	236.660	166495.297
GSC	183	13328.476	8678.295	11109.150	125.420	48537.262
GHC	183	12593.098	8651.863	10361.320	62.710	44725.352
GRC	183	16803.404	11879.687	14341.470	48.520	73232.727
GS	183	80.625	10.370	83.594	48.374	96.809
FS	183	31.433	0.958	31.390	28.990	33.787
DAR	183	0.482	0.214	0.479	0.081	0.995

(Source: Research data, 2026)

Pearson correlation. Table 2 presents the Pearson correlation matrix, which illustrates the initial bivariate relationships among the variables prior to the multivariate regression. The matrix reveals a positive but statistically insignificant correlation between GIC and ROA (0.073, $p = 0.325$). This preliminary finding implies that the mere accumulation of green assets does not automatically guarantee immediate profitability. Furthermore, the governance pillar (GS) demonstrates a positive and highly significant correlation with GIC (0.215, $p < 0.01$), indicating that companies with superior governance frameworks are more inclined to invest in and accumulate green intellectual assets (Cek & Kalmaz, 2025). Interestingly, the bivariate relationship between GS and ROA shows a weak negative correlation (-0.123, $p < 0.1$), suggesting that the stringent implementation of ESG compliance and monitoring structures may incur short-term operational expenditures that temporarily depress accounting returns.

Table 2. Pearson correlation

Variable	ROA	GIC	GS	FS	DAR
ROA	1.000				
GIC	0.073 (0.325)	1.000			
GS	-0.123* (0.098)	0.215*** (0.003)	1.000		
FS	-0.307*** (0.000)	0.062 (0.407)	0.142* (0.055)	1.000	
DAR	-0.304*** (0.000)	0.079 (0.288)	0.084 (0.258)	0.231*** (0.002)	1.000

p-values in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. (Source: Research data, 2026)

Beyond revealing initial relationships, the correlation matrix screens for potential multicollinearity among the independent and control variables. Multicollinearity occurs when predictors are too highly correlated, which can distort regression coefficients, inflate standard

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errors, and invalidate hypothesis tests. The highest correlation among the predictors is between firm size (FS) and leverage (DAR) at 0.231, followed by that between GIC and GS at 0.215. All values remain well below the conventional threshold of 0.80, indicating that severe multicollinearity is not a concern and that the independent variables possess distinct explanatory power for the subsequent estimations.

Main regression. Table 3 presents the results of the panel regression analysis used to test the hypotheses. The full specification in column (3) explains 18.5% of the variance in firm performance (R^2 = 0.185). The control variables behave consistently across all three specifications: both firm size (FS) and leverage (DAR) have a negative and statistically significant effect on ROA, at least at the 5% level. This outcome indicates that, within the sampled companies, larger corporate structures may suffer from bureaucratic inefficiencies or diminishing marginal returns that dampen profitability, while heavy reliance on debt financing constrains net income through substantial interest burdens. Regarding the main effect, the regression output reveals that GIC exerts a positive and statistically significant influence on firm performance ($t = 1.995$, $p < 0.05$), supporting Hypothesis 1 (H1). From the resource-based view (RBV) perspective, this finding validates that intangible environmental assets function as critical VRIN (valuable, rare, inimitable, and non-substitutable) resources (Barney, 1991; Chen, 2008). The results confirm that by accumulating specialized green knowledge, establishing sustainable organizational infrastructure, and fostering external ecological networks, companies can optimize internal process efficiency and achieve distinct market differentiation. Ultimately, the strategic accumulation of green intellectual assets enables firms to translate complex ecological commitments into superior and sustainable financial returns (Mouritsen et al., 2004).

Table 3. Baseline regression

Variable	(1) ROA	(2) ROA	(3) ROA
GIC	0.000* (1.819)	0.000** (2.062)	0.000** (1.995)
GS		-0.001 (-1.259)	0.001 (0.677)
GIC × GS			-0.000* (-1.811)
FS	-0.021*** (-2.691)	-0.020** (-2.538)	-0.020** (-2.567)
DAR	-0.093*** (-2.692)	-0.091*** (-2.683)	-0.085** (-2.509)
Constant	0.750*** (3.195)	0.776*** (3.322)	0.654*** (2.867)
R^2	0.163	0.172	0.185
Adjusted R^2	0.149	0.153	0.162

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Variable	(1) ROA	(2) ROA	(3) ROA
F	11.955	9.561	8.717
N	183	183	183

t-statistics in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01. (Source: Research data, 2026)

Conversely, the interaction term between GIC and the governance pillar (GIC × GS) presents an intriguing and counterintuitive result. The coefficient is statistically significant (t = -1.811, p < 0.1) but negative, leading to the rejection of the proposed positive moderation in Hypothesis 2 (H2). Instead of amplifying the financial benefits, high governance scores weaken the positive impact of GIC on ROA. From an agency theory perspective, while governance mechanisms are designed to mitigate opportunistic behavior, overly stringent or rigid monitoring structures can inadvertently generate excessive compliance costs and bureaucratic friction (Asiaei et al., 2022; Jensen & Meckling, 1976). In the context of green innovation, intense governance scrutiny may push managers into risk aversion, transforming strategic green investments into box-ticking compliance exercises rather than agile, value-creating innovations (Sheikh, 2022). Consequently, the administrative burden and structural rigidity associated with maintaining top-tier ESG governance may temporarily offset the immediate economic gains from green intellectual assets, thereby dampening their overall profitability effect.

Additional analysis. To provide deeper managerial insights, an additional analysis was conducted by disaggregating GIC into its three dimensions: green structural capital (GSC), green human capital (GHC), and green relational capital (GRC). While the baseline regression establishes the overall importance of green assets, analyzing the components individually offers a more granular understanding of which types of ecological investment yield financial returns. Table 4 presents the regression outputs in which each dimension is tested separately against firm performance (ROA), retaining firm size (FS) and leverage (DAR) as control variables. Isolating these elements helps corporate executives identify the most effective pathways for resource allocation within their sustainability portfolios.

Table 4. Additional analysis

Variable	(1) ROA	(2) ROA	(3) ROA
GSC	0.000* (1.845)		
GHC		0.000* (1.756)	
GRC			0.000* (1.793)
FS	-0.021*** (-2.706)	-0.021*** (-2.721)	-0.021*** (-2.657)

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Variable	(1) ROA	(2) ROA	(3) ROA
DAR	-0.092*** (-2.678)	-0.093*** (-2.701)	-0.092*** (-2.692)
Constant	0.751*** (3.208)	0.760*** (3.225)	0.743*** (3.164)
R^2	0.163	0.164	0.162
Adjusted R^2	0.149	0.150	0.148
F	12.039	11.912	11.898
N	183	183	183

t-statistics in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01. (Source: Research data, 2026)

The results in Table 4 reveal that all three dimensions have a positive and statistically significant effect on firm performance. Specifically, green structural capital (t = 1.845, p < 0.1), green human capital (t = 1.756, p < 0.1), and green relational capital (t = 1.793, p < 0.1) uniformly drive profitability at the 10% significance level. From the RBV perspective, this consistent significance underscores that corporate sustainability is a holistic endeavor (Chen, 2008). GSC provides the technological infrastructure and eco-friendly databases necessary to streamline operations and reduce waste-related costs (Ghosh & Haque, 2023). Concurrently, GHC equips the workforce with the environmental competencies and awareness required to execute these structural innovations effectively (Jiang et al., 2026; Shahbaz & Malik, 2026). Finally, GRC leverages external partnerships with green suppliers and environmentally conscious consumers to enhance corporate reputation and secure market share (Agyabeng-Mensah & Tang, 2021; Xu et al., 2019). Rather than prioritizing a single aspect, firms should therefore cultivate a balanced portfolio of internal (GSC, GHC) and external (GRC) green intellectual assets to maximize their overall financial performance.

5. Conclusion

This study empirically investigates the impact of green intellectual capital (GIC) on firm performance and the moderating role of the governance pillar among publicly listed companies in Indonesia. The findings support the first hypothesis, confirming that the systematic accumulation of green intellectual assets significantly enhances corporate financial performance. However, in contrast to the anticipated moderating effect, stringent ESG governance structures exert a negative moderating influence. Rather than amplifying profitability, highly rigid governance frameworks appear to generate excessive compliance costs and administrative friction that temporarily dampen the immediate financial benefits of agile green innovations.

Theoretically, this research contributes to the sustainability literature by combining the resource-based view (RBV) with agency theory. The positive GIC-performance nexus reinforces the RBV, validating that intangible environmental knowledge, infrastructure, and networks are non-substitutable resources capable of driving enduring competitive advantage. Furthermore, the counterintuitive negative moderation introduces a nuance to agency theory in

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the context of environmental strategy: while oversight is necessary to mitigate managerial opportunism, hyper-vigilant or excessively rigid monitoring mechanisms can inadvertently induce managerial risk aversion. Such over-monitoring can stifle the dynamic execution of green initiatives, transforming them into burdensome compliance exercises rather than authentic, value-creating strategies.

From a practical perspective, the findings offer strategic guidance for corporate executives and policymakers. The supplementary analysis underscores that firms should not view green investments myopically; rather, they should allocate resources across a balanced portfolio of green structural, human, and relational capital to maximize operational efficiency and market reputation. Concurrently, board members and regulators should reevaluate their approach to ESG compliance. To prevent governance structures from becoming innovation bottlenecks, organizations should design more flexible, collaborative oversight mechanisms that foster environmental proactivity rather than forcing managers into mere administrative compliance.

This study has several limitations that provide avenues for future research. First, the sample is confined to a single emerging market, which may limit the generalizability of the findings to developed economies with mature environmental regulatory frameworks; future studies could expand the scope to the wider ASEAN market for cross-country comparative analyses. Second, this study relies exclusively on return on assets (ROA) as an accounting-based performance metric; subsequent research could incorporate market-based valuations, such as Tobin's Q, to capture forward-looking investor expectations regarding green assets. Finally, future studies might explore alternative moderating variables, such as green organizational culture, executive compensation structures, or digital transformation capabilities, to further unravel the dynamics of green intellectual investment.

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